ANNUAL REPORT 2021

RMK
ANNUAL REPORT
2021

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CERTIFICATES

RMK's goal is to manage the state forest economically and efficiently – in other words, sustainably. RMK has been awarded the sustainable forest management certificates FSC® (FSC-C022757) and PEFC™; RMK's management system has been found to meet ISO 14001 and ISO 9001 environmental and quality management standards.

RMK has held an FSC forest management and supply chain certificate since 2002. The validity of the certificate was extended in 2021 until 31 January 2027.

RMK was awarded a PEFC forest management and supply chain certificate in 2010, with the current certificate expiring on 28 November 2025.

The sustainable forest management certificates confirm that the economic, social, and ecological aspects of forest management are taken into account equally when managing forests. The fact that timber originating from state-owned forests has sustainable forest management certificates expands the sales market for many Estonian timber products. The certificates also confirm, among other things, that RMK's prescribed cuts will continue to remain sustainable in the future and that local communities will be involved in the planning of forest management activities.

Both systems are subject to annual audits, and recertification takes place at five-year intervals. Starting in 2021, RMK will be audited by the international auditing company BM Certification Estonia OÜ, with regard to matters relating to both FSC and PEFC certificates.

ISO 14001 is an environmental management system that helps to monitor and reduce the environmental impacts inevitably associated with the operation of any organisation. RMK has held an ISO 14001 certificate since 2002, and the current certificate is valid until the end of 2022.

The aim of the ISO 9001 quality management system is to ensure customer satisfaction, to set measurable objectives for the organisation, and to monitor their achievement. RMK obtained an ISO 9001 certificate in 2010 and, similarly to the ISO 14001 certificate, recertification is conducted every three years. The current certificate is valid until the end of 2022.

ISO systems are audited by Bureau Veritas Eesti OÜ.

PEFC™
PEFC/19-23-01

FSC®
www.fsc.org
FSC® C022757
The mark of responsible forestry

ISO 14001
ISO 9001

THE FOREST IS IMPORTANT. INCREASINGLY IMPORTANT!

The forest is growing. On the one hand, independent of us, while, on the other hand, being influenced by us. The manner and extent to which we understand and are able to use forest growth is a matter of social consensus. What is certain is that the work entrusted to RMK has been done with love and care.

RMK manages 45% of all forests in Estonia. We planted 24.5 million new trees there in 2021. We made sure that the young forest has good growing conditions and that today's middle-aged stands are able to grow old with dignity and in good health. We performed regeneration cutting on 1% of forest land, providing one-third of the wood used in Estonia. A lot of conservation work was also done – both on protected forest land (39.1% of our forest land) and elsewhere: bogs, meadows, and parks. We restored habitats that are of key importance to maintaining and promoting biodiversity, and contributed to the replenishment of Estonia's fish stocks. People took advantage of the forest holidays created by us on 2.9 million occasions; 46,000 children and young people got their first taste of nature through the educational programmes we provided. I am grateful to my 690 colleagues and at least 5500 other employees of partner companies who made all of this possible!

RMK has already been focused on climate change for some time. For the most part, this has meant adapting to increasingly extreme weather conditions. We carried out a carbon audit of our operations to assess our ability to tackle climate change. We assembled research and data on our forests and lands. We measured, weighed, modelled and determined the carbon stocks we currently have stored. We also determined the annual level of carbon sequestration by RMK's forests and other land, as well as how much our actions affect the climate. The result is a generously positive carbon footprint – one that helps offset a quarter of Estonia's total annual carbon emissions.

Aigar Kallas
Chairman of the Management Board of RMK

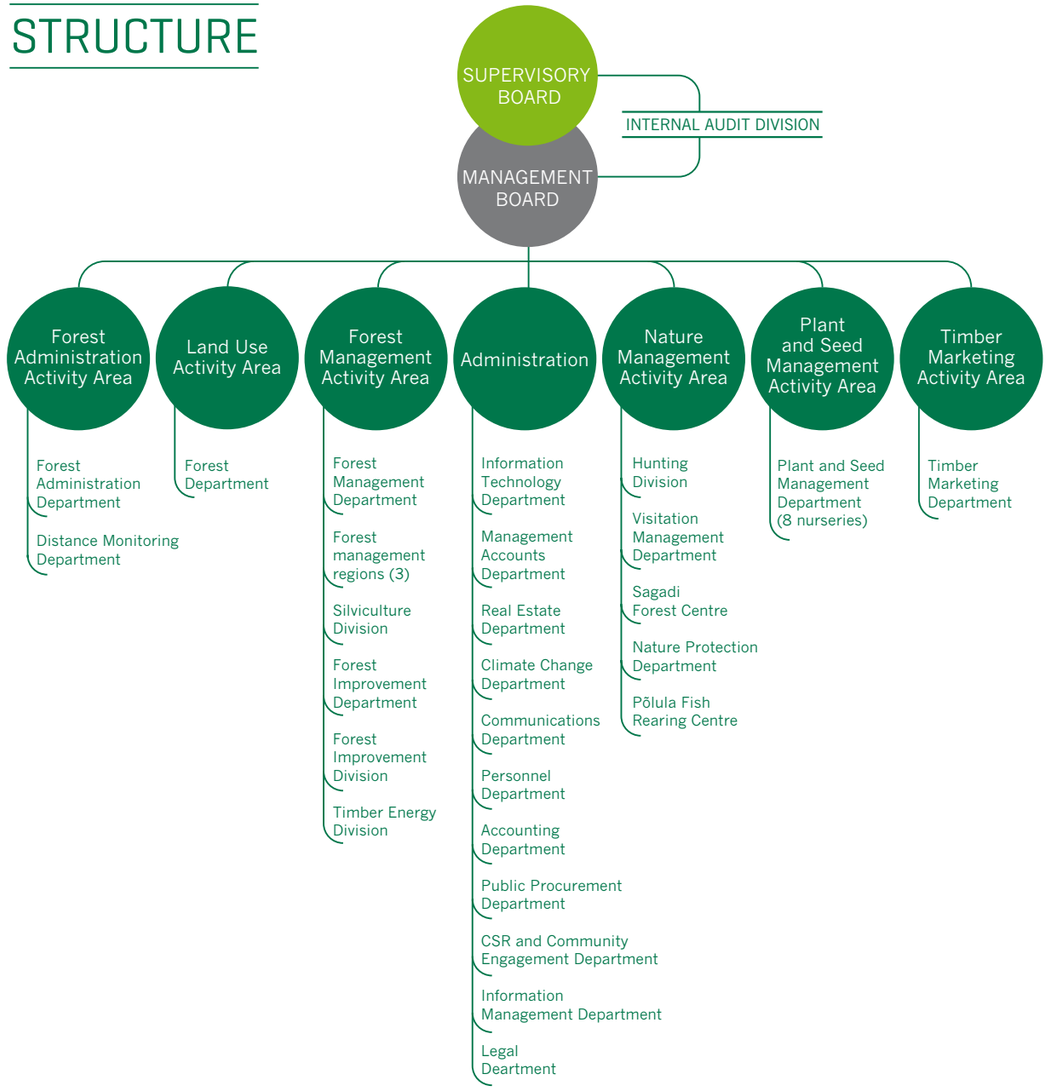
Of course, forests alone will not save the world. There is an undeniable need to invest in other renewable energy solutions, but the forest is what we have, and what continues to grow. When used wisely, it puts bread on the table, warms our homes, and captures large quantities of greenhouse gases in the atmosphere; not to mention the wide range of other benefits the forest offers.

Many of the faces of the forest are reflected in this yearbook. It is my hope that each reader will find something new here, while also being able to test their existing knowledge. Can you identify the buds of Estonian trees looking back at you from the following pages? The correct answers are given at the end of the annual report. Have a good read!

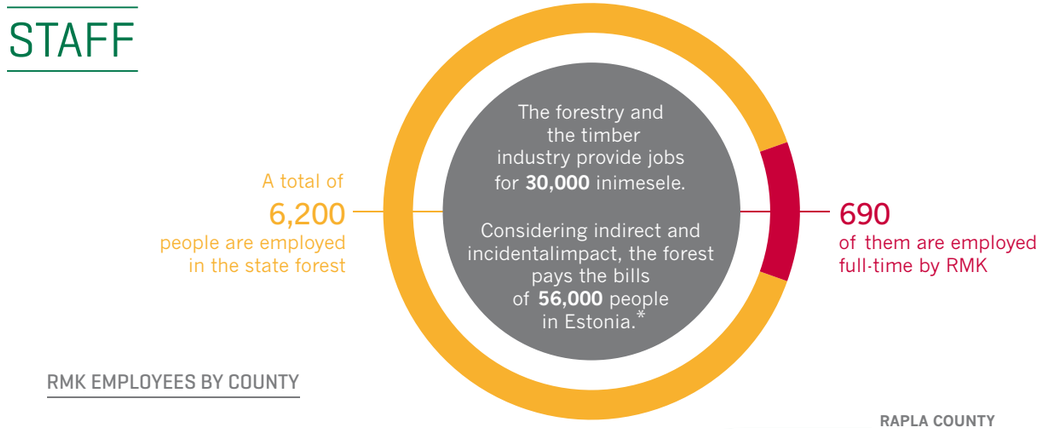
ABOUT THE ORGANISATION

State land managed by RMK ... of which forest land	1,428,644 ha 1,048,329 ha
Full-time employees	690
Turnover	EUR 221.3 million
Operating profit	EUR 84.4 million
Dividends and income tax paid into state budget	EUR 38.8 million
Labour taxes	EUR 7 million
Land tax	EUR 4.7 million

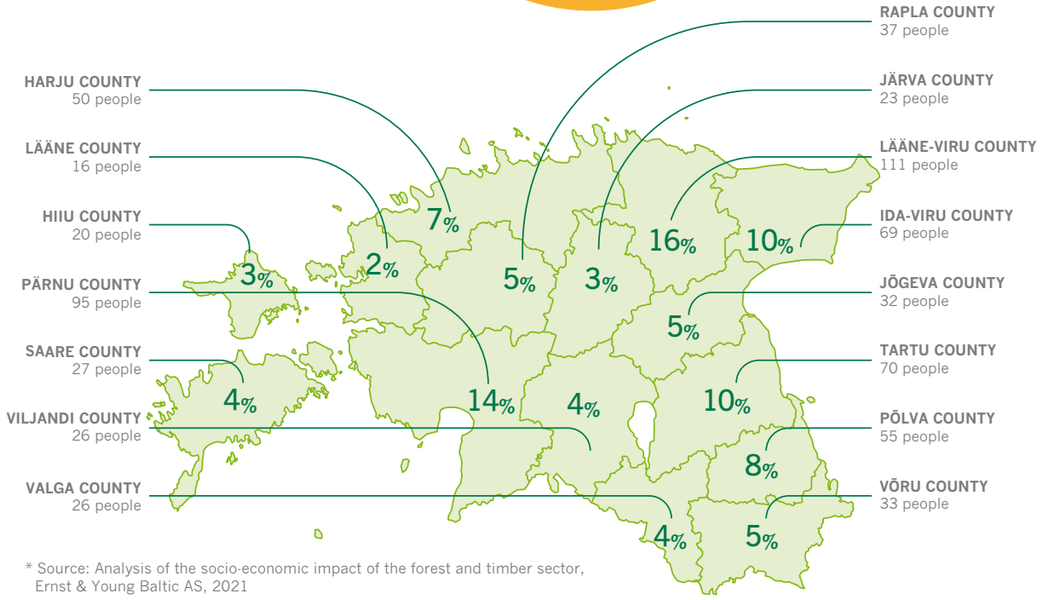
STRUCTURE



STAFF



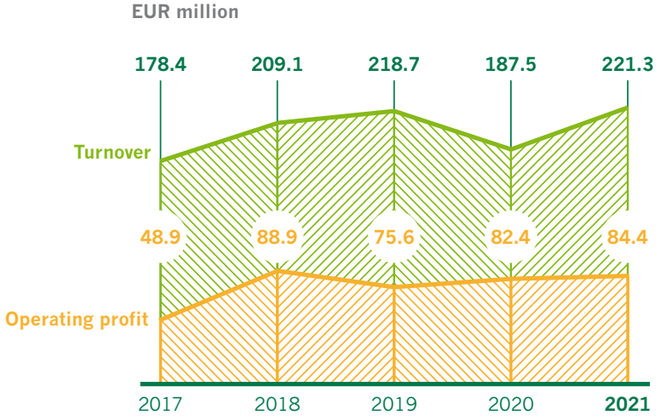
RMK EMPLOYEES BY COUNTY



* Source: Analysis of the socio-economic impact of the forest and timber sector, Ernst & Young Baltic AS, 2021

CONTRIBUTION TO THE ECONOMY

RMK's economic indicators (EUR million)	2017	2018	2019	2020	2021
Turnover	178.4	209.1	218.7	187.5	**221.3**
Operating profit	48.9	88.9	75.6	82.4	**84.4**
Dividends and income tax paid into state budget	28.1	26.9	51.4	80.7	**38.8**
Land tax	4.8	4.9	4.9	4.7	**4.7**
Labour taxes	6.9	6.6	7.1	7.2	**7.0**



COOPERATION PROJECTS

RMK participates in activities which help people better understand and move around in nature, to enhance the value of timber as a building material, and to honour the traditions of foresters and the heritage of ancient Estonians.

Forestry and timber use

- The Estonian Woodhouse Association held a professional contest for the builders of handcrafted log homes on Good Home Day, in Räpina, with RMK providing the timber.
- Under the auspices of the Estonian Forest Society and with the support of RMK, the xCUT Cup competition was held, demonstrating professional skills in logging. The series opened with the Tartu Cup, in June, followed at the end of July by the Estonian Logging Championship, in Järvselja, and the TOP 10 in Viljandi Castle Hills, in September.
- The non-profit association Emajõe Lodjaselts continued the construction of a two-masted Peipsi barge in the Barge Hall, which should be completed in time for Tartu becoming the European Capital of Culture in 2024. RMK supported the project with larch timber.
- The Valga Patriotic Exposition Foundation organised the 13th international Valga Military History Festival, which was supported by RMK with timber.
- Forestalia, the joint choir of foresters, continued its series of joint singing events with support from RMK.
- A total of 28 substitute homes and 14 hospitals across Estonia received a free Christmas tree from RMK.
- RMK supported the stage set of the play Estonian Funeral, at SA Vene Teater, with timber.
- With the support of RMK, anyone interested was able to receive an envelope from Lotte Village with tree seeds and instructions on how and where to sow the seeds.

Healthy living and visiting nature

- In compliance with Covid restrictions, RMK's Estonian Orienteering Days were held to promote opportunities for outdoor activities and healthy lifestyle. From spring to autumn, 254 day races took place, with 5024 amateurs making 40,596 starts.

Environmental and nature conservation

- More than 40 photographers once again took part in the Bloodless Hunt, with Enel Lepik being voted the winner for the photo "Nutcracker", depicting a squirrel flying from one tree to another. For the first time, an exhibition of the best photos was displayed outdoors, in the courtyard of the Forest House.
- RMK offered prizes at the photography contest Looduse Aasta Foto.
- RMK supplied firewood to the non-profit association Estonian Union for Child Welfare camps at Remniku and organised nature study programmes for campers.

FOREST MANAGEMENT

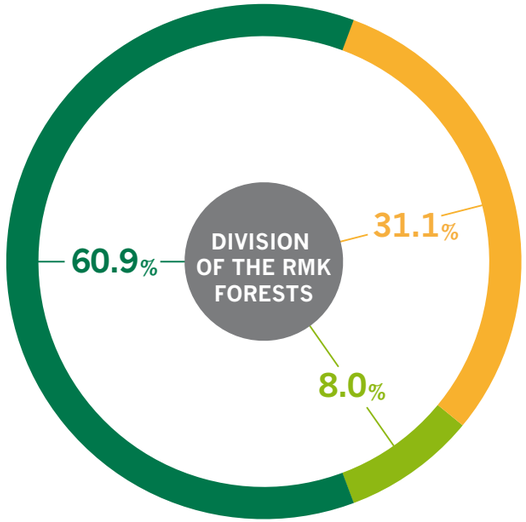
State forest surplus	197 million m^3
Renewed forest area	13,100 ha
New forest plants	24.5 million
Maintained young forest	40,700 ha
Thinning	7,900 ha
Regeneration cutting	11,200 ha
Timber sold	3.8 million m^3
Revenue from the sale of timber	EUR 218.8 million

OVERVIEW OF FORESTS

Division of the RMK forests (%)	2017	2018	2019	2020	2021
Strictly protected forests	25.3	28.6	29.1	30.2	**31.1**
Forests with economic limitations	11.0	7.6	7.1	8.2	**8.0**
Managed forests	63.7	63.8	63.8	61.6	**60.9**

Managed forest

Economic activity is permitted in these forests. Wood as a renewable natural resource is the best alternative to oil-based materials and also, for example, concrete and to steel. Forestry gives jobs to thousands of people. Sustainable forestry will help mitigate the effects of climate change.



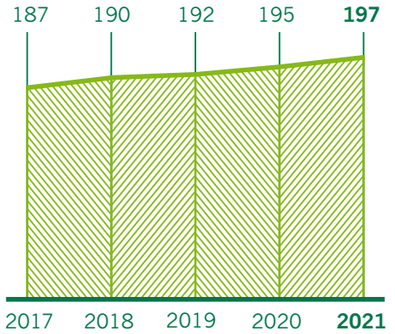
Strictly protected forest

RMK does not manage forests in these areas, but activities may be necessary for conservation purposes. Nature reserves, dedicated protection zones for permanent habitats and protected areas, precious habitats and Natura 2000 habitats overlapping with restricted zones and storage areas are under strict protection.

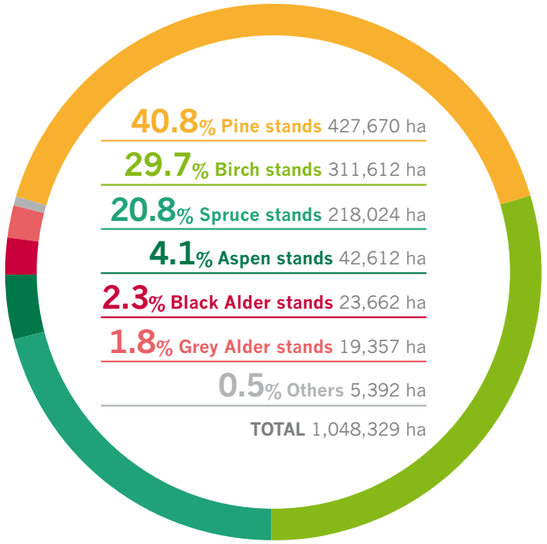
Forest with economic limitations

Economic activity is permitted in these forests, but additional restrictions apply. Such areas include for example restricted zones and preserves outside the Natura habitat.

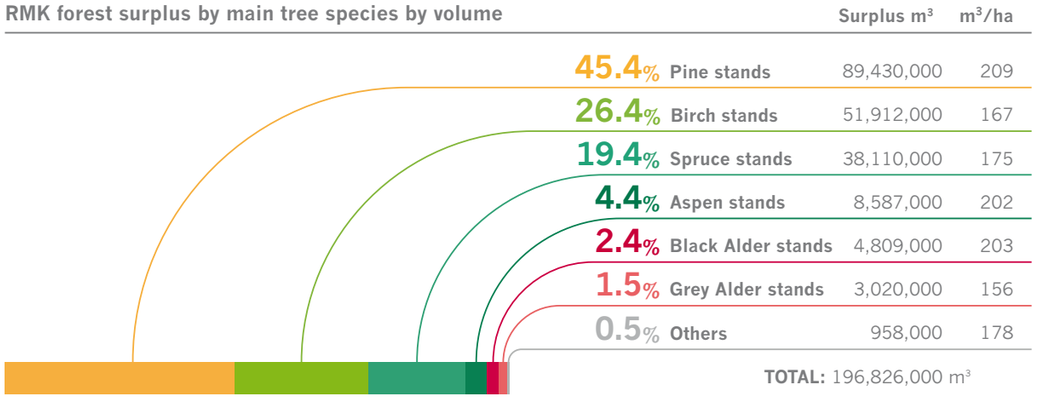
RMK forest surplus (million m³)



RMK forest area by main tree species

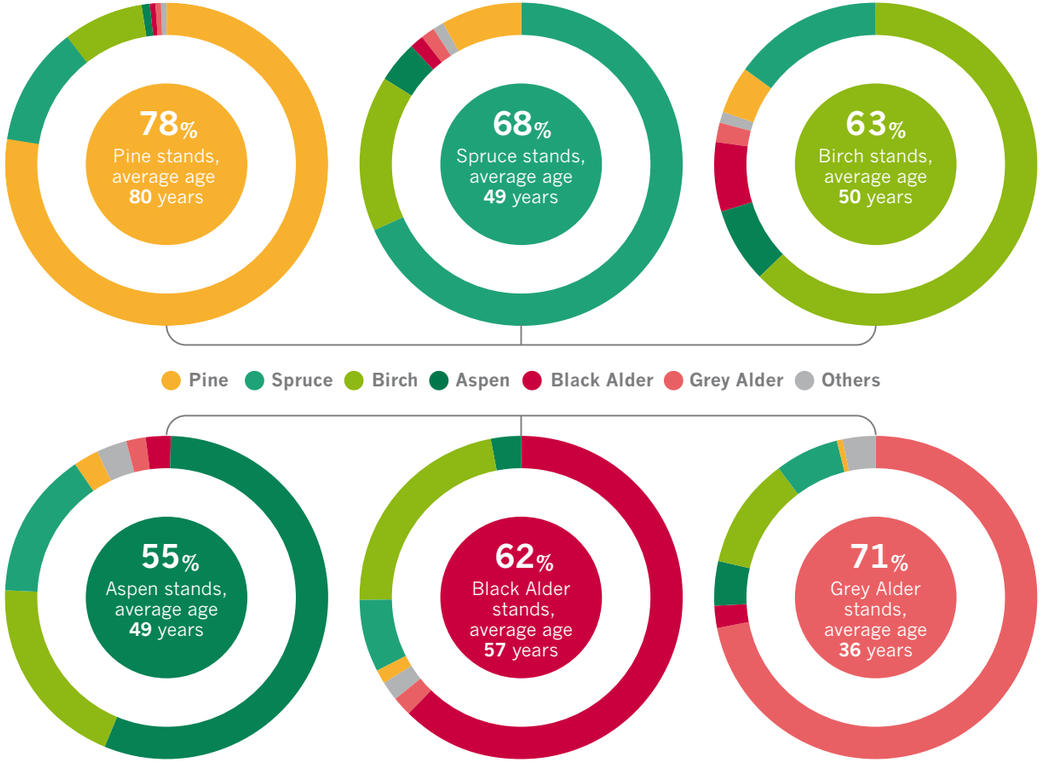


RMK forest surplus by main tree species by volume



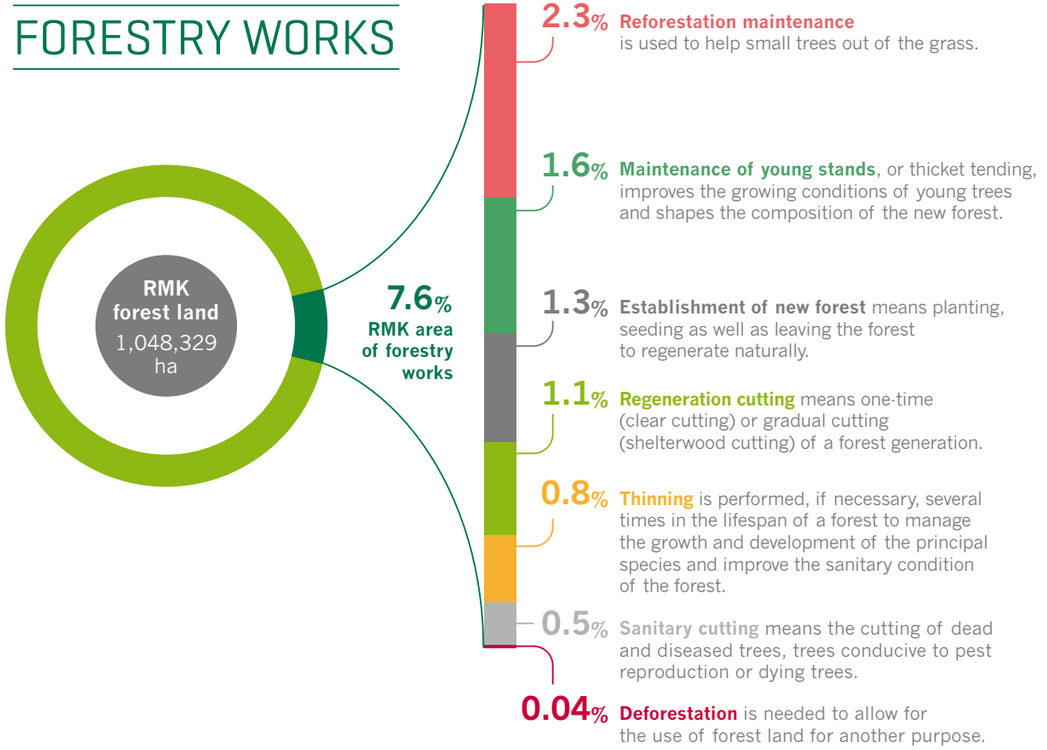
	Surplus m³	m³/ha
45.4% Pine stands	89,430,000	209
26.4% Birch stands	51,912,000	167
19.4% Spruce stands	38,110,000	175
4.4% Aspen stands	8,587,000	202
2.4% Black Alder stands	4,809,000	203
1.5% Grey Alder stands	3,020,000	156
0.5% Others	958,000	178
TOTAL:	196,826,000 m³	

Distribution of the surplus of stands by main tree species and the average age of stands



It's not just pine trees growing in pine stands, birches in birch stands and spruces in spruce stands. Pine stands have the largest share of the main tree species, thanks to the good ability of pine to grow in very dry and very wet growing areas where other tree species have difficulties. The species composition is much more diverse in spruce, birch, aspen and alder stands.

FORESTRY WORKS



Cutting (ha)	2017	2018	2019	2020	2021
Regeneration cutting	10,866	11,227	11,394	11,383	**11,245**
... of which clear cutting	10,797	11,083	11,195	11,226	**11,152**
... of which shelterwood cutting	69	144	199	157	**93**
Thinning	9,944	8,478	8,812	8,319	**7,906**
Sanitary cutting	3,980	3,906	7,810	12,043	**5,642**
Deforestation*	725	1,605	1,335	2,027	**469**
Design cutting	149	72	245	730	**299**

* The area of deforestation from 2017 to 2020 also includes the roads and trenches of RMK which were cleaned of the trees and brushes that had grown there.

Growing a new generation of forests

RMK renewed forests on 13,124 hectares, which is 1.3% of RMK's forest land. This included afforestation of 346 hectares, where forest had not grown before (low-value grasslands, shrubland, and quarries).

A record 24.5 million tree seedlings were planted: 11.2 million pines, 10.7 million spruces, 2.4 million birches and 200,000 alders and oaks.

Besides planting, forest is also renewed by sowing or through natural regeneration. About one-fifth of clear-cut areas were left for natural renewal where, due to the soil and humidity, the natural renewal of broad-leaved trees is successful. Based on the results of a silvicultural analysis, RMK has abandoned the practice of mineralising the land to promote natural regeneration.

In addition to RMK's logging workers, up to 2000 people from partner-companies also contributed to forest planting.

RMK maintained young forests on 40,701 hectares, which is 3.9% of RMK's forest land. This includes forest renewal maintenance, i.e. helping small trees to grow out of the grass, and maintenance of young stands, or thicket tending, which improves the growing conditions of young trees and shapes the composition of the new forest.

A total of 12,390 hectares of forest were counted as regenerated, more than ever before.

RMK provided EUR 19.5 million for forest planting and maintenance and protection of young stands.

Forest renewal	**2017**	**2018**	**2019**	**2020**	**2021**
Mineralization of the land for planting (ha)	7,918	7,924	8,358	8,812	**9,233**
Mineralization of the land to aid natural renewal (ha)	1,686	1,604	1,867	575	**5**
Forest sowing (ha)	311	335	207	173	**200**
Forest planting (ha)	7,140	7,177	7,477	8,353	**10,003**
Aiding natural renewal with planting or sowing (ha)	434	705	856	618	**577**
Leaving for natural renewal (ha)	2,021	1,680	1,662	2,037	**2,339**
Contribution to the forest renewal (ha)	2,940	2,959	3,890	3,250	**3,304**
Plants planted (million)	21.2	21.3	22.1	23	**24.5**
... out of which pot plants (%)	52	52	52	51	**57**
Cleaning (ha)					
Maintenance of young stand	19,072	18,462	18,527	18,988	**16,592**
Forest renewal maintenance	24,607	23,201	24,618	24,342	**24,109**
TOTAL	**43,679**	**41,663**	**43,145**	**43,330**	**40,701**
Planting and sowing by tree species (ha)					
Pine	2,925	3,241	3,318	3,431	**3,636**
Spruce	4,046	4,267	4,204	4,687	**5,280**
Birch	469	683	977	976	**1,235**

Arrangements for the management of local forests

For the management of forests of high public interest, RMK held consultation meetings in 51 regions. In 45 cases, an agreement was reached with the local communities on forest management conditions. In six cases, a different agreement was reached: in three cases the parties decided to wait for the results of the initiative to set up a protected area, in two cases no cutting will be carried out because new key biotopes were found in the area, and in one case only part of the work was carried out. For the remaining work, it was agreed to wait five years, assess together with local people how the work carried out so far has impacted the forest, and then decide on the next steps.

RMK intends to continue to negotiate management plans for areas of heightened public interest (HPI) with local communities, and a detailed guide for public consultations was prepared in 2021. The views of local communities are sought at every stage of the public consultation process, from the description of the site to the preparation of a management plan.

The locations of the HPI areas are coordinated between RMK and the local authorities. From the moment RMK has agreed with the local authority that the state forests in a certain area are HPI areas, RMK enters these areas on its forestry map and the local community is consulted as regards the planning of harvesting operations. The list of HPI areas is constantly growing.

State forest accounts for local authorities

RMK prepared comprehensive inventories for local authorities, giving an account of the state forests growing on their territory.

The accounts outline the state forests growing on the territory of the local authority, the forest management, nature conservation and forest protection work that has been carried out there in the past decade, and the work that can and should be done in the coming decade. They also describe the hiking trails, campsites and other infrastructure and heritage sites for outdoor activities and recreation. Any areas of heightened public interest have been listed.

Such accounts were drawn up for 76 local authorities, i.e. for all those on whose territory RMK owns land. There are no state forests on the territory of three local authorities (Maardu, Sillamäe and Rakvere). RMK's forest managers also presented the accounts to local officials, including the recently elected municipal councils. In particular, more detailed explanations were needed about the principles of forest management and nature conservation issues.

The online brochures are also available on the RMK website.

PLANT CULTIVATION

Growing forestry plants (million)	2017	2018	2019	2020	2021
Pine	10.8	10.2	10.6	10.6	**11.3**
Spruce	10.7	9.6	9.2	10.5	**10.7**
Birch	1.2	1.6	2.4	2.7	**2.5**
Other (black alder, oak)		0.1	0.1	0.1	**0.2**
TOTAL	**22.7**	**21.5**	**22.3**	**23.9**	**24.7**

Tree seedlings from in-house nurseries

RMK's nurseries provided 24.5 million forest plants for state forests, while 130,000 plants were sold to the Luua Forestry School. RMK has eight nurseries and 17 seed orchards. Seed orchards, or plantations established to obtain forest tree seeds, are used to stock good quality seeds.

Forest tree seeds were used in the amount of 1,059 kg and EUR 380,000, of which 263 kg were sown in RMK nurseries and 83 kg in the forests.

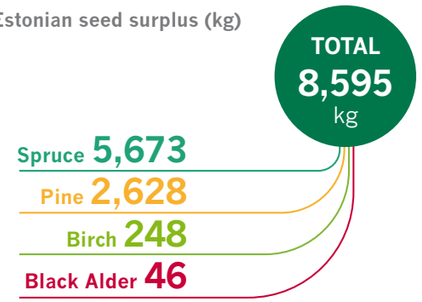
Stocks were replenished with 657 kg of new pine seeds, 69 kg of silver birch seeds and 46 kg of alder seeds. The stock of forest tree seeds at the end of the year was 8,595 kg comprising 66% spruce seeds, 31% pine seeds and 3% silver birch and alder seeds. The stocks will cover Estonia's forestry needs for 12 years in case of spruce seeds, for 6 years in case of pine seeds and for 4 years in case of birch seeds.

Strong trees of the future

In cooperation with scientists from the Estonian University of Life Sciences, RMK is contributing to a programme for improving Estonia's forest trees – to ensure that our future forests are healthy and the timber is of high quality, that the forests can withstand climate change and store plenty of carbon dioxide.

Over the past ten years, the partners have selected the best pine, spruce and silver birch trees and have created cultures for progeny trials. While the pine and spruce trial plots were established earlier, the first silver birch trial plants were planted in 2021.

Estonian seed surplus (kg)



TIMBER MARKETING

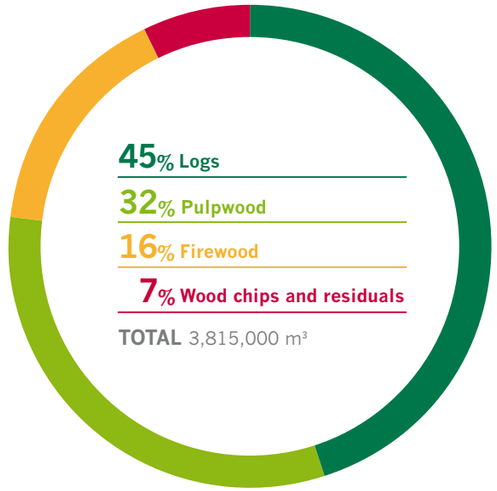
Sale of timber (m³)	2017	2018	2019	2020	2021
Logs	1,798,000	1,795,000	1,845,000	1,845,000	**1,717,000**
	48%	49%	47%	46%	**45%**
Pulpwood	1,213,000	1,200,000	1,285,000	1,259,000	**1,221,000**
	32%	32%	33%	32%	**32%**
Firewood	579,000	565,000	611,000	644,000	**597,000**
	15%	15%	15%	16%	**16%**
Wood chips and residuals	205,000	150,000	189,000	255,000	**280,000**
	5%	4%	5%	6%	**7%**
TOTAL	**3,795,000**	**3,710,000**	**3,930,000**	**4,003,000**	**3,815,000**

Record prices on timber market

RMK sold 3.8 million cubic metres of timber during the year, which is less than the year before. The timber placed on the market by RMK accounts for almost a third of the average volume of timber harvested in Estonia in recent years.

Logs made up 45% of the sales volume, pulpwood 32%, fuelwood 16% and wood chips 7%. Revenue from the sale of timber amounted to EUR 218.8 million, an increase of EUR 34.6 million from 2020.

Nobody could have predicted the dramatic changes in the timber market during the year. The economic recovery measures necessitated by the Covid



pandemic led to a surge in global demand, with producers unable to offer a quick response. The construction market continued to expand, which led to an increased demand for prefabricated products. The gradual increase in the price of construction timber around the turn of the year resulted in higher raw material prices.

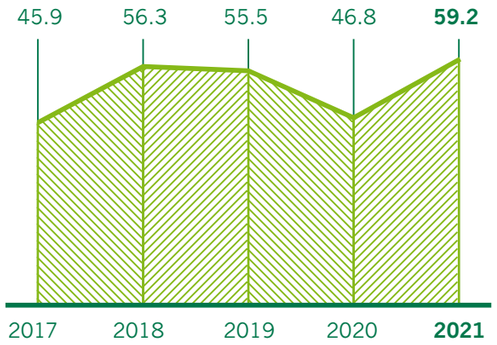
The market appeared to have reached an equilibrium in the middle of the first half of the year, but it did not remain in this state for long. Around mid-summer, the price of softwood logs started to soar, caused by a lack of stocks in some product groups during the peak of the building season. Although prices fell just as quickly, they remained at a new historic record high until the end of the second half of the year.

The prices of all types of logs increased in the course of the year. Against the background of the rise in log prices, the price of pulpwood also continued to rise, unnoticed. Compared to other types, the rate of price increase was higher in the case of pulpwood from birch, with Finland and Sweden as its main markets. The prices of fuelwood and wood chips remained relatively unchanged throughout the year, helped by the stabilisation of local use at the same level as in the previous year.

RMK sold 85% of timber under long-term contracts and 15% using other methods of sale. RMK's strategy for timber marketing favours companies who process the wood on site and export products with higher added value.

The cutting rights to growing trees were sold to private persons for the purpose of storing fuelwood, to the lessees of semi-natural biotic communities for maintenance operations, and for infrastructure projects and the clearing of peatlands. Altogether, RMK sold cutting rights for 14,000 cubic metres.

Average price of the sold round wood (EUR/m³)



Biggest clients by the amount purchased	thou-sand m³	% of total sales
Horizon Tselluloosi ja Paberi AS	230	7%
Estonian Cell AS	222	6%
Toftan AS	211	6%
Stora Enso Eesti AS	196	6%
Metsä Forest Eesti AS	144	4%
Graanul Invest AS	137	4%
Combimill Reopalu OÜ	122	3%
Vara Saeveski OÜ	111	3%
Barrus AS	109	3%
Osula Graanul OÜ	106	3%
TOTAL	1,588	45%

FOREST IMPROVEMENT

Forest improvement indicators	2017	2018	2019	2020	2021
Forest roads built, reconstructed and renewed (km)	348	316	328	221	**319**
Reconstructed and renewed drainage systems (ha)	22,600	25,700	19,600	18,700	**17,000**
Investment into forest roads and drainage systems (million euros)	23	23.5	25.9	21.1	**23.5**

During the year, RMK renovated 290 km of existing forest roads and built 29 km of new forest roads. Always looking for ways to reduce the environmental footprint of its operations, the company began to reinforce ditch banks with erosion barriers made entirely of natural materials, which will completely decompose within a year or two when the ditch slopes are covered with vegetation.

RMK lands contain 9,281 km of forest roads belonging to RMK. In addition, RMK uses and therefore maintains some 2,000 km of roads on the land of other owners.

Well-maintained forest roads facilitate forestry and nature conservation operations, ensure a steady supply of timber for customers, and make it easier to get around in nature and fight forest fires. There are 799 fire-fighting water outlets in RMK forests.

Almost half of RMK's forest land has been drained. No more drainage systems will be built; however, existing systems do require maintenance and reconstruction. Draining increases the increment of RMK forests by 700,000 cubic metres every year and properly maintained drainage systems reduce the damage to soil during forest management.

Drainage systems also play an important role in coping with the effects of climate change. Increasing precipitation and shorter winters will lead to higher humidity, and a functioning ditch network is needed to drain excess water from the forest.

WASTE COLLECTION

Waste collection in RMK forests	2017	2018	2019	2020	2021
Amount (kg)	281,800	290,200	250,000	250,000	**152,000**
Expenses (EUR)	92,000	100,000	98,000	120,000	**78,600**

RMK collected 152 tonnes of waste from the forests, which is almost 100 tonnes less than a year earlier. Unfortunately, this cannot be attributed to a dramatic improvement in people's behaviour in the forest, but rather to the fact that there was no need to clean up large, unauthorised dumpsites which was the case in previous years. The cost of waste clean-up was EUR 78,600 and it was carried out by RMK's contractual partners Ragn-Sells and Eesti Keskkonnateenused.

RMK gives the collected and sorted plastic waste new life by using posts made of waste as holders for state forest signs. Collecting waste from the forest is necessary not only because the waste taken to nature hurts the eyes, but because it is a threat to the environment and the forest residents.

FOREST FIRES

Forest fires in RMK forests	2017	2018	2019	2020	2021
Number (pcs)	1	45	8	5	**10**
Area (ha)	4	269	39	11	**24**
Average fire (ha)	4	6	5	2	**2**

HUNTING

Hunting in RMK land	2017	2018	2019	2020	2021
RMK average price for using hunting land (EUR/ha)	3.8	2.3	3.4	2.1	**2.6**
Income from hunting (EUR)	250,000	178,000	207,000	152,000	**205,000**

RMK earned EUR 205,100 from hunting, mostly from public auctions of subscription rights for hunting permits.

On average, RMK was paid EUR 2.59 per hectare for hunting. RMK shared EUR 22,800 of the revenue from public auctions with private land owners who permit hunting on their lands.

RMK manages the Kilingi-Nõmme, Kuressaare and Väätsa hunting districts. In those hunting districts where RMK itself is not administering hunting activities, RMK has concluded contracts for the use of state land for hunting, covering 325 hunting districts. Among other things, the contract also states when hunters have to compensate for any damage caused to forests by game.

The area of significant game damage in RMK's forests decreased to 440 hectares, a reduction of almost a third compared to 2020. Young forests are mainly damaged by moose and, on islands, by deer. RMK submitted 18 claims for game damage to 12 hunting associations. This concerns altogether 30 hectares, where RMK has to renew the area or make significant additional efforts for forest renewal. The total amount of the damage claims is EUR 8,200.

NATURE PROTECTION

Protected species	500
Sites with protected species	43,062
Total area of key biotopes	30,680 ha
Semi-natural biotic communities, rented	25,868 ha
Restored habitats	4,528 ha
Cost of nature protection works	EUR 4.1 million

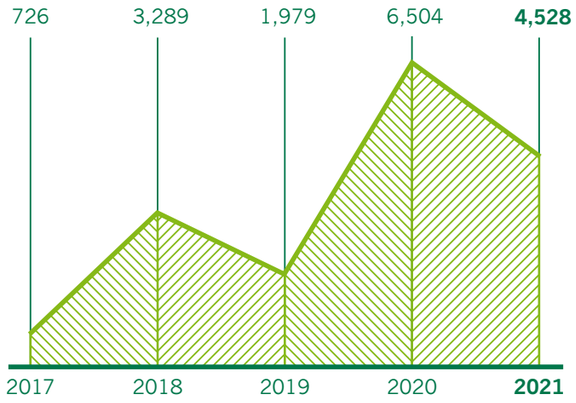
NATURE PROTECTION WORKS

Cost of protection works (EUR)	2017	2018	2019	2020	2021
TOTAL	**4,050,000**	**5,580,000**	**6,640,000**	**4,910,000**	**4,130,000**
...incl. government grants received (state budget, UCITS)	2,510,000	3,100,000	3,420,000	2,310,000	**1,840,000**

RMK is the largest performer of nature protection works in Estonia. Under RMK's initiative, 304 works were performed in 2021, aimed at the preservation or improvement of the condition of valuable protection sites. The largest category of works in terms of area was bog restoration, followed by restoration of semi-natural communities. A new line of work for RMK involves practical efforts to improve the condition of watercourses. The cost of nature protection works was EUR 4.1 million.

Nature protection works are necessary as some species need a living environment that is untouched by human activities; while others, however, prefer to live in communities that have emerged as a result of long-term, low-intensity human activity. Closing trenches in bogs helps to restore the primary bog ecosystems, which serve as a habitat for species that are afraid of humans; whereas restoration of wooded meadows creates preconditions for permanent less-intensive agriculture, providing suitable conditions for the development of Europe's most species-rich communities.

Restoration of habitat (ha)



Habitat restoration works (ha)	2017	2018	2019	2020	2021
Bog community restoration	291	2,784	1,425	5,982	**4,105**
Semi-natural community restoration	388	505	554	522	**314**
Other community restoration	47	0	0	0	**109**
TOTAL	**726**	**3,289**	**1,979**	**6,504**	**4,528**

Bogs as carbon sinks

Several previously started extensive restoration works of bog habitats were completed. Together with its partners, RMK restored more than 4,000 hectares of bog communities, with a 1,095 ha area in Saessaare bog and a 584 ha area in Kauni bog, Soomaa National Park, being the largest ones.

Having lasted for several years, the cooperation projects with the Centre for Defence Investments and AS Enefit Power ended with the restoration of Kerretü bog in Võru County (491 ha) and the eastern edge of Selisoo in Ida-Viru County (171 ha), respectively.

Bogs are important for ensuring biodiversity, conserving clean water, fighting floods and droughts, and sequestering carbon from the atmosphere. Bogs that comprise just 3% of the planet's land store 20% of the entire carbon found in the soil of the planet.

Regeneration of peatlands

However, cut-over peatlands, or unrecovered peateries, covering 9,000 hectares of Estonia, do not store carbon. These can be extremely flammable dry areas, which emit a lot of carbon and accelerate global warming. Sowing of peat moss fragments was tested in Ess bog, in Võru County, to kickstart natural regeneration of the former peatlands. This was done in collaboration with researchers from the University of Tartu, who are helping to identify the most effective way to restore cut-over peat bogs as wetlands.

Maintenance lease of meadows and pastures

To preserve semi-natural communities, RMK leases meadows and pastures on its land to local entrepreneurs for management. The total area of semi-natural communities on RMK's land amounts to 33,389 hectares, and 25,868 hectares were leased for maintaining semi-natural communities by the end of 2021.

In order to make the areas serviceable, RMK restored 314 hectares of meadows and pastures in 2021. The most extensive restoration of semi-natural communities took place in Tartu County (163 ha) and Saare County (59 ha).

Two roads, totalling 1.15 km in length, were built to improve the management conditions of semi-natural habitats. The Kärevere glade culverts, the Nasja road exit lane and the access to the Kirna glades in the Alam-Pedja Nature Reserve were reconstructed. The new roads and reconstructed facilities will facilitate management of 246 hectares of semi-natural communities. Semi-natural biotic communities are areas characteristic of the Estonian landscape, that have been used as pastures and meadows, where moderate human intervention is required to preserve their biodiversity.

Work for the protection of species

Specific works were performed for the benefit of 20 rare and endangered species on a total of 70 hectares. The status of the spawning waters of the northern crested newt, the natterjack toad and the common spadefoot was improved at eight sites in permanent habitats and protected areas. Habitat improvement work for protected plant species was carried out at 20 sites. Improved growing conditions for the orchid family were created in six habitats, the largest of which are located in Varangu, in Lääne-Viru County, and the Nehatu Nature Reserve, in Pärnu County.

Tidy parks and open landscape views

Landscape maintenance and restoration works were carried out on 26 hectares. The largest maintenance sites were in Rapla County, at Varbola Stronghold (6 ha), in Lääne-Viru County, around Neerut lakes and hiking trails, (6 ha) and at Kostivere caves (5 ha). In most cases, landscape maintenance and restoration involves maintaining open views.

Park maintenance and restoration work was carried out in 16 parks across Estonia. The most extensive activities were in Keila-Joa Manor Park where, based on an expert opinion, wild dogwood bushes were replaced with other bush species, and in Brafmann Park where dangerous trees were felled and stumps milled. In other parks, grass was mowed and brushwood was cut to maintain the visual appearance, and hazardous individual trees were cut to ensure the safety of visitors. Hazardous trees were removed at 26 stand-alone sites.

PROTECTED AREAS

Buying protected land

In 2021, RMK bought ten properties with conservation restrictions from private owners. The acquired land, with total area of 10.5 hectares, cost EUR 670,000.

RMK was first assigned the task of purchasing land with high natural value for the state in 2018; previously this was done by the Land Board. Over the past three and a half years, RMK has purchased 96 properties with a total area of 771 hectares for nearly EUR 7.1 million. RMK obtains the required funds by selling land that is not necessary for the fulfilment of its main assignments.

Protected areas in RMK forests (ha)

Special mgmt. zone of the protected area	204,557
Limited mgmt. zone of the protected area	70,137
Limited mgmt. zone of Species protection site	29,968
Special mgmt. zone of Species protection site	24,849
Special conservation area	17,898
Strict nature reserve of a protected area	3,168
Protected area without protection rules	305
Single object in nature	129

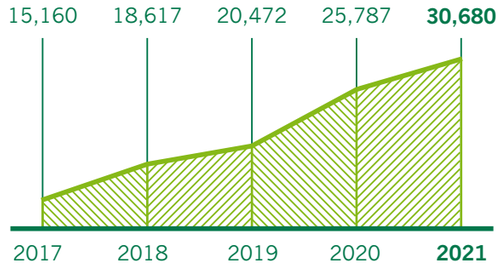
The zones of the protected areas may partly overlap.

KEY BIOTOPES

On RMK land, 30,680 hectares of key biotopes have been selected and this area increased by 4,893 hectares in the past year. Over the last ten years, the area of key biotopes in RMK forests has grown 2.7 times.

RMK has been taking inventories of key biotopes since 1999, and in addition to RMK's trained forest managers, external experts also take inventories. The last major inventory-taking was launched in 2019, when RMK decided to check 55,000 hectares of mature forest, where the existing inventory data indicated a higher likelihood of key biotopes than elsewhere. The area surveyed represented about 1/3 of the total area of mature forests under management that meet the criteria for regeneration cutting and they will not be harvested before the inventory is completed. 80% of the inventory-taking had been completed by the end of 2021.

Key biotopes in RMK forests (ha)



Key biotopes are suitable habitats for rare and endangered species where structures of natural forests have been preserved: for example, very old trees, large fallen and dead or burnt trees. Key biotopes fall under the category of strictly protected forests, which altogether cover 325,000 hectares, or 31% of RMK's forests. The share of strictly protected forests is growing year by year.

PROTECTED SPECIES

In Estonia, 568 plant, fungi, lichen and animal species have been placed under protection. Of them, 500 have been registered on RMK land. A total of 54 species belong to the most strictly protected 1st category, 236 to the 2nd category and 210 to the 3rd category.

In addition to the number of species, the situation of the protected species can be characterised more substantially by the number of protected species' habitats. The number of habitats of protected species on RMK's lands is 43,062; increasing by 2,285 in the past year. A habitat is defined as a natural growth site of one specimen of a species or, in the case of plants growing in groups, as the site of the group, in the case of birds, the nest area, etc.

In the past year, the number of protected species on RMK's land increased by five:

- dog lichen (*Peltigera collina*)
- fen puffball (*Bovista paludosa*)
- the black kite (*Milvus migrans*)
- cliff scalewort (*Corda porella*)
- orbicular helleborine (*Epipactis helleborine subsp. orbicularis*)

BIODIVERSITY IN MANAGED FORESTS

Maintaining biodiversity is important in all forests – those that are strictly protected, those having economic restrictions, as well as managed forests. In order to preserve the biodiversity of the Estonian forests, RMK has taken on several obligations, some of which are even stricter than the law provides for.

- Cutting is ceased from 15 April until 15 June.
- In the reconstruction of the drainage systems, care is taken not to damage the wet forests with a natural water regime.
- Buffer zones are maintained near natural bodies of water to reduce possible erosion.
- In the case of clear cutting, more old trees and down wood are preserved than required by the Forest Act.

PÕLULA FISH FARM

Fish populated to rivers from Põlula

Year	Species	Larva	One-summer-old	One-year-old	Two-summers-old	Two-years-old	Three-summers-old	Total
2017	Salmon		54,682	60,851	21,186	42,795		179,514
2018	Salmon	75,000	118,355	79,497	9,256	32,767		314,875
2019	Salmon	47,370	164,375	73,862	12,739	28,648		326,994
2020	Salmon	21,994	187,008	69,193		16,099		294,294
2021	**Salmon**		**202,194**	**73,980**		**16,824**		**292,988**
2017	Whitefish		6,885					6,885
2018	Whitefish		43,774					43,774
2019	Whitefish		30,374					30,374
2020	Whitefish		12,020					12,020
2021	**Whitefish**	**633,900**	**41,623**					**675,523**
2019	Sturgeon		4,820					4,820
2020	Sturgeon		1,944	1,143				3,087
2021	**Sturgeon**		**11,384**		**1,780**		**355**	**13,519**

Replenishment of fish stocks

Põlula Fish Farm released 293,000 salmon, 632,000 Peipsi whitefish, 44,000 Pärnu semi-migratory whitefish and 13,000 Baltic sturgeon into water bodies. Salmon were released into the Jägala, Purtse, Pärnu and Valge rivers, whitefish into Lake Peipus and the Pärnu River, and sturgeons into the Narva River. This was the first time that the population of Peipsi whitefish has been restocked.

Cooperation continued with the Peipsi Sub-basin Fishermen's Association and the University of Tartu's Peipsi Fisheries Working Group on the restoration of the stocks of Peipsi whitefish. Cooperation with the Harju Fisheries Association was started for hatching European whitefish roe from the Gulf of Finland and for breeding and stocking juvenile fish. Experimental work continued on the farming of Baltic sturgeon and crayfish.

Saving freshwater pearl mussels

With the support of the LIFE programme and the Ministry of the Environment, the six-year LIFE Revives project, to restore the population of the fresh-water pearl mussel, started in Põlula in the autumn of 2021. The population of this 1st conservation category invertebrate species has declined to critical levels. The project will help restore the catchment and habitat of the native river of the freshwater pearl mussel, monitor the river water and habitat, grow young mussels in a laboratory and on plates placed in the river, and study the abundance and age composition of the remaining population.

RMK contributes nearly EUR 1.7 million to the project. A grant from the Cohesion Fund has been received for the construction of a growing station on the banks of the native river of the freshwater pearl mussel.

In 2021, freshwater pearl mussel larvae were transferred to their native river on special plates to facilitate continued growth. In May, 384 individuals from the 2020 batch of larvae were placed in the river, followed by 1,350 individuals from the 2021 batch in August. An inspection in the autumn revealed that two thirds of the mussels had survived in both batches. The results of overwintering in the river will be known in spring.

Some of the young mussels are grown in the fish farm laboratory.

Clearing of fish migration routes

The rehabilitation of watercourses and the clearing of fish migration routes in salmon rivers were added to RMK's tasks in 2020. Most of 2021 was spend on design efforts, with the artificial rapids of Varangu dam being the first site where preliminary work started at the end of the year.

By 2023, RMK needs to dismantle 11 dams on salmon rivers or find other viable solutions for clearing fish migration routes and for improving the spawning conditions. The Cohesion Fund has earmarked EUR 1.9 million for this purpose.

The work will involve close communication with landowners, authorities and local residents, and a natural and sustainable solution will need to be developed for each site to facilitate fish migration. Many artificial solutions, such as fish lifts, screw traps and chamber traps, are not effective enough on Estonian rivers and are not eligible for funding. Solutions need to be found that do not require later maintenance or additional investment by the owner.

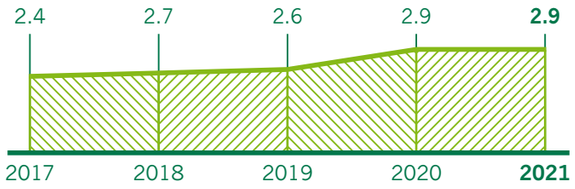
Throughout the year, there were community work days on smaller dam ruins, with the involvement of Estonian environmental agencies and volunteers. In a joint effort, the degraded dams were made passable for all aquatic life.

VISITING NATURE AND NATURE AWARENESS

Visits to RMK's recreational areas and protected areas	2.9 million
Visitors at the information desks	68,000
Visitors to Elistvere Animal Park	80,600
Visitors to Sagadi Forest Museum	2,800
Participants in nature education programmes	46,700
Expenditures on visitation infrastructure and promoting nature awareness	EUR 8.7 million

VISITING NATURE

Visits to RMK's recreational areas and protected areas (million)



Long hiking trail extended to Hiiu County

In early September, RMK opened the 234-kilometre-long Heltermaa-Ristna-Sarve hiking trail in Hiiu County, which is a continuation of RMK's popular Peraküla-Aegviidu-Ähijärve hiking trail.

Starting from Heltermaa Harbour, the trail allows you to cross Hiiu County from end to end. There are many diverse natural, cultural and military sites in the vicinity of the trail that are unique and rare in Estonia and the world. In addition to other places, the route passes through 12 protected areas, some of which are off-limits to vehicles and bikes. The trail also crosses private lands, which is why many agreements were made with landowners.

A walk along the Hiiu County section of the trail gives a good overview of RMK's range of activities: restoration of alvars, leasing of areas for grazing and meadow maintenance, restoration of glacial bogs, felling areas, newly planted and young forests, as well as protected forests and historical heritage. The future plan is to extend the hiking trail from Hiiu County to Saare County.

Estonians continue to spend a lot of time in nature

RMK's recreational and protected areas were visited 2.85 million times. Compared to the first year of the coronavirus (2020), there were 50,000 fewer visits. The applied restrictions reduced the proportion of nature tourists from abroad and caused cancellation of many of the traditional events that have attracted people to nature.

Newly completed sites were well received. For example, the Tiksoja hiking trails and camping site used to receive an average of 11,000 visits a year, rising to 32,800 in 2021. Popular spots included the Harilaiu rest stop with a hiking trail and a camping site in Vilsandi National Park, the Rumpo hiking trail in Vormsi Landscape Protection Area, and several camping sites: Oore, Lemme, Kaleste, and Tuhkana.

According to RMK's visitor survey (2021), the largest visitor groups to RMK's infrastructure are 25–34 and 35–44 year-olds from Tallinn, Tartu or Pärnu with families. They come to a hiking trail or a camping site by car and consider walking and nature observation to be the most important activities of the hike. A total of 95% of survey respondents are satisfied with the services and facilities provided by RMK.

New recreational sites

Opportunities for outdoor activities were improved at 22 sites. Construction works were completed on the Koiva heritage footpath, Simisalu observation tower, Tiksoja camping site and hiking trails, Suur-Taevaskoja bridge, Langevoja platform, and Keila-Joa park. The Kilingi-Nõmme forest house, which was destroyed by fire in the summer, was rebuilt.

The Kõnnu-Suursoo and Loodenina observation towers, the Veere viewing platform, the Penijõe hiking trail, the boardwalks of Lake Endla and the Selisoo nature trail, the campsites of Tenno, Paidra, Piusa, Metsavenna, Muinasküla and Rebasemõisa, the Palojärve camping area, and the hiking trails of Tilleoru and Lake Rae have been renovated.

- **3,300** km of nature trails
- **738** fireplaces, including, **328** covered fireplaces
- **61** campsites
- **27** forest cabins
- **20** forest houses
- **1** cross-country areas

RMK hiking trail:

- **812 km** Peraküla-Aegviidu-Ähijärve
- **234 km** Heltermaa-Ristna-Sarve
- **613 km** Penijõe-Aegviidu-Kauksi
- **370 km** Oandu-Aegviidu-Ikla

RMK Visitor Centres

Most visited recreation areas

- The recreation area near Tallinn (including Keila-Joa Park, 377,000 visits)
- Northern Shore of the Lake Peipus Recreation Area (including Oru Park, 288,000 visits)
- Nõva recreation area (218,000 visits)

NATURE AWARENESS

Nature programmes and number of participants	2017	2018	2019	2020	2021
Nature programmes organised	2,667	2,594	2,380	3,036	**2,424**
Participants in programmes	52,000	51,600	49,400	39,500	**46,700**

More non-contact learning

A total of 46,700 people participated in the nature education programmes at RMK visitor centres, nature houses and the Sagadi Forest Centre. This is a fifth more than the year before. The selection included both guided and self-guided, or 'backpacking' programmes. Fewer guided nature learning programmes could be offered due to restrictions, leaving more room for independent exploration. Among other things, RMK's interactive games offer a good opportunity to do this, with 50 already created for specific trails. Without leaving home, you can solve interactive quizzes and play a waste sorting game on the RMK website. Geocaching is a more adventurous way of acquiring new knowledge and it can be played in all six Estonian national parks.

The number of people participating in the nature awareness activities organised by RMK was 236,900. Information desks provided advice on 68,000 occasions. RMK also opened an information desk in Narva, and there are now a total of 18 information desks across Estonia.

Despite the difficult conditions of home schooling, RMK's interactive forest quiz was taken by a record number of students – 11,508 students from 265 schools. RMK's forest quiz was held for the 20th time and it is designed to assist teachers in teaching natural science. Also, a competition 'Forest Postcard of Estonian Schoolchildren' was held.

Immersive exposition of the treasures of the Alutaguse region

In June, RMK opened a permanent exhibition of the region's cultural and natural treasures at the visitor centre of Alutaguse National Park. The visitor centre in Kauksi is like a gateway to Alutaguse National Park, with exhibits providing an overview of its fauna and flora, cultural heritage and landscape.

The permanent exhibition is complemented by an illuminated outdoor area in the courtyard, which offers 24/7 information about other Estonian national parks and the opportunities for outdoor activities in Ida-Viru County.

SAGADI FOREST CENTRE

Number of visitors to the Sagadi Forest Centre	2017	2018	2019	2020	2021
Visitors at Forest Museum	31,400	34,600	41,900	18,400	**2,800**
Accommodation clients	7,100	8,200	9,700	5,700	**2,600**

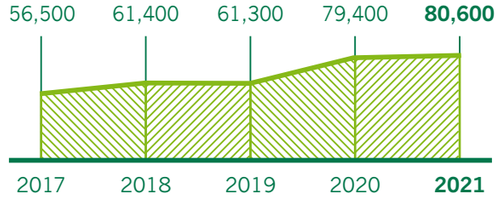
RMK's Sagadi Forest Centre was visited 17,600 times during the year. This is almost half the number of the previous year, and activities were inevitably affected by Corona restrictions, as well as the reconstruction work that started in July on the manor house and the forest museum. The hotel and restaurant at Sagadi Forest Centre continued to operate, and traditional events such as family days at the nature school, night museums, tree days and a mushroom exhibition took place.

ELISTVERE ANIMAL PARK

Over the year, 80,600 people visited the Elistvere Animal Park, which is the highest-ever result. The start of the year was much busier than in the past, but this turned into a decline after restrictions were imposed and a Corona certificate was required to enter the park. The customer service staff at the animal park have never had to deal with so many annoyed visitors.

Fortunately, the lives of animals were not affected that much by the coronavirus. Koroonius, the wolf that moved to Elistvere a year ago, seems to have settled in and usually shows himself to visitors. Seeing a lynx in Elistvere is increasingly a matter of luck, because Gella, a female lynx that had been brought from the Tallinn Zoo, passed away in the summer, having spent most of her days sitting on the roof of her kennel like a stone statue, letting herself be watched. The remaining two lynx, Kriimu and Printsess, are very good at hiding.

Visits to Elistvere Animal Park



The only animals that bred during the year were the fallow deer. The story with a bear cub found on the side of the road and then brought to Elistvere had an unhappy end, as the cub did not survive.

Traditional Elistvere Animal Park events took place: the celebration of Valentine's Day, Easter, and Karoliina the bear's birthday, as well as the celebration of the long summer nights with longer than usual opening hours.

NATURE CAMERAS

Over the year, RMK's nature cameras transmitted images from seven locations in Estonia. The deer camera in Saare County was in its traditional location from January to April, while it was moved to a new site on the other side of the same forest clearing by the start of the autumn season. Whether it was the change of location or something else, the deer glade has been visited by an exceptionally high number of deer since the autumn. Spring was a time for shedding horns and the rapid growth of new ones.

In spring, a fish camera was set up in the shallow waters of Lake Võrtsjärv, to capture spawning bream, pike and various invertebrates, as well as the sounds of spring coming from the water's edge.

During the summer months and early autumn, the fish camera transmitted images from the Keila River. Its permanent neighbours included a beaver and a family of otters with two pups. The beaver chewed on the alder tree that had the camera's antenna and router attached to it, whereas an otter dropped two rocks just next to the camera housing.

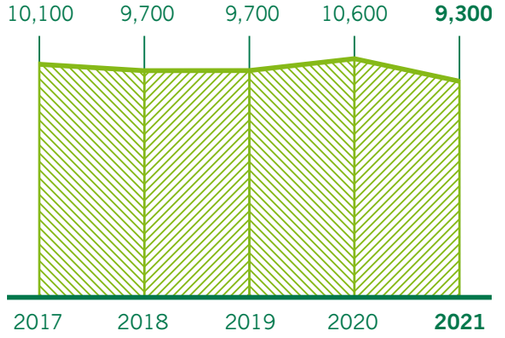
A species that had not previously been detected by the fish camera in Keila River, or perhaps was never present there before, is the non-native species known as the round goby. Seeing it in one of the best salmon rivers in Estonia was not an occasion for celebration.

In autumn, a fish camera was set up at a spawning site of the brown trout in the Vääna River. Unfortunately, frequent rain made the water hopelessly muddy and it was difficult to see the spawning trout.

A badger camera was located in two nearby badger settlements in Saare County: for a while in a forest clearing near a burrow dug into the soil and later in an old spruce forest near a badger settlement with 32 burrows. The camera captured the activities of two badgers and visitors to the badger settlement: deer, elk, roe deer, wild marten, squirrels, and wild boar. Indeed, the sounds of deer mating season – powerful roars in the night – could be heard from the badger cam.

CHRISTMAS TREES

Christmas trees from RMK forest



Nearly 9,300 fir trees were brought in from state forests for Christmas. Along with thousands of families, this time the Christmas trees from state forests also brought joy to hospitals, with RMK presenting them as a gift to thank medical staff for their brave work and to offer comfort to patients. Traditionally, RMK also donates fir trees to substitute homes and various social institutions.

For RMK, the sale of Christmas trees is not a way to earn income, but a possibility to invite people to nature also in winter and keep alive an old tradition.

Fir trees may only be taken from places where they cannot grow to maturity: the sides of roads and ditches, under overhead power lines and old forests.

HERITAGE CULTURE

Over the year, 1,374 sites were added to the database of heritage culture prepared by RMK, which now contains information on 40,532 sites. Around a fifth of these are located, in whole or in part, on RMK land.

A significant contribution to the addition of new sites was made by researchers of local lore, who have discovered the database to be an important source of information and are willing to cooperate diligently to supplement and refine the data.

On the international side, a collection of articles from the 2018 conference *European Forests – Our Cultural Heritage*, held in Austria, was published in cooperation with the Austrian Forest Society and the Institute of Ethnology of the Czech Academy of Sciences.

On the International Day of Forests, RMK participated in the organisation of an international conference, which was held online, as was typical of the times. The main theme of the conference was the potential of carbon sequestration in timber, with presentation topics ranging from wood chemistry to wooden musical instruments. All 38 presentations are available for viewing on-demand on the website worldwoodday.org. A similar conference is planned for 2022.

RESEARCH

Applied research projects supported including in progress	19 2
2017–2021 budget for applied research	EUR 1.1 million
Forestry scholarships	5
Scholarship spending in a year	EUR 36,700

APPLIED RESEARCH

The RMK Research Council was established in 2008. Since then, it has allocated support for 19 applied research projects, with total payments amounting to EUR 2.8 million. Two applied research projects were completed in 2021, with work continuing on two more.

When funding applied research, RMK prioritises versatile and sustainable forestry applicable in Estonian conditions, which includes ecological, economic and social research areas.

RMK Research Council

- **Jaan Liira**, Associate Professor of Plant Ecology, Institute of Ecology and Earth Sciences, University of Tartu
- **Ahto Kangur**, Professor and Head of the Chair of Forest Management and Forest Industry, Estonian University of Life Sciences
- **Kalev Jõgiste**, Professor of the Chair of the Forest Biology, Estonian University of Life Sciences
- **Kalev Sepp**, Professor, Head of the Chair of the Landscape Management and Nature Conservation, Estonian University of Life Sciences
- **Ülo Mander**, Chair of Physical Geography and Landscape Ecology, Professor of Physical Geography and Landscape Ecology, University of Tartu
- **Krista Lõhmus**, Associate Professor of Applied Ecology, Institute of Ecology and Earth Sciences, University of Tartu (member of the Research Council until the end of 2021)
- **Aigar Kallas**, Chairman of the Management Board of RMK
- **Kristjan Tõnisson**, Member of the Management Board of RMK

Finalised science projects

Increasing the purpose of protected forest fragments

Duration: 2018–2021

Project Manager: Kadri Runnel from the University of Tartu

Project's main executives: Anneli Palo, Piret Lõhmus, Raul Rosenvald, Indrek Tammekänd

RMK funding: EUR 152,517

The aim of the study was to find out how the management of the surrounding forest affects the preservation of natural values in forest fragments. The study measured correlations between the structure of protected forest fragments (0.5-15 ha), biota and management of the adjacent forest. The sample of sites included 127 forest fragments, the majority of which were key biotopes and the remainder were fragments of protected areas surrounded by commercial forest. In addition, the survival of mosses in 16 old crop tree stands was studied as an example of extreme treatment.

The study found that mosses, which are sensitive to environmental changes, survive better in old crop tree stands on clear-cut areas than on scattered old crop trees, and that older broad-leaved trees and a mix of tree species should be preferred in old crop tree stands.

Despite their small size, the protected forest fragments were found to be habitats for many species of conservation value. However, it was observed that adjacent felling reduced both the habitats (structural elements) and numbers of such species as well as diversity of species in the 30 m edge zone. The 30 m edge zone accounts for more than half (depending on shape) of the area of the less than 3 hectare fragments.

Based on the results, buffer zones would help to maintain the value of protected forest fragments (e.g. key biotopes) as habitats for species of conservation value. The purpose of buffer zones is to increase the habitat area of forest fragments and to support the biota of current forest fragments across the whole area, including edges. As climate change is likely to increase edge impacts in the near future (e.g. through more frequent storms), establishing buffer zones would also be in line with the precautionary principle. In order to increase the size of the fragments, less representative parts of the stand should also be included in them.

In the long term, an unmanaged buffer of at least 30 m will ensure area effectiveness and the prevention of potential damage in protected forest fragments. Further studies are needed to answer the question of whether stricter restrictions are required for edges open to certain directions or for particular forest types. In forest fragments that have already been felled to the edge, the regeneration of denser and taller forest (buffering capacity) must be promoted within at least 30 m of the outer edge of the fragment, including by avoiding thicket tending and thinning. The aim is to create a more uniform edge strip along the boundary of the forest fragment for sheltering the inner area in the future.

Although the study focused on forest fragments, the recommendations are, according to the authors, also applicable for the edges of larger forests with high conservation value.

Biocontrol efficiency and the use of antagonistic fungi to control *Heterobasidion annosum* in the spruce stands and the infestation of different plant types in fertile nursery types

Duration: 2019–2021

Project managers: Tiia Drenkhan from the Estonian University of Life Sciences, and Kadri Põldmaa from the University of Tartu

Project's main executives: Tiit Maaten, Kalev Adamson, Leho Tedersoo, and Rein Drenkhan

RMK funding: EUR 194,213

The growth of common spruce stands in fertile types of nurseries is inhibited by the widespread presence of root rot. Damage caused by root rot can be mitigated with the use of Rotstop®, a preparation made from the spores of the white-rot fungus. The project focused on analysing the effectiveness of Rotstop and the impacts of treatment on biota. In addition, the effects of other fungal species on root rot and the infestation of different types of forest plants by root rot were also investigated.

It was found that spraying stumps with Rotstop continues to be useful for root rot control, as significantly more of the white-rot fungus was detected on stumps treated with Rotstop 12 months later compared to control stumps that were not sprayed with Rotstop.

The efficiency of stump treatment with Rotstop increases at higher temperatures, i.e. the warmer the weather at the time of stump treatment, the better the result. However, as root rot spores are airborne at temperatures from 0 °C, it is necessary use the Rotstop treatment at lower average temperatures than the previously recommended 5 °C or above. Previous results also show that felling at lower temperatures does not prevent the spread of root rot infection. In future, decisions on using Rotstop should be made on the basis of air temperatures in the given year, and stumps should be treated when the average daily air temperature is consistently between 1°C and 4°C or above.

In terms of the abundance of fungal species, there was no significant difference between stumps treated with Rotstop and untreated stumps: the overlap of fungal families between both sites was at 75%, but fungal diversity was higher in treated sites. The use of Rotstop therefore has a neutral effect on fungal diversity and it does not significantly alter the natural fungal community.

Comparison of the interaction of potential antagonists with root knot showed that strains 1 and 4 isolated from the white-rot fungus in Estonia had the fastest growth rate, significantly faster than the growth of annosus root rot on spruce and pine. These strains in particular could have good prospects in further laboratory and field trials. Another observation was the frequent occurrence of the root rot parasite (*Sphaerostilbella broomeana*) and the representatives of the genus *Trichoderma* in combination with pine and spruce root rot.

Analysis of the roots of different forest plants planted in the trial plots showed that root rot is more prevalent in spruce and birch with exposed roots, whereas cold rot occurs more frequently on potted pine and birch. Cold rot was detected more frequently on roots than spruce root rot, and potted plants were in turn more susceptible to cold rot infection than plants with exposed roots. It appears that potted spruce plants are not ideal for cultivation in fertile habitat types due to significantly higher dropout.

Ongoing science projects

Impact of selective felling on the carbon balance of the forest eco-systems and economic aspects

Duration: 2020–2023

Project Manager: Veiko Uri from the Estonian University of Life Sciences

Project's main executives: Mats Varik, Mai Kukumägi, Jürgen Aosaar, Kristiina Aun, Mikko Buht, Marek Uri, Kaido Soosaar, and Alisa Krasnova

RMK funding: EUR 204,000

The topic of selective cutting has found wide resonance in Estonian society, but has at the same time remained predominantly a subject of theoretical debate. There is a shortage of underlying scientific knowledge and practical experience.

The main objective of the project is to study the ecological impact of selective cutting on the forest carbon balance compared to clear-cutting over a three-year period, and to evaluate selective cutting from an economic perspective. The study focuses on the carbon cycle, as this approach will allow an assessment of the impact of selective cutting on the functioning of the forest ecosystem over a relatively short period of time. Also, the impact on the carbon cycle and thus on the climate is now a key issue in assessing the environmental impacts of any forest management activity.

The trial selective cutting plots established in the course of the project will provide the basis for further research and can also be used as demonstration and training plots.

The project has got off to a successful start and has entered a phase of extensive and labour-intensive research. All five trial plots have been established as planned: three in pine stands and two in mixed stands. Each trial plot consists of three experimental variants: a clear-cut area, a selectively cut area and a control area.

The trial plots have been provided with the necessary research infrastructure and all of the planned studies are now underway. The biomass and productivity of the tree line and undergrowth in the stands have been estimated to ascertain the level of carbon stocks and carbon flows. Continuing work includes measurement of soil aeration and carbon leaching, as well collection and analysis of tree crown litter. In most of the trial plots, extensive soil surveys have been carried out to assess the carbon stocks in soil and decaying matter.

In the spring of 2022, a measurement tower with a corresponding station will be set up in one of the trial plots to estimate carbon flows using the turbulent covariance method, in cooperation with the University of Tartu. The hope is to collect sufficient data by the end of the year to start publishing the initial findings.

Three doctoral students in forestry are involved in the project, and the results of the study will be an important part of their dissertations.

Factors determining the protection capacity and growth of common spruce in pure and mixed stands: impact of climate change and growth site

Duration: 2021–2023

Project Manager: Priit Kupper from the University of Tartu

Project's main executives: Arvo Tullus, Katrin Rosenvald, Gristin Rohula-Okunev, and Pille Mänd

RMK funding: EUR 195,219

The aim of the project is to study the ability of spruce to adapt to climate change. To start with, observation plots were established in March, in the habitat types to be studied (hepatica, wood sorrel, drained swamp sorrel, mead wort, sedge / mead wort). The observation plots are located in two larger clusters, in Lääne-Viru County and Tartu County. Three stands with different proportions of 40-to-54-year-old spruce were selected for each habitat type. During the characterisation of the observation plots, measurements of the breast height diameter and height of the trees were performed, canopy volume was estimated, stand cross-sectional areas and productivity were calculated, and the increment of the diameter at breast height was determined.

Based on the cross-sectional area and the height of the first layer, the most productive pure spruce stands were those in the wood sorrel and hepatica habitat types. Mixed forests tended to have larger cross-sectional areas in wet habitat types, whereas pure spruce stands had larger cross-sections in drier habitats. The spruce diameter increase depended significantly on the habitat type: the average annual increment was higher in wood sorrel and hepatica stands and lowest in the mead wort stand. The composition of the stand had no significant effect on the increment of the diameter at breast height.

In May-June, ecophysiological characteristics of the shoots (photosynthesis, transpiration, water potential) were measured using light shoots formed during the 2020 growing season. The content of needle nutrients and polyphenolic defensive substances were later determined on the same shoots. Photosynthesis of spruce shoots in mixed stands was higher than those grown in pure stands. Photosynthesis was highest in the drained swamp sorrel habitat type and lowest in the mead wort habitat type. Measurements of physiological parameters are expected to continue in the summer of 2022, this time using shoots formed in the current year. There was no difference in the needle nutrient content between the pure and mixed stands. The sedge/mead wort habitat type had the lowest nitrogen and phosphorus percentages.

In each habitat type, in the stands with predominantly deciduous trees, three spruce trunks were equipped with water flow sensors and digital dendrometers. During the record hot summer of 2021, there were significant differences in water flows between habitat types; however, a more detailed analysis of the data is needed to assess the effects of high temperatures and drought episodes on tree water exchange and growth dynamics. Comparative measurements of water flows in the stands with different proportions of spruce within the same habitat type are planned for the summer of 2022.

Spruce resin productivity was estimated on the basis of three 24h harvests in June, July, and August. Such harvests facilitate a good characterisation of the effect of a particular day's environmental conditions on the resin flow. During the harvest in June, the amount of resin was dependent on both the habitat type (highest in the mead wort habitat) and the proportion of deciduous trees in a 5 m radius around the observed tree (resin flow increased with increasing proportion of deciduous trees). In the summer of 2022, measurements of the resin flow will continue, with week-long harvests during the active growing season. In 2022, increment cores will also be taken to measure the functional area of tree rings and trunk resin cavities.

RMK SCHOLARSHIPS

Endel Laas Scholarship

- for doctoral students at the Estonian University of Life Sciences
- EUR 4,800 per year
- Recipients in 2021: Kristjan Ait and Agnes Sepaste

Heino Teder Scholarship

- for Master's students at the Estonian University of Life Sciences
- EUR 3,200
- Recipients in 2021: Airiin Vaasa, Mari-Liis Kapp

Toomas Ehrpais Scholarship

- for students of Luua Forestry School
- EUR 1,917
- Recipient in 2021: Trond Bjarte Tagamets

Award-winning Master's thesis on annosus root rot

For the 20th time, RMK presented an award for the best Master's thesis in forestry at the Estonian University of Life Sciences, with Viljar Veeväli winning this year's award for his study of annosus root rot control. The amount of the award is EUR 700.

While a preparation based on the spores of the white-rot fungus (*Phlebiopsis gigantea*) and sold under the Rotstop® brand has been used for many years in Estonia to control annosus root rot, the Master's thesis by Viljar Veeväli showed that the strains of white-rot fungus growing in Estonia are much more effective in inhibiting annosus root rot than the currently used fungicide.

Annosus root rot is a major forest pathogen, causing an estimated EUR 790 million worth of annual damage in Europe. In Estonia, annosus root rot affects both the Norway spruce and the Scots pine.

RMK decided to award the prize to Veeväli because his work has a high application value and supports adaptation to climate change. The study has the potential to improve the quality of softwood timber and increase the volume of harvested rot-free timber. A forest that has not been damaged by root rot has a higher carbon stock and undamaged wood can be used to manufacture wood products with a long lifespan – both aspects are important for mitigating the effects of climate change.

Viljar Veeväli's Master's thesis 'Analysis of Potential Antagonistic Fungit to Control Heterobasidion spp.' was supervised by Tiia Drenkhan, researcher at the Estonian University of Life Sciences, and Professor Rein Drenkhan.

CARBON REPORT

RMK's carbon stock in forests and lands	258.9 million tonnes
CO_2 sequestrated during the year in RMK's forests and lands	5.67 million tonnes
CO_2 removed during the year from RMK's forests in the form of timber	2.89 million tonnes

CARBON REPORT

RMK's Climate Change Department has prepared the RMK Carbon Report, an overview of how much carbon RMK sequestered and how much it emitted in 2021. The carbon stock of all land and forest owned by RMK was also calculated.

Worthy carbon sink

About one third of Estonian land is under the use of RMK, among forest as well other lands (eg. bogs, grasslands). The carbon stock shows how much carbon is stored in the area. As at 2021, RMK had 258.9 million tonnes of carbon stock locked up in its lands. Two thirds of the carbon was stored in soil and one third in trees. Forests and forest land accounted for 85% of the carbon stock, and non-forested land for 15%.

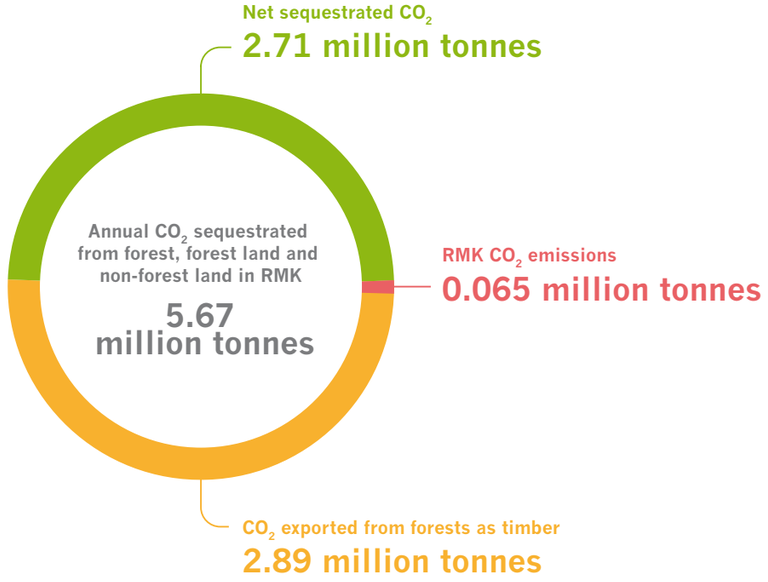
The carbon stock included carbon stored in the soil as well as carbon in aboveground sections of trees (trunk, canopy) and the belowground part (roots).

Carbon captured annually

Alongside a large carbon stock, which is already locked up underground for the most part, forests capture new carbon dioxide molecules from the atmosphere every year. Carbon sequestration depends on the growth rate of the forest. Carbon sequestration is higher in young and middle-aged forests and lower in older forests.

In 2021, RMK's forests, forestland and non-forest land sequestered 5.67 million tonnes of CO_2 from the atmosphere. Most of this was sequestered by growing forest, with peatlands being the main sinks among other lands, locking carbon into peat.

About half of the carbon sequestered during the year – 2.89 million tonnes of CO_2 – was extracted from the forest by RMK in the form of timber from clear cutting. In long-lasting wood products, this carbon remains locked up for many decades, and the manufacture of such products provides jobs for many people in Estonia. In addition, the substitution effect offered by wood, i.e., the fact that wood and wood-based materials can replace fossil fuels, plastics, steel and concrete, is very important. Unlike wood, these materials are not based on renewable resources and therefore have a more severe impact on the environment and climate.



Important to know

- The main greenhouse gases are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), which are expressed as a CO_2 equivalent (hereafter CO_2) for consistency.
- Trees sequester carbon dioxide (CO_2) from the air, but carbon (C) is stored in them and in other plants and soil. Based on molecular mass, one tonne of carbon equals 3,7 tonnes of carbon dioxide.

Carbon and climate change

- Carbon is all around us. It is in permanent circulation. Much of the carbon is in the oceans, a large amount is trapped in the ground, while a portion is suspended in the atmosphere.
- Plants, including trees in forests, absorb carbon dioxide from the air and store it within themselves. The problem arises when the atmosphere fills up with it faster than the vegetation and ocean are able to absorb it. Excessive amounts of greenhouse gases raise the temperature of the atmosphere – the climate is warming.

RMK's footprint

The extraction of carbon from forests in the form of timber is inevitably linked to activities that have an impact on the climate. Carbon is also released when you visit the forest to plant or when receiving visitors. To estimate carbon emissions, all activity by RMK was measured. Carbon emissions from various forestry activities (planting, maintenance, felling, chipping of energy timber, and the transport of timber to the customer) were taken into account, as well as carbon emissions related to nature conservation work, ditch and road maintenance, employee travel and RMK's offices, visitor centres, nurseries and separately even the Põlula Fish Farm.

During the year, RMK emitted 0.065 million tonnes of CO_2 during the course of its activities. For comparison, this is about 1% of the amount of carbon sequestered annually on land owned by RMK. Carbon was mainly emitted from forest management operations, and more specifically from the fossile fuels used there. The impact of RMK's various works is shown in the adjacent table and more details on the development of these numbers can be found in the full text of the carbon report.

Carbon emissions in the course of RMK activities	**CO_2 (t)**
Forestry management	47,442
Forest improvement	8,206
Forest planting	668
Nature protection works	1,152
Employee trips	1,908
Offices	1,779
Nurseries	1,342
Other real estate	2,294
Põlula Fish Farm	250
Total	**65,041**

Balance is strongly in the black

Taking into account the carbon sequestered by RMK's forest, forest land, and other lands (5.67 million tonnes of CO_2), minus the carbon extracted from the forest in the form of timber (2.89 million tonnes of CO_2) and the carbon emissions related to RMK's activities (0.065 million tonnes of CO_2), the result is a positive carbon footprint of 2.71 million tonnes of CO_2 sequestered from the atmosphere in 2021.

The Ministry of the Environment has released the preliminary greenhouse gas inventory data for 2020, according to which Estonia emitted 11.58 million tonnes of CO_2 in 2020. Most of this (8.29 million tonnes) was emitted by the energy and transport sectors. Comparing these figures, it can be argued that the carbon sequestered on RMK's land covers a quarter of Estonia's annual carbon emissions.

In Estonia, sustainable forest management is one of the, if not the only, ways to capture large amounts of carbon from the atmosphere and contributes to mitigating the effects of climate change. Through smart forest management, including timely cutting, channelling timber into long-term products, and high-quality and rapid reforestation, RMK can make a significant contribution to climate change mitigation.

EVALUATION CHAIN

The calculation of carbon stocks and sequestration is based on RMK inventory data. RMK knows the forest reserves in its possession and the volume increment. There are also descriptions of the volume of timber on non-forest land prepared through the use of remote sensing.

In the case of carbon stock, the carbon stored in the woody biomass (for each tree species) and the carbon stock in the soil were calculated. Carbon sequestration is calculated on the basis of the current annual increment, which is estimated for each tree species. Added to this is other plant production: twigs, roots, leaves, thorns, ground vegetation, and underbrush. Generally speaking, 80% of all woody biomass is located above ground and 20% underground.

Depending on the tree species, stem wood accounts for 80–90% of total above-ground biomass. The proportion of carbon varies in the different parts of the tree, and the calculations of the carbon report are based on the assumption that 50% of the dry mass of wood is carbon.

Soil respiration, or emission from soils, has been found based on results evaluated in scientific research, for mineral soils and peat soils separately.

Carbon sequestration was estimated using the NEP (net ecosystem production) method, which assesses whether an ecosystem acts as a sink or source of carbon. In the course of the method, total plant production that sequestrates carbon through photosynthesis has been calculated and the emission from the soil by soil respiration has been deducted from it. The difference between plant production and soil respiration indicates whether the ecosystem is carbon sequestering or carbon emitting.

Experts from the Environmental Agency and the Estonian Environmental Research Centre have been consulted in the preparation of the carbon report. The calculations and inputs used have been reviewed by Veiko Uri, Professor, Academician, Estonian University of Life Sciences.

References to the research and input materials used in the preparation of the RMK carbon report, together with a more detailed description of the calculation procedure, can be found in the full text of the carbon report. It is available for review on the RMK website.

FINANCIAL SUMMARY

Asset value	EUR 1.7 billion
Operating profit	EUR 84.4 million

BALANCE SHEET

(in thousands of euros)

ASSETS

Current assets	31.12.2021	31.12.2020
Cash	114,446	82,924
Receivables and prepayments	18,632	13,390
Inventories	23,662	19,349
Biological assets	39,342	30,053
Total current assets	**196,082**	**145,716**

Non-current assets		
Investment properties	892	773
Tangible assets	582,504	571,623
Intangible fixed assets	1,640	1,474
Biological assets	914,176	746,794
Total non-current assets	**1,499,212**	**1,320,664**
TOTAL ASSETS	**1,695,294**	**1,466,380**

LIABILITIES AND EQUITY CAPITAL

Liabilities

Short-term liabilities	31.12.2021	31.12.2020
Debts and prepayments	20,182	13,928
Short-term provisions	3,027	3,049
Total short-term liabilities	**23,209**	**16,977**

Long-term liabilities		
Long-term prepayments	0	6
Long-term provisions	615	642
Total long-term liabilities	**615**	**648**
TOTAL LIABILITIES	**23,824**	**17,625**

Equity capital		
State capital	1,169,680	1,174,064
Retained profit	241,251	93,403
Accounting year profit with profit from the revaluation of biological assets	260,539	181,288
TOTAL EQUITY CAPITAL	**1,671,470**	**1,448,755**
TOTAL LIABILITIES AND EQUITY CAPITAL	**1,695,294**	**1,466,380**

INCOME STATEMENT

(in thousands of euros)

	2021	2020
Revenue	221,329	187,540
Other operating revenue	3,554	49,032
Gain from biological assets	247	351
Changes in inventories of finished goods and work-in-progress	4,381	-6,507
Work performed by an entity in the production of fixed assets for its own purpose and capitalised	33	38
Goods, raw materials and services	-98,067	-99,808
Miscellaneous operating expenses	-9,987	-9,808
Labour costs	-27,098	-27,652
Depreciation and impairment of fixed assets	-11,295	-10,702
Other operating expenses	1,376	-99
Operating profit	**84,473**	**82,385**
Other financial income and expenditure	-23	109
Profit before income tax	**84,450**	**82,494**
Income tax	-5,444	-14,662
Profit for the accounting year	**79,006**	**67,832**
Revaluation of biological assets	181,533	113,456
Accounting year profit with profit from the revaluation of biological assets	**260,539**	**181,288**

APPROVAL OF THE SUPERVISORY BOARD AND THE MANAGEMENT BOARD

Randel Länts
Chairman of the Supervisory Board

Yoko Alender
Member of the Parliament of Estonia, Environment Committee

Ando Leppiman
Representative of the Ministry of Economic Affairs and Communications

Aigar Kallas
Chairman of the Management Board

Mihhail Korb
Member of the Parliament of Estonia, Economic Affairs Committee

Margit Martinson
Representative of the Ministry of the Environment

Merike Saks
Representative of the Ministry of Finance

Tavo Uuetalu
Member of the Management Board, Forest Management

Mihkel Undrest
Expert on the proposal of the Minister of the Environment

Hardi Tullus
Representative of the Ministry of the Environment

Ülo Needo
Expert on the proposal of the Minister of the Environment

Kristjan Tõnisson
Member of the Management Board, Nature Use

AUDITOR'S REPORT

Grant Thornton

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INDEPENDENT AUDITORS' REPORT

To the supervisory board of Riigimetsa Majandamise Keskus (RMK)

The accompanying summary financial statements on pages 58 to 60, which comprise the balance sheet as at 31 December 2021 and the income statement for the year then ended, are derived from the audited financial statements of RMK for the year ended 31 December 2021. We expressed an unmodified audit opinion in those financial statements in our report dated 23 February 2022. The summary financial statements and audited financial statements do not reflect the effects of events that occurred subsequent to the date of the auditor's report on the audited financial statements, which may require adjustment of, or disclosure in, the audited financial statements.

The summary financial statements do not contain all the disclosures required by the Estonian Financial Reporting Standard, which was applied in the preparation of the audited financial statements of RMK.

Reading the summary financial statements, therefore, is not a substitute for reading the audited financial statements of RMK.

Management's responsibility for the summary financial statements

Management is responsible for the preparation of the summary financial statements derived from the audited financial statements in accordance with the accounting and measurement requirements of the Estonian Financial Reporting Standard.

Auditor's responsibility

Our responsibility is to express an opinion on the summary financial statements based on our procedures, which were conducted in accordance with International Standard on Auditing (ISA) 810 *Engagements to Report on Summary Financial Statements*.

Grant Thornton

Opinion

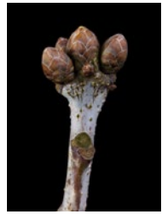
In our opinion, the summary financial statements derived from the audited financial statements of RMK for the year ended 31 December 2021 are consistent, in all material respects, with those financial statements, in accordance with the accounting and measurement requirements of the Estonian Financial Reporting Standard.

Mart Nõmper
Sworn Auditor
License number 449

Grant Thornton Baltic OÜ
Licence number 3
Pärnu road 22, 101451 Tallinn
23 February 2022

REGISTER OF PHOTOGRAPHS

Front cover
Baltic pine
Pinus sylvestris



page 6
Common oak
Quercus robur

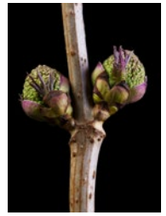
page 7
Grey alder
Alnus incana

page 12
Baltic pine
Pinus sylvestris

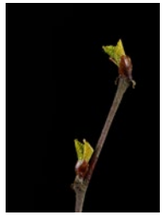
page 13
Silver birch
Betula pendula

page 26
Norway maple
Acer platanoides

page 27
Common hazel
Corylus avellana

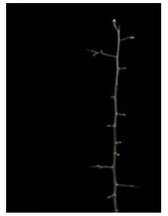


page 34
Red elderberry
Sambucus racemosa



page 35
Moor birch
Betula pubescens

page 42
Common ash
Fraxinus excelsior



page 43
Hawthorn
Crataegus

page 50-51
Small-leaved linden
Tilia cordata

page 56
Norway spruce
Picea abies

page 57
Willow
Salix

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Text:
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Translation:
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Design and layout:
Creative Agency PULT

Photos:
Jarek Jõepera

Typography:
Geogrotesque
News Gothic MT

Paper:
cover Munken Lynx 300 g
content Munken Lynx 120 g

Printed by
Paar