The pathway for efficient operations in private forests

O1: Handbook

Imprint

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INTRODUCTION

An innovative handbook for forest owners is developed to increase income from their forest through lowering costs without neglecting environmental constraints on one side and efficient marketing of wood and forest services on the other side.

Handbook is presenting situation in all participating countries by giving the insight on private forest owners sector and their main innovation needs. Partners will identify the needs of forest owners and address them in one chapter of this handbook. Selected and presented topics (in handbook) will be further elaborated in technical guidelines that will further support efficient forest operations in private forests.

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ESTONIA

Author: Livia Pošlin

1.1. Forests and forestry in Estonia

In Estonia the total area of forest land is 2.33 million hectares, which is almost half of the country's territory (51.4 %). 48% of forestland is private (by the law there are about 80,000 private forest owners, another 33,000 private forest owners have their forest (at least 0,1 hectares) growing on a different land type). 24.6 % of the forests are protected and nearly 39% of the stands are over 60 years old. Mostly growing trees are pines (31.3%), birches (29.3%) and spruces (18.8%). In this century the pine forests have been reduced a little bit, but there has been small increase among spruce, birch, grey-alder forests and in aspen groves.

In 2017 the total stock was 486 million cubic meters and the area of the stands was 2.16 million hectares (Table 1). The growth of managed forest land has grown up to the last years and reaches 14 million tons annually. Based on In Estonia there is 2,023,000 hectares managed forestland. Its growing stock is 407.4 million cubic meters.

Table 1: Area of forest land and annual growth of managed forests (Source: Environment Agency).

	2000	2005	2010	2015	2016	2017	2017/2020
Forest land, thousand ha	2245	2270	2221	2310	2313	2331	103.8%
Area of stands, thousand ha	2096	2107	2080	2146	2143	2157	102.5%
Total stock of stands, Mm^3	428	432	449	484	485	486	112.2%
Annual growth of managed forests, thousand m^3	12832	12975	13244	14164	1468	14094	109.8%

Compared to year 2000, both total forest stock, forest stock per hectare as well as the increase in the wood stock growth has gradually increased.

Estonian Forestry Development Plan until year 2020 marks that the annual cutting in Estonia's forests should be 12-15 ml m^3. In 2017 the cutting volume reached 11 million m^3 (Figure 1). At the moment Estonian Forestry Development Plan 2021-2030 is being compiled and the suggested cutting volumes might change for the next 10-year period considering also LULUCF sector's carbon sequestration responsibility for Estonia.

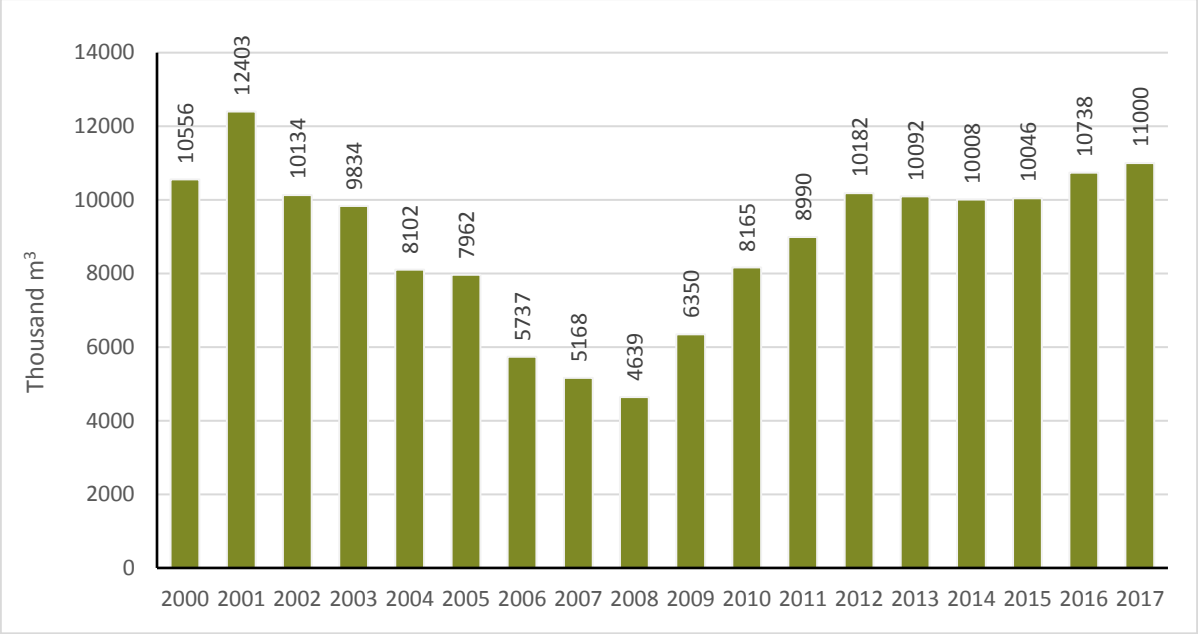

Figure 1: Cutting volumes in Estonian forests (Source: Statistics Estonia [1]).

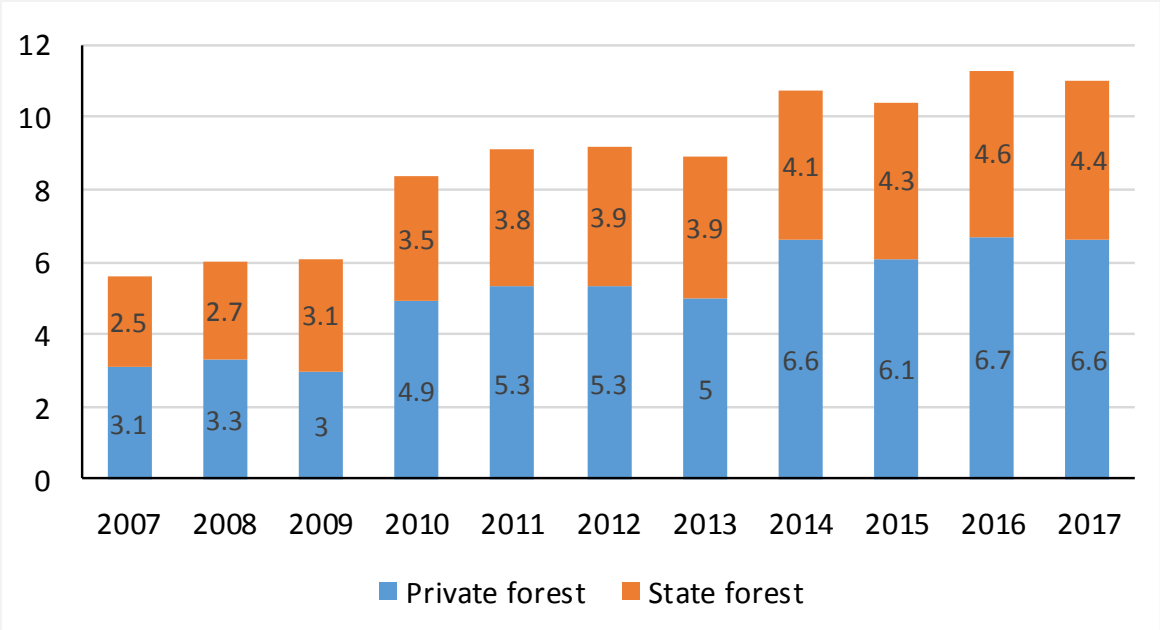

Figure 2: Logging volumes by forest owners (in private and state forests) 2007-2017 in Mm^3.

Based on Yearbook Forest 2017 [2] in 2017 there was reforestation done on 9,571 hectares in the state forests. 75% of the reforestation was planting, 22% was left for natural regeneration. Seeding has continuously declined – in 2016 it was 3%. There was planted mostly spruce (57%) and pine (37%), the rest was birch. The scarification was made on 7917.3 hectares in state forests. The current Estonian Forestry Development Plan foresees that by 2020, 40% of private forest regeneration fellings will be renewed by planting and/or sowing. To achieve this goal 11.7 million forest plants per year are needed in private forests.

Accordingly to Analysis of cultivation material production 2014-2016 [3] in private forests there were planted on 5,377 hectares and sowed on 475 hectares. Altogether there were used 8.7 million forest plants.

In Estonia forest regeneration is subsidized every year and its popularity has increased a lot. Due to that about 77% of the applied plants have got approval for subsidy, there hasn't been enough for the rest in the budget.

1.1.1. Issues regarding forests and forestry in Estonia

In the processes of compiling new Estonian Forestry Development Plan 2021-2030 [4], experts who are representing different stakeholders brought out 12 issues regarding Estonian forestry. The reason for selecting issues is that they are giving focus on the Forestry Development Plan that is being composed at the moment. These 12 issues are following:

- the financial mechanism for preserving the natural values of forests is not sufficient, sustainable or fair;
- measures to fairly compensate for the restrictions have not been sufficient;
- compensation of forest owners and local governments for loss of income due to restrictions is often insufficient or non-existent;
- the impact on forest management and land use on the carbon stock of Estonian forests needs to be clarified with the aim of increasing the carbon stock and carbon sequestration capacity of forests through knowledge-based management;
- the cutting volume is at level that threatens biodiversity through changes in the age structure of forests and may threaten other ecological functions of forests. *When wording the last problem, the experts representing different stakeholders were unable to reach consensus*;
- the problem of maintaining and stimulating the productive (woody and non-woody) functions of forests is that the maintenance and development of forestry-related infrastructure (roads) is not sufficiently guaranteed;
- the problem of preserving, protecting and adequately improving the biodiversity of forest ecosystems, which changes tree species mixture of private forests economically less valuable tree species;
- problem related to the maintenance of socio-economic functions and conditions that forest management and forest protection are in one ministry;
- the problem related to the maintenance of socio-economic functions and conditions that the state does not have a long-term comprehensive plan for the proportion of managed forests, restricted forests and strictly protected forests, with an impact assessment on forestry education and employment. The development plan explains that Estonian forestry does not have a long-term vision and that forest management scenarios have not been prepared together with an impact assessment on forestry education and employment. Nor does the state have a long-term plan for the proportion of managed forests, forests with economic restrictions and strictly protected forests;
- the continuous decrease in the number of individual forest owners and the forest land owned by them and the intensive increase in the forest area of legal forest owners;

- insufficient teaching in schools of ecological traditions and forest-related traditions of Estonian folk culture;
- natural sanctuaries would speak to more people in today's culture if they were interpreted in terms of the relationship between forest and health.

Numerously most problems were highlighted in the fields of ecology and economy. Issues were also formulated that were either contradictory in substance or dealt with the same issue from different angles. Although there was mutual understanding about the need to protect nature values and that the financial mechanism for preserving forest values was not sufficient, sustainable or fair for forest owners. Regarding forest management it has been acknowledged that the annual harvest will decrease due to the decline of mature forests in the future, but activities to ensure long-term wood use are important.

1.1.2. How climate change affects forestry in Estonia?

There have been made some future prognosis how climate change affects forestry in Estonia. The peculiarity of Estonia is the variation of air temperatures over the years and this will remain high. The winters will certainly be warmer in the future. Precipitation and humidity are very low throughout the year, and summer precipitation may decrease. In more negative scenarios, weather changes lead to droughts, storms, floods.

It is difficult to predict the composition of tree species in the future. However, it can be predicted that a significant amount of tree species will not be accrued, but neither will they disappear. Estonia is located in the northern part of area of dominant tree species, there is few hardwoods. As the weather gets warmer, the better for deciduous trees. The situation of spruce trees is the most problematic in the future. Estonia’s weather varies greatly over the years. For conifers, winter minimum temperatures become crucial, the frost on the cone has a negative effect because it breaks certain substances from the needles - the tree consumes energy to rebuild them and becomes more susceptible to disease. As the air warms up, the spread of diseases, especially thorns and rootworm will be more intense. Windstorms are a problem in the management of spruce trees, with less risk for pine and mixed forests.

Compared to half a century or a century ago, our forests have started to grow faster. Trees grow meter and a half higher than a century ago in the same unit of time. Therefore, the rotation may become shorter in the future. When considering the increase in rainfall, management should plan how to do drainage and clean up the forest roads.

Approximately 38,000 people are employed in the forest sector, as well as people who are indirectly connected with forests and the management thereof, e.g. people working in the fields of transport, tourism and collection of non-wood products. Climate change may considerably affect the capacity of the sector and its share in economy and employment. The composition of forest crop and through that the quality and availability of timber from excessively wet forests may deteriorate as the result of climate change and the costs in the forestry sector may increase. Estonian Climate Change Adaption Development Plan until 2030 [5] suggests that, investments in the infrastructure of forests and the outreach activities should be increased in order to ensure the preservation of use of timber and the quality of timber and to thereby increase carbon sequestration. Forest growers and owners must be

given advice for using nature-friendly forestry methods which mitigate climate change. More attention should be paid on forest plant growing, forest selection, maintenance of stands, forest protection and forest pathology.

Due to climate change, species that are currently not represented or are scarce in Estonia but causing more and more damage in the neighboring countries (including invasive alien species) are an increasing risk in Estonia.

1.2. Forest production chains

In Estonia the main purpose of wood industry is the production of conifer logs and logs d<18. Figure 3 shows the basic scheme of wood use in Estonia. After clear cut the wood will be transported to sawmills which are taking the best part of the timber that is meant for construction and furniture details. Residues from the forest and leftovers from sawmills, more than half of cutting volume, are being used for energy. Residues and leftovers are used for woodchips and pellets. Woodchips are being produced mainly for domestic use and pellets for export.

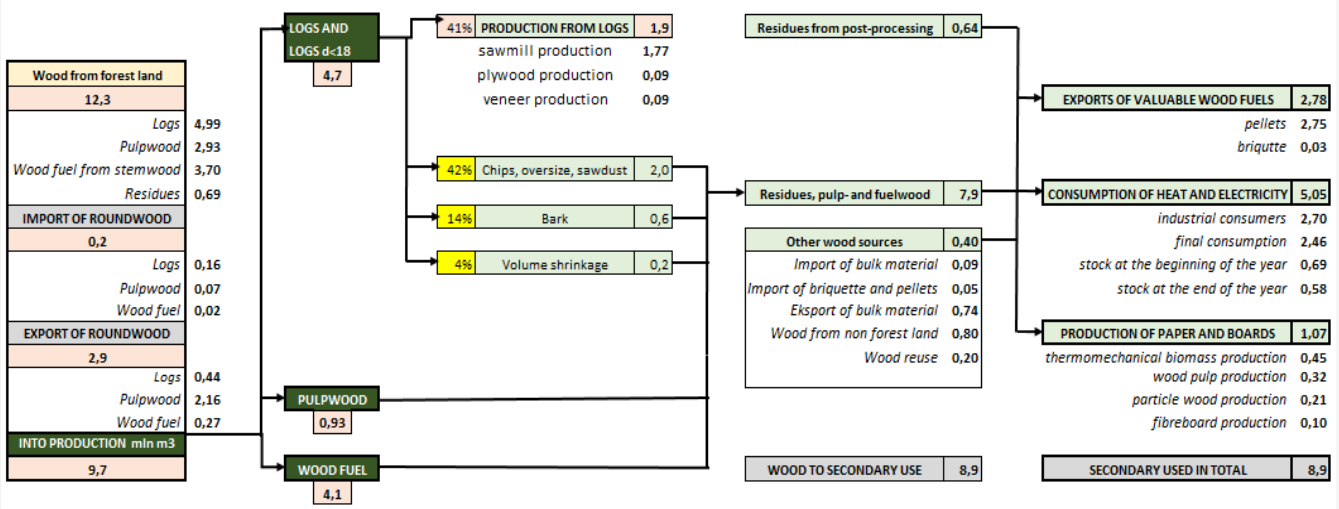

Figure 3: Millions of m^3 wood used in 2017 in Estonia (Source: Wood Balance in 2017 by Environment Agency [7]).

In Estonia Graanul Invest group is one of the biggest pellet producers is Europe. Pellets are produced from softwood sawdust and wood chips. Another famous forestry company is Estonian Cell which produces high-quality chemi thermo mechanical aspen biomass, which is being used in paper industry. It's important that they are able to use also aspen wood with lower quality. They export all the product, 170,000 tons of aspen biomass per year.

1.2.1. Reforestation

When reforesting it's important to consider what tree species to prefer. Mostly it depends on habitat site type. The fastest growing trees are spruce (9.6 m^3/ha/a), grey alder (6.6 m^3/ha/a), aspen (9.4 m^3/ha/a), birch (6.5 m^3/ha/a) and pine (7.4 m^3/ha/a). But it's also important to

consider that birch and pine trees are growing on more poor soils also. When a forest owner is planning activities and wants to take increments in economical wise into account, the volume increment should be multiplied by the price. For a forest owner this would be 'stump price' – money which would be kept after wearing felling costs. These kinds of calculations show that conifers have twice-triple advantage ground comparing to hardwood. Within the last decades the average stump price has been distributed approximately like this: if spruce's stump price is 100%, then pine's is 90 – 110%, birch's 70-85%, aspen's 30-45% and alder's 20-50%.

There are very good results of growing birch forests at better site types when managing forests consistently by thinning, trimming etc. The most profitable would be two-storied stand, where the first layer of forest as dominant tree species would be birch (or also pine) and the second layer would be spruce. When looking at the general efficiency of different tree species (whole increment at a certain period with dead timber) at identical site conditions, then the most successful is to grow conifers. The increment in the best birch forests can be quite high, but the productivity (based on volume) is higher in conifer stands.

There are few ways to reforest – to seed, to plant or to leave it for natural regeneration. When deciding to seed then usually it's been seeded pine, less birch. What comes to planting then usually it has been planted spruce, pine, birch, black alder, hardwood and linden. As is the custom the planting is for fertile and seeding for less fertile or rocky soil. Seeds can be collected by own from forest or bought (most important such as spruce, pine, birch, black alder, ash) from Estonian State Forest. When purchasing conifer seed it's There are recommendations to seed pine in the early spring after the snow has melt, birches such as pubescens birch (*Betula pubescens*) and European white birch (*Betula pendula*) should be seeded in early spring or late summer. Oak and ash can be seeded in spring and in autumn, but the rodents can damage autumn-seeds.

Soil preparation is being done before the seeding, planting and also before natural regeneration. Soil can be prepared fully or partly. Due to the price it is preferred to be done partly. The preparation can be mechanized by ploughshare or manually by shovel. There are being used different types of partial soil preparations:

- **Furrows** - for too wet soils or to alvar landscape for "fattening" the soil layer. Plants are being planted on top of the furrow.

- **Rows** – are being made for temperate or for dry soils digging them over by mixing with mineral soil of raw humus. The seeding is done in continuous or intermittent rows. It's more reasonable to sow in intermittent rows – in every meter 0.5 m of seeding.

- **Patches** – are being made on recent clear areas where the roots have not been plucked up. The size of the patch depends on the fertility of the site type. There are bigger patches on fertile areas. When planting on a patch, then one maintenance time could be enough during the planting year. On small clearing the soil can be prepared by shovel. In this case the usual size of patches should be 50x50 cm, but on a less fertile land the patches can be smaller. When sowing the distance between patches

should be around 1-1.5 m, when planting then 1.5-2 m. There should be 15-25 conifer seeds sowed on seeding patch, which makes it 0.3-0.4 kg seeds per hectare.

Spades or planting pipes are being used mainly for planting the forest. Planting bars and soil axes are being used less often. Plants can be carried in buckets or in special plant carrying equipment that is convenient to attach to the body.

In Estonia there used to be regulation which regulated reforestation with certain origin reforestation material. Due to the similar climate conditions in the whole country now it's allowed to use reforestation material anywhere in Estonia irrespective of the origin of material.

The forest material producer has to check the quality of the plants and assure that they are healthy and viable. The suppliers of the reforestation material are obligated to send twice a year marketing report about the cultivation material to Estonian Environmental Board. That's necessary for the overview of how much has been marked, imported, exported etc. It helps to give prognosis whether the production needs should be increased or if there is enough demand.

When reforesting it's recommended to prefer the seeds (or plants grown out of them) from the same region. Estonian reforestation material production has increased throughout the recent years. Ideally the production should increase even more so the local reforestation material could cover most of the needs in the country.

The easiest is to order the reforestation plants from Forest owners' association, who generally has contracts with bigger manufacturers and mediators. Usually the plants should be preordered for half a year, otherwise there could be no plants left on the market.

1.2.2. Forest maintenance

Tending of thicket

After the reforestation the weed around the small tree plants starts blocking the sunlight and nutrients. In Estonia there are no chemicals allowed to use in forests. Methods for killing weed are treading weed under feet, cut weed with scythe or with trimmer. Weed should be repelled up to 5th year after cultivation. On the first year of cultivation the weed is being repelled 1-3 times per year, later on 1-2 times per year.

Maintaining forest

According to forest age and health conditions maintenance fellings are divided into:

- **Cleaning** is done in the forest aged 5-20 or in the stands with diameter up to 8 cm. Main purpose of this felling is to design tree species mixture and to improve light and victual conditions.
- First **thinning** is usually done in 20-40 year-old stand. Main purpose of thinning is to complete designing tree species mixture, by raising the value of a stand. After the cleaning there are growing 2,000-6,000 trees per hectare, but in the mature age

(before clear cut) there could fit only 400-600 trees per hectare. There wouldn't be enough light, nutrients and water for all the trees. Thinnings are considered to be almost the most important maintenance job in forests. When thinning forest, it's useful attributes should be preserved and increased.

- Sanitation cutting is usually done for sick and damaged and also for dying trees.

1.2.3. Clear cutting

In Estonia the average clear-cut area is 1.5 hectares. In the case of clear cutting 20-70 seed trees (pines, white birches, ashes, oaks, black alders, European white elms or Scots elms) dispersed or situated in small groups will be left as seed trees per 1 hectare. Although it's not necessary to leave seed trees if there are no suitable trees for seed or if there is viable undergrowth of the tree species suitable for the forest site type. Also, it is not mandatory to leave seed trees on a part of the cutting area which is located at a distance of less than 30 meters from the edge of a conifer stand of the seed-bearing age or less than 50 meters from the edge of a white birch stand of the seed-bearing age.

Old crop trees (trees that are necessary to ensure the biological diversity, or the preserved standing parts of such trees) will be left permanently in the clear cutting area with the total volume of stem wood of at least five solid cubic meters (2-3 trees) per hectare or, in the case of a cutting area sized over five hectares, at least ten solid cubic meters per hectare. There are doubts if that amount of old crop trees is enough for the biodiversity and environmentalists have made the proposal to demand the double of the amount of old crop trees to be left irrespective of the size of the clear-cut area.

1.2.4. Service providers

In the private forests there are working private forest owners and forestry companies who provide the service. In Estonia there are about 4700 legal persons who own forest. Some of them are forest companies and they manage their forests intensively to gain as much profit as possible. The biggest forestry company is Estonia is Tornator Estonia who owns over 60 000 hectares forest land in Estonia. Average individual forest owners who have only little knowledge about forestry tend not to manage their forests or if they do then on much smaller scale. They might do the forestry work by themselves or order it from the service provider – directly from forestry companies or from forest owners' associations who have contracts with forestry companies.

The biggest forest owners' association in Estonia is Ühinenud Metsaomanikud (United Forest Owners' Association) with 1144 members who own 172 000 hectares forestland. They provide typical forest management services, possibility for forest owners to use drone and certification (FSC and PEFC) service. Forest certification is a mechanism that helps to control the quality of forest operations. There are PEFC and FSC certifications in Estonia. FSC forest certification is distributed into: FSC forest management certification, FSC supply chain certification, FSC controlled wood. PEFC forest certification is distributed into: PEFC forest management certification service.

1.3. Wood market

The options of selling wood are selling standing trees and selling wood at forest roadside. Selling wood at forest roadside requires quite good knowledge about forestry and there is a lot of risk for the owner to succeed in the best way with the forestry work and wood sales. Selling standing trees requires less work for the forest owner, but there will be uncertainty about the real value of the forest and the profit might be smaller comparing to the first method.

Estonian Private Forest Centre has a contract with a forestry expert in order to have the quarterly overview of the wood prices. Table 2 shows the overview of wood prices of different assortments from 2011-2018.

Table 2: Wood prices without sales tax (Source: Wood price information by Estonian Private Forest Centre [6]).

Sortiment eur/tm	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2011-2018**
pine log	65	66	70	74	69	66	70	81	70.2
pine poletimber	61	61	64	68	64	62	65	77	65.4
spruce log	62	63	71	73	68	66	72	80	69.4
spruce poletimber	60	61	65	68	64	63	68	77	65.7
birch bundle	80	95	100	96	91	90	93	117	95.2
birch log	58	59	59	59	60	59	61	74	61.1
aspen log	38	37	41	41	40	37	37	43	39.3
alder log	39	39	39	39	37	33	33	40	37.4
pine pulpwood	43	33	37	36	30	32	36	60	38.4
spruce pulpwood	42	31	36	35	29	30	36	60	37.5
birch pulpwood	43	38	35	35	33	30	32	55	37.6
aspen pulpwood	30	32	34	32	30	27	27	39	31.3
firewood	27	25	24	24	23	21	23	31	24.8

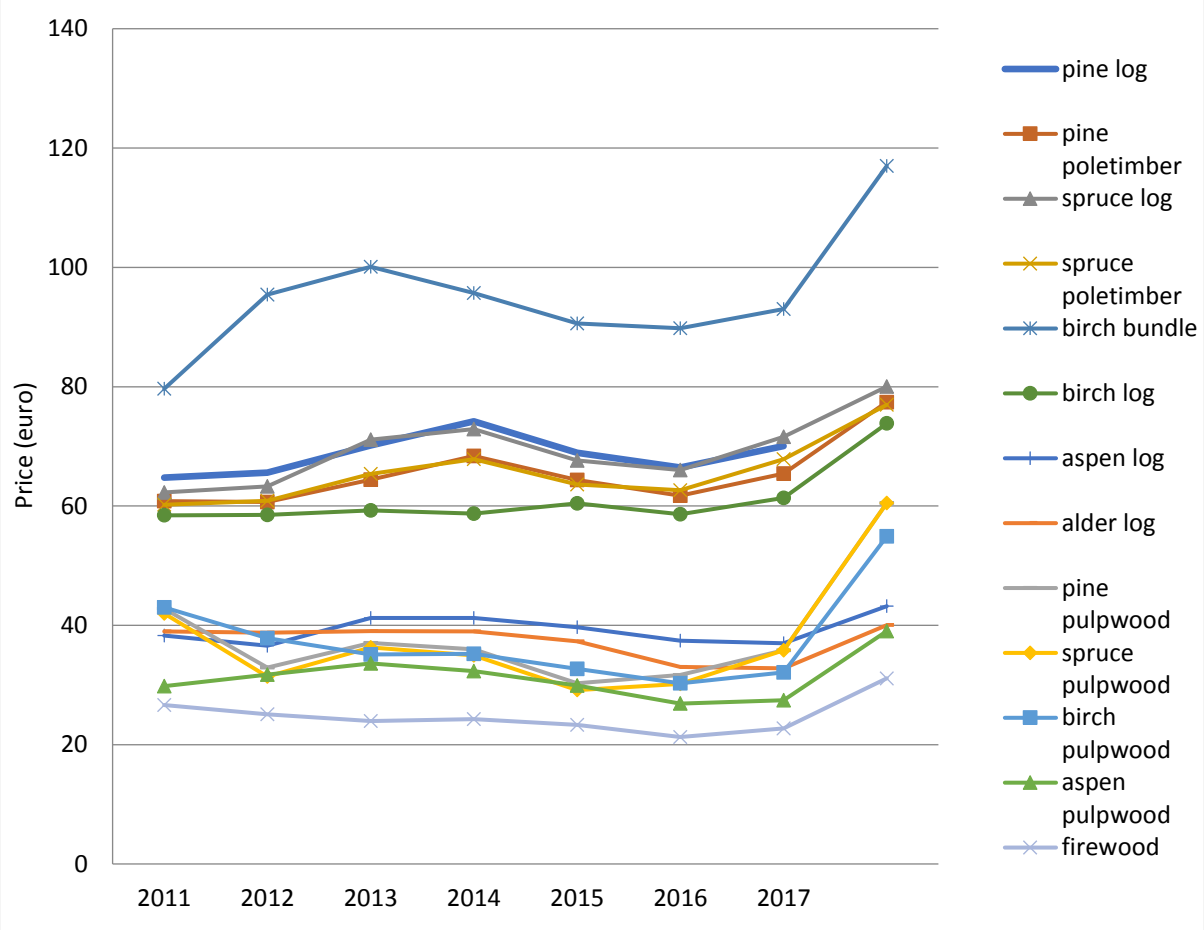

Figure 4: Average wood prices per year without sales tax.

Europe is expecting a huge supply of damaged wood in summer 2019, which in turn will depress the price of cheaper assortments, pulpwood and firewood. Also, in Estonia there are signs of a rapidly growing bark beetle's damage. While there is similar demand for conifer logs as previously or slightly downward, then among birch log buyers there are different directions and it's expected that the businesses are rising and falling prices in the second quarter in 2019. The spring caused decrease in the felling activity and the offer of round logs which will not bring to the market any increase of prices in the second quarter of 2019.

During the last three years the import of wood chips has increased. The other way around is with wood pellets - their import has decreased. What comes to export of wood chips and pellets then this has increased during last three years. The import of fuel wood in logs, in billets, in twigs, in faggots or in similar forms has increased remarkably during last three years, but the export shows no trend in decrease or increase. Export of wood pellets and wood chips is increasing until wood usage will be limited by regulation or market demand. The import of biofuels depends on domestic wood demand, wood prices, weather for forest works and renewal of forestry development plan, but since demand for wood fuel is increasing, export situation is rather promising. Table 3 shows the import and export of wood fuels on year 2017.

Table 3: Import and export of wood fuels in 2017.

	Import		**Export**	
	euro	ton	euro	ton
Fuel wood, in logs, in billets, in twigs, in faggots or in similar forms; wood in chips or particles; sawdust and wood waste and scrap, whether or not agglomerated in logs, briquettes, pellets or similar forms	**5 226 919**	**103 729**	**209 442 461**	**1 979 447**
Fuel wood, in logs, in billets, in twigs, in faggots or in similar forms	**1 479 061**	**15 601**	**17 614 055**	**226 613**
of which coniferous	785 278	9 966	4 513 212	90 166
of which non-coniferous	693 783	5 635	13 100 843	136 447
Wood in chips or particles	**1 494 918**	**48 644**	**31 262 897**	**477 196**
of which coniferous	557 696	13 211	27 148 404	424 613
of which non-coniferous	937 222	35 433	4 114 493	52 583
Sawdust and wood waste and scrap, agglomerated in logs, briquettes, pellets or similar forms	**1 846 859**	**23 715**	**159 882 757**	**1 263 081**
of which wood pellets	1 289 498	8 198	159 317 745	1 250 596
of which other	557 361	15 517	565 012	12 485
Sawdust and wood waste and scrap, not agglomerated	**406 081**	**15 769**	**682 752**	**12 557**
of which sawdust	253 264	10 334	108 257	460
of which other	152 817	5 435	574 495	12 097

In 2017 total volume of wood balance was 16.9 ml m^3 (Figure 4) which is ca 5% bigger than the wood balance on year 2016. Most important wood sources were forest felling (73% of total balance) and import (20%). The biggest areas of use were exporting (62%) wood and its products and using wood for energy (34%).

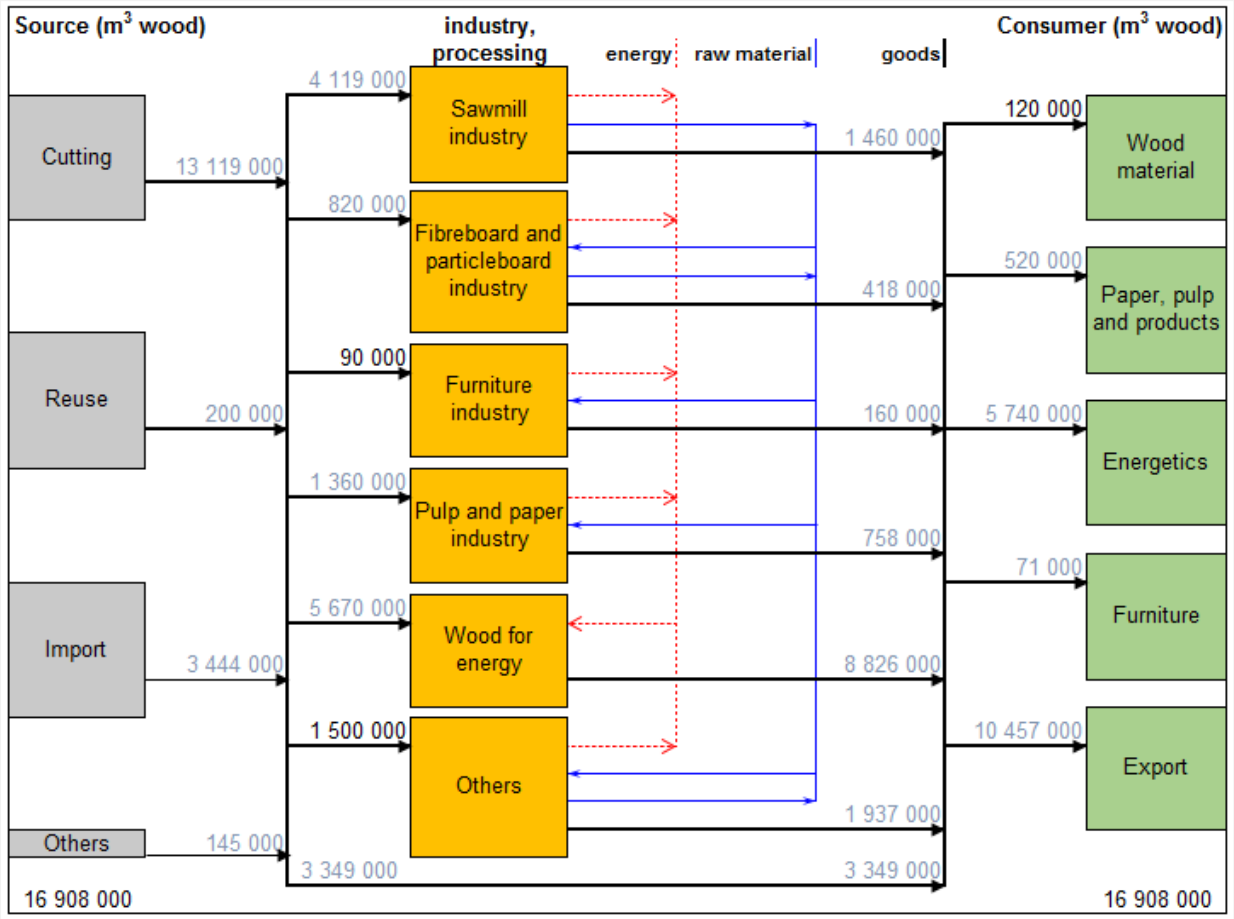

Figure 5: Generalized chart for the wood balance in 2017 (Source: Wood Balance 2017 by Estonian Environment Agency [7]).

In the process of compiling wood balance there were also observations made for prognosis about the need for wood in the coming years. The forestry companies estimated that the need for wood on year 2021 would be covered by an increase in imports of 1.5-2m^3 or cutting volume at level 13.5 ml m^3.

In 2017 80% of the exported round wood, 2.5 million cubic meters or a quarter of the felling volume, was paper wood, which is currently practically unused in Estonia. Saw logs are also sold in frontier areas and near ports, but in smaller quantities and in situations where lower transport costs make it more profitable to sell material for export than to industry. Within 7 years, imports of saw logs have increased 81%, most of it comes from Russia, but Estonia is increasingly importing material for post-processing from Latvia, Finland and Sweden. To some extent Estonia exports logs to China. 70-80% of wood products (related to construction – sawn and planed timber, prefabricated houses, window frames, doors, glue-laminated timber, wooden furniture and their parts) are exported. In 2017 most of wood products were exported to Sweden, Finland, Norway and Germany. Continuously Estonia is exporting only a little to Eastern Europe.

1.4. Forest ownership

Here in this paragraph is overview about forest ownership based on Yearbook Forest 2017 [2] by Estonian Environment Agency. Estonia there are about 113 000 forest owners with 1066 mil ha of forestland. Approximately another half of the forests belong to State Forest. Based on the data that was collected in 2015 the average size of private forest ownership was 9.3 ha. Individual persons had that 6.4 and legal persons 65.7 ha. 44.4% of individual forest owners own less than 2 ha of forestland. So, the forestry land is quite fragmented. Average size of legal person's forest land is 65.7 ha. Ordinary forest owner lives far from property and has no forestry education.

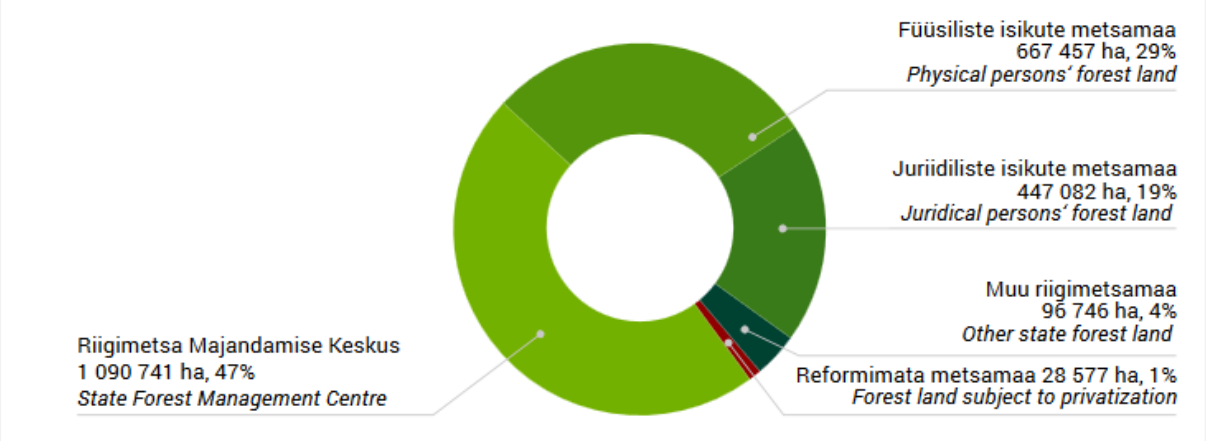

Figure 6: Distribution of forest land area by ownership categories (NFI 2017).

54.6% of private forest owners are females and owning 36.7% of private forest land. The average size of forest land owned by male is 7.5 ha and owned by female is 5.2 ha. Thus, males own more forest land and the average size of the forest that belongs to them is noticeably bigger than females'.

Based on age the biggest size of forest land is owned by individual forest owners in age group 41-50 years (22.4% of forest land among the individual owners), 51-60 years (24.9%) and 61-70 years (19.6%). In those age groups the size of forest land is bigger than in other age groups. The younger the owner, the smaller is his/her forest land. Also, the elderly people hold smaller forest lands comparing to middle age people.

The tree composition of private forests is more inclined towards deciduous trees (58% of the area and 52% of the growing stock) while in state forests deciduous trees cover roughly 34% of the forest area and 32% of the growing stock. One of the primary reasons for the greater representation of deciduous species in private forests is that afforestation tended to occur on former (private) agricultural land. The intensity of total fellings in private forests has been increasing (~2-3 m^3/ha/a in the mid-1990s to ~6 m^3/ha/a in the first half of the 2010s), whereas in state forests it has been more stable (around 2-3 m^3/ha/a) during the last two decades. Nevertheless, there is still criticism towards private forest owners for not doing enough investment-based activities such as reforestation or pre-commercial thinning.

Within last ten years there have not been submitted any forest notifications (they are compulsory when planning cuttings) about the third of the private forest land.

1.4.1. Private forest owners

By the law In Estonia there are about 80,000 private forest owners. Another 33,000 private forest owners have their forest (at least 0,1 hectares) growing on a different land type. There are 30 active forest owners' associations which members are 13,240 forest owners. On the contrary, private forest land owned by owners who belong to forest owners' associations, is over 500,000 ha – almost half of the total private forest land. There is support system for private forest owners, presented on figure 7.

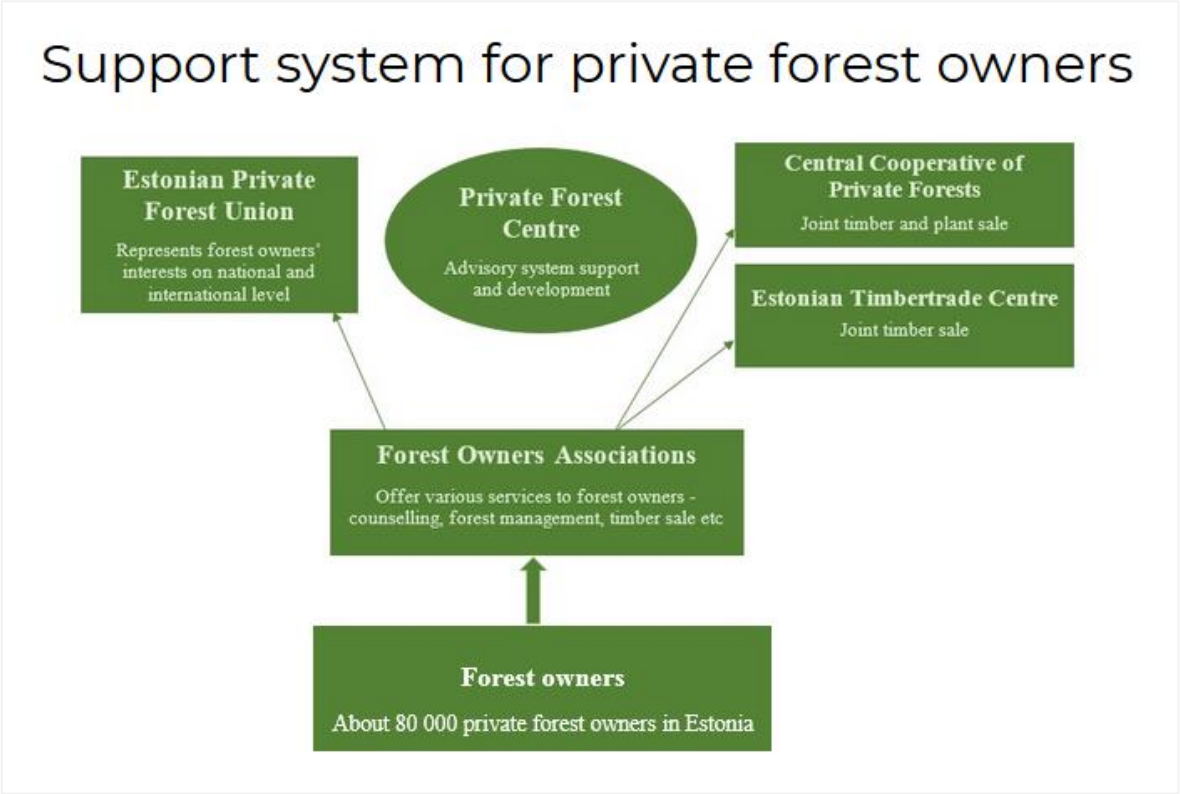

Figure 7: Support system for private forest owners in Estonia.

Forest owners associations

Local forestry associations that communicate with forest owners first hand. They provide information, know-how and practical solutions such as evaluating forest value, marking borders, organizing forest harvests, organizing sale of timber. Associations organize group counseling, many associations also contribute in educating school children, our future forest owners, in forestry related issues and activities. In forestry association a forestry consultant will make most of the contacts with the forest owners. Forest Owner`s Associations are partially government funded. Financing is available through Private Forest Centre and is granted for specific activities. The trend is to increase the percentage of self-financing.

Estonian Private Forest Union

Consists of forest owners associations and represents their members (forest owners) political, economic and other interests on policy level. With state support and in cooperation with local associations they also educate private forest owners. Private Forest Union is self-supporting through membership fees and different projects.

Estonian Private Forest Centre

Government-established foundation to support the development of Estonian private forestry. Organizes informing and training of key persons of forest owners associations, forestry advisors and forest owners, manages the funding of forest owners associations and administrates the subsidies for private forest owners for sustainable forestry. Estonian Private Forest Centre is government funded and intended to stay that way, since carries out nationwide goals.

Timber sale organizations

Central Cooperative of Private Forests and Estonian Timbertrade Centre are founded by forest owner associations. Their goal is to organize timber sale for smaller sellers and to gain a better price when selling jointly. Joint procurement of seedlings and their division to forest owners has also become their activity during recent years. Timber sale organizations are self-supporting due to service charges.

Role of forest owners in development of bio-economy

Forest owners have relevantly important role in developments of bio-economy. Forest owners' attitude and actions in their forests could be reflected in the society and also the opposite. Bio-economy includes many factors – wood products and bioenergy are just few of many. There are several ways how private forest owners can contribute into developments of bio-economy such as:

- doing reforestation (planting, sowing or leaving it to natural regeneration);
- after forest thinning producing or selling woodchips from residues or bush;
- doing nature friendly forest land improvement and forest road infrastructure;
- maintaining forest objects of cultural heritage;
- preserving or increasing species richness – forest cuttings should be preferred in winter time, not in spring and summer when the wildlife is breeding and nesting; thinning and clear cuttings should be preferred during the winter mostly because it also minimizes the damage for the soil and roots;
- forest works don't always have to be done by heavy machines that are running on fossil fuels. If a forest owner has skills and lives nearby his/her forest site, then the management can be done manually and therefor more slowly. Why not to take manual work as physical exercise;
- using forest mainly for its byproducts – picking berries, mushrooms and herbs; also, beekeeping and nature tourism play important role at forest use.

Forest owners' problems that they are facing at their day-to-day work in forests

As mentioned earlier in this report ordinary forest owners don't have forestry education. Owners who don't have large areas to regenerate might be willing to do the planting themselves. Mistakes can be made in plant transportation, planting, but more importantly, in the choice of tree species. Owners should have a forest management plan and can ask an advice from advisor about the reforestation.

Forestry machines are usually quite expensive for forest owners to buy. It's more reasonable to purchase forestry machines in collaboration (for example by forest owners' association), then there are less services to buy in and the cost of forest works are smaller for forest owners.

Most of the roads in private forests are former farm roads. They have been extended, but their surface is not capable of bearing heavy forestry machines. The problem becomes acute in the spring when storm damage occurs and the roads are impossible to use and the material deteriorates in the forest. Sometimes it's necessary to use neighbors' roads. According to the law, private roads may not be used without the permission of the owner, it's possible only in exceptional cases. After all, the road owner could allow his/her neighbors to use their own road, but at the same time it would damage the condition of the road. It is possible to sign a contract with the owner of the road, which allows users to use the road and pay him/her a certain amount. If there is no road at all and there is a plan to construct it, then it's worth consulting with neighboring property owners. It's much more affordable to construct it together.

Some forest owners are very confident and are not using any safety equipment when doing forestry work. There is this misunderstanding that common sense is enough that prevents accidents, but it's not sufficient to ensure maximum safety. On forest felling, forest owners should be using special clothing, gloves and boots plus a helmet with visor and safety earmuffs.

Under current law forest sales (selling standing trees or wood at forest roadside) is taxable. Only when being a forest owner of so-called first round (to whom the forestland was returned after regaining Estonia's independence) and selling forest with the land is tax-free transaction. Therefore, many older forest owners prefer to sell the land too when deciding to sell forest, so they would not have to pay tax. Certain changes in the tax system would solve the problem.

1.4.2. Identification of forest owners needs

Recently there was a survey conducted among private forest owners with a purpose to create the profile of average forest owner in Estonia and to identify the owner's needs. Based on the answers we can give short overview that the average forest owner is:

- Estonian, working employee, lives in rural area, gained the forest via inheritance and is sole owner, has owned forest for more than 6 years;
- wants to keep the current forest land, not planning to increase or decrease it;
- within 10 years has had thinning done in his/her forest or in the next ten years is planning to do it;

- has not joined a forest owner's association and is not planning to do so, because of not seeing the practical use of it;
- doesn't want the state to interfere with his activities;
- doesn't rely on forestry subsidies;
- is concerned about his/her offspring and about the nature, thus prefers environmentally friendly forest management.

Modern forestry technology would help forest owners to increase income from their forests. Technology that we are focusing on in this handbook are mini-harvesters and drones. Mini-harvesters cause less negative impact on forest land soil and roots and due to its small size, there is no need for skidding roads in the young forests. Other advantages of mini-harvesters in pre-commercial thinning compared with big harvesters are lower operating costs and also the price of the machine is much lower than the big harvesters. Estonian Private Forest Centre is planning to start to subsidy forestry equipment and accessories in the next period (2021 – 2027) of Common Agricultural Policy programme.

Drones can be used for monitoring cuttings (clear cut, thinning and pre-commercial thinning). Forest owners can also use drones for checking windstorm damages and beavers' dams. Another fields in forestry where drones are beneficial is checking certificate conformity. Monitoring FSC or PEFC certified forests is part of owning a certificate. Using drones in forestry has very low costs, it helps to save time and to provide clear overview of the forest situation.

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LATVIA

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2.1. Forests and forestry in Latvia

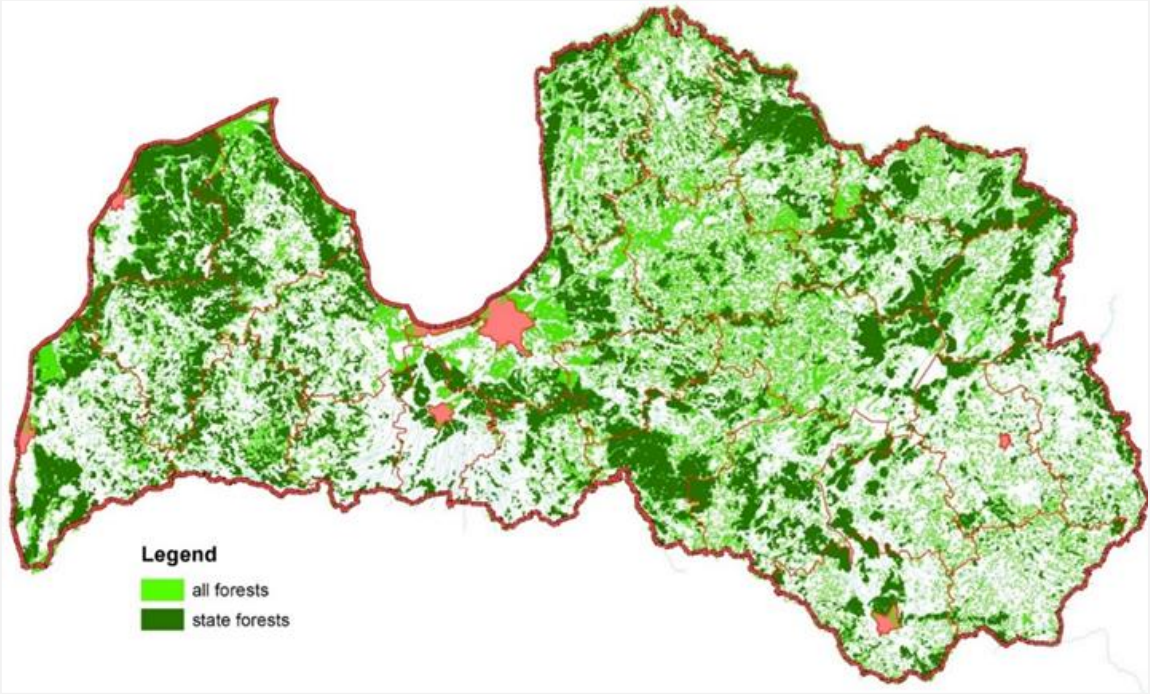

Figure 8: Forests in Latvia (Source: Latvian Forest Owners' Association).

Forests in Latvia cover 3.4 million hectares of land, or 52% of the country's territory. The amount of forestland is expanding, both naturally and thanks to afforestation (planting) of unused agricultural land. Afforestation today is mostly done because of unfavorable location, small plot size, poor accessibility and soil quality. Due to high demand for agricultural land by productive farms, over last few years, afforestation has noticeably slowed down.

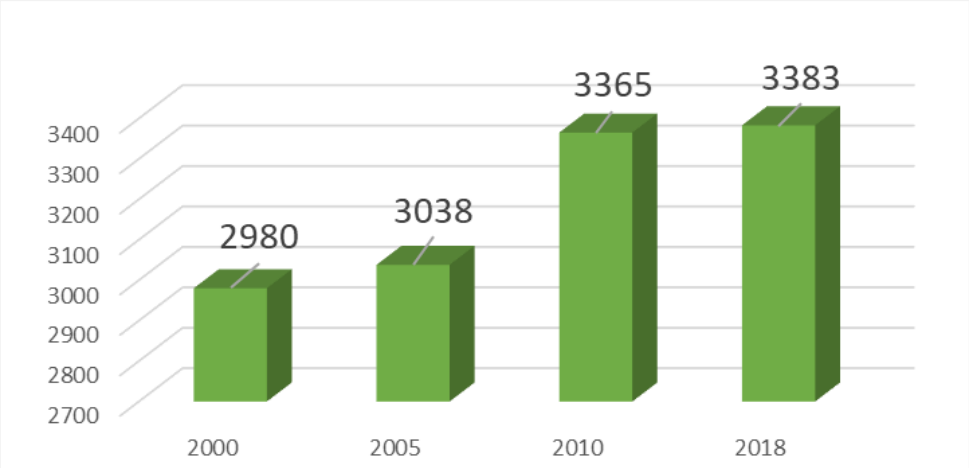

Figure 9: Forest area in Latvia 2000-2018 (thousand ha) according to international forest definition (=Include forest stands, damaged stands, burnt areas, windfalls, cutting areas, gaps and the land under forest infrastructure facilities) (Source: LATVIAN FOREST SECTOR IN FACTS & FIGURES).

Volume of standing timber (stock) in the forest is increasing. Cutting reaches only around 50 percent of the annual increment. This is due to many forest management restrictions, often not compensated to the owners, that require significant share of forest land to be set aside for nature protection. State is still very much involved in also restricting forest management in commercial forests, by establishing cutting ages, cutting diameters, protective belts along water bodies and wetlands, sizes for cutting areas, number of trees to be left after harvesting, etc. Not much is done to motivate and educate forest owners (135 thousand in total) to practice productive commercial forestry on their properties.

But still forestry work in Latvia has been very successful. During last ten years, on an average, approximately 10 - 12 million m³ of roundwood is being harvested every year. Such harvested volume has enabled establishment of a modern and competitive wood processing industry, which includes sawmilling as well as plywood and board production.

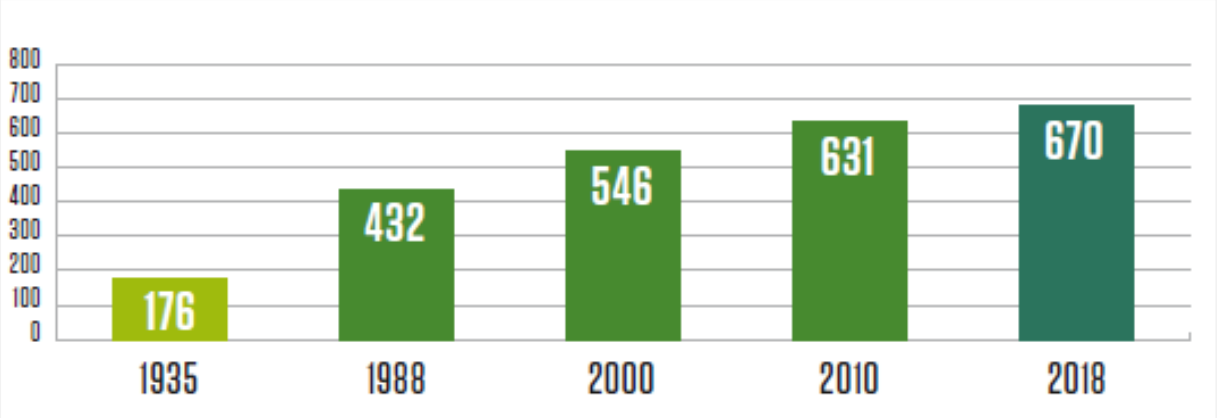

Figure 10: Total growing stock volume in million m³ (Source: LATVIAN FOREST SECTOR IN FACTS & FIGURES).

The forest sector is one of the cornerstones of the national economy. Forestry, wood processing and furniture manufacturing represented 4.8 percent of GDP in 2017, while exports amounted to EUR 2.2 billion – 20 percent of all exports. There are very few municipalities in Latvia, which do not have larger or smaller wood processing companies. Often these are the most important employers in the surrounding area, thus supporting local (rural) economies and residents.

In historical terms, the intensive use of Latvia's forests for economic purposes began in the second part of 19th century. After the WWII, due to establishment of the socialist economic system, significant share of forestland was left to natural processes. This has allowed us to preserve considerable biological diversity. Various forest management restrictions today apply to 28.2 percent of Latvia's forests. This is much too much. Most of this territory is owned by the state, but also private forests are affected. Uncontrolled expansion of these areas and lack of compensations are a significant problem.

Figure 11: Forestry machinery (© Foundation Centre for Support of Forest Owner Cooperation).

In all forests nearly everywhere, people are free to hike and to pick mushrooms or berries. The number of places for recreation is increasing every year, and the territories, in which recreation is one of the main goals of forest management, today represent 8 percent of all forestland. Almost all these recreational areas are in state forest.

The forest sector in Latvia is under the supervision of the Ministry of Agriculture. It works with stakeholders to draft forest policies, development strategies for the sector, as well as regulations on forest management, the use of forest resources, environment protection and hunting. The State Forest Service, under the Ministry of Agriculture, is the responsible agency for supervising how the provisions of the laws and regulations are observed in forest management irrespective of the ownership type. Since 1999, state-owned forests (half of all forests) are managed by company “Latvijas valsts meži”. It implements interests of the state in preserving and increasing the value of the forest and enhancing the contributions of the forest to the national economy.

Figure 12: Artificial forest restoration - young spruce (© Foundation Centre for Support of Forest Owner Cooperation).

Main issues today are:

- Ongoing expansion of areas covered by practically uncompensated forest management restrictions, which leads to conflicts and discourages green practices of forest owners.
- Providing forest owners with more freedom to decide forest management issues themselves, rather than by the state officials and organizations.
- Assistance to forest owners through education, unbiased advice and forest owner co-operation.
- Proper control of game animals through hunting is not happening. Freely roaming herds of deer and elk do significant damage to commercial forestry.

2.2. Forest production chains

In all forests, due to high costs of manual harvesting and general lack of skilled workers, mechanized harvesting today is the dominant method. Because of comparatively rich soils, almost any harvesting activity starts with manual cutting the undergrowth. Mechanization at this stage is still very rare. Then roundwood assortments are harvested by machines, forwarded to roadside by forwarders and delivered by trucks to the buyer. As forests in the cutting sites often have not received proper silviculture treatments, chainsaw operators are usually needed at the end to remove large leftover trees with big canopies, which are difficult (or impossible) to handle and delimb by a harvester.

Logging residues for chipping can be taken out from the forest at the cutting time or later, when they have dried out. If it is done at cutting time, roundwood forwarders will generally perform the task. This is more expensive and, as forwarding work needs to be payed, tends

to tie up working capital. If forwarding is done later, due to drying, energy wood is higher value and less working capital is needed. Adapted agricultural tractors are then usually employed. Ideally, residues should stay in forest over the summer until autumn, when, due to lower air temperatures, energy chip market becomes more active. At the current energy chip price level, residues are seldom forwarded to the roadside more than 500-700 meters. Unless owner, in order to clear the site for soil preparation and planting, is ready to give residues away for free. Then distances can be larger.

Figure 13: Harvesters (© Foundation Centre for Support of Forest Owner Cooperation).

Ten years ago, harvesting was still often done by the owner himself and his family members. These were chainsaw-based operations. In such cases forwarding to the roadside was often done by neighbor's adapted agricultural tractor. Today this is very seldom the case. With the large number of assortments (more than ten in almost every cutting project is very normal) to maximize harvest value, skills in assortment preparation and wood quality grading are needed. And these skills are often not possessed by the owners themselves. Generational change is also taking place. The young owners today are less and less keen to perform physically demanding manual tasks required in chain saw harvesting.

Figure 14: Stacked birch logs (© Foundation Centre for Support of Forest Owner Cooperation).

Utilization of small-scale machinery in forest harvesting has not yet happened. Even though various projects have been ongoing to popularize such equipment. Medium (mostly) and large commercial harvesters do most of the cutting. And the same applies to forwarding.

Significant problem for timber transportation is generally poor condition of forest roads in private forests. This increases transport related risks (and often costs) due to weather conditions, particularly warm winters and heavy rain. Problematic weather conditions have not been uncommon lately. Repairs on roads are often needed after trucking and forwarding is finished. Spoiling of valuable (perishable) assortments, when transportation cannot be done, can happen. This leads to losses for the owner. It is not common for forest owners to work together to maintain forest roads connecting their properties to the general road network.

Quality of forest operations is best controlled by the owner himself. But, in most cases, it depends on the companies, organizing these operations. Certification schemes have led to occasional site audits from the roundwood buyers. But these are random and far apart, to make any impact. More attention to work quality issues is paid in companies which have engaged themselves in chain of custody schemes.

2.3. Wood market

Both wood selling methods: on the roadside and selling standing trees are commonly used. Deals are generally done based on measurements of standing trees or measurements of delivered assortments done at the buyer.

Historically selling of standing trees was dominant. It was done based on measurements of standing trees. Measurement data then could be used to obtain several offers (or used in auction) and to arrive at the highest possible bid. Benefits of such a system: highest bidder can be identified and sales price fixed (and often also paid) before cutting the stand. Seller can use this method even if he or she does not have deeper knowledge and understanding on wood harvesting. All the quality, price, weather etc. risks are carried by the buyer and, after money is paid, are not any more a concern for the seller. It is important to agree in advance on how to deal with possible soil, drainage and road damages, damages to trees in neighboring properties, damaged border markings, etc. Drawbacks: measurement of standing trees is not precise and does not take wood quality aspects into account. Attention has to be paid to the quality and honesty of measurement, as it sometimes can be biased towards a certain buyer. This system, if applied properly, can work in clear cuts. But it is difficult in commercial thinning, where trees to be cut would have to be marked (additional cost). It has to be noted, that such marking would not guarantee leaving of unmarked trees standing by the buyer. This becomes even more difficult with mechanized cutting, which today is a norm also in commercial thinning. Generally, popularity of this method is decreasing.

Figure 15: Roundwood warehouse of birch logs (© Foundation Centre for Support of Forest Owner Cooperation).

Selling wood on the roadside is mostly used by larger forest owners and farmers, which may have some agricultural tractors adapted to perform forwarding work. Such a method requires

skills to organize harvesting work and evaluate qualification of the workers. Some understanding of the timber market and quality aspects of roundwood assortments comes useful. Control measurements can be done on ready (stacked) assortment piles therefore quality risks can be better managed and precision of such measurements (cubic meters measured) is considerably higher. Key to the success in this method is in qualifications of the owner or his employees. A lot of timber value can be lost in harvesting, if it is not organized properly.

In the last few years the third selling method is fast gaining popularity. Sales of standing timber are done based on their real (arithmetic) value, which is determined in the end, when trees are cut, forwarded and delivered to the buyer, measured and harvesting costs subtracted from the revenues. Such a method is used by co-operatives and some commercial companies. It requires an honest, efficient and reliable partner with good reputation to organize all the work. Owner in such way can get the maximum value for his or her timber. Such a method works very well not just in clearcuttings, but also in commercial thinning as owner gets paid for the trees that are really cut. But for such a method to work, trust is the key.

Figure 16: Roundwood warehouse (© Foundation Centre for Support of Forest Owner Cooperation).

Understanding of wood market and effective timber trading requires skills. Different measuring and quality grading methods co-exist. All solid cubic meters are not equal. Which means that it is possible to choose buyer, who measures less and pays higher price or vice versa. Depending on priorities of the seller. Higher price may come hand in hand with different grading approaches. It is very common to have general (announced) price and

separate additional price based on larger volume deliveries and bi-agreements. This makes it almost impossible for unexperienced owners to get the best value for their trees. There are few wood price trend sources, that are publicly available. Co-operative Mežsaimnieks also has such information in Latvian language on their web page.

Latvian timber market can be characterized by quite significant volatility and price fluctuations. Particularly for pulpwood, where domestic market is used as marginal supplier by pulp producers in Sweden, Germany and Finland to regulate pulpwood prices in their respective home markets.

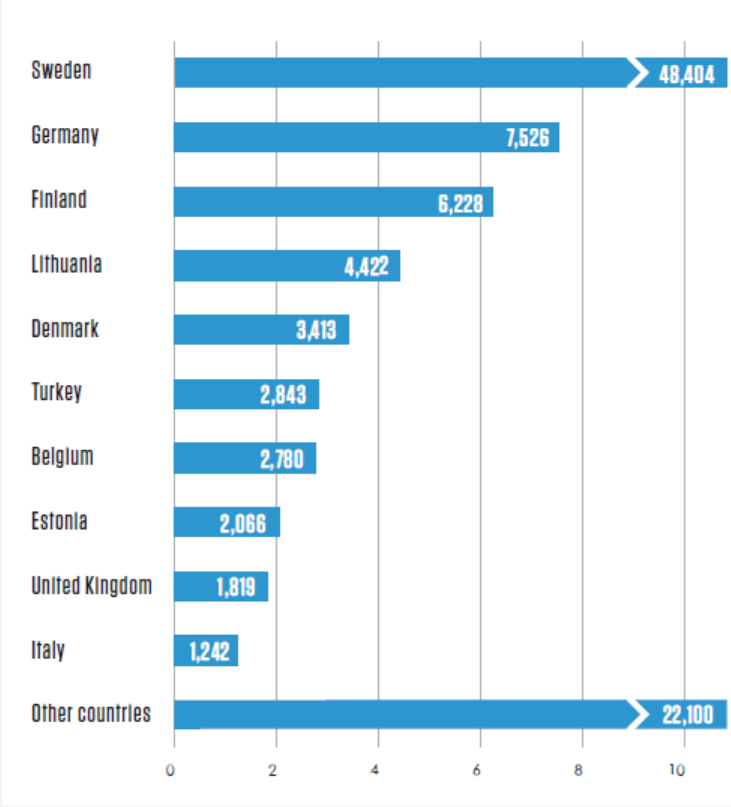

Figure 17: Export markets for the main products of the forest sector in 2017 (Million EUR) PULPWOOD (Source: LATVIAN FOREST SECTOR IN FACTS & FIGURES).

Pulpwood prices can double in one year and fall back next year. It is not uncommon. Other assortments are less volatile, bet still can go up and down by some 20-30 percent. Birch sawlogs experience seasonal fluctuations, when prices are falling every summer. All of this makes it difficult in private forests to maintain constant, uninterrupted flow of forestry work for contractors and flow of wood for the buyers. State forests are less affected as they try to maintain constant flow of wood irrespective on market prices. That is not possible with price sensitive private owners.

For the Latvian timber market year 2019 is a crisis year. Practically all prices were extremely high last year. From the beginning of this year they have come down, with some stability reached only at the end of this summer. Outlook for the future is not very positive. Prices for a while could stay, where they are today. Nevertheless, relative stability, after the recent freefall, is good news.

2.4. Forest ownership

Forest cover has increased from less than 30 percent in 1930s to a bit more than 52 percent today. Practically all this increase has happened on private land through natural afforestation of, for different reasons (war, collective farming, neglect, etc.) abandoned agricultural land. Therefore, today there are large areas in private forest dominated by not so valuable pioneer species, such as birch, aspen and alder. Size of the state forest, in the meantime, has remained less or more the same and species composition there is considerably better, dominated by commercially more valuable pine and spruce.

Figure 18: Birch forest stand (© Foundation Centre for Support of Forest Owner Cooperation).

From the total forest land of 3.4 million hectares, the Latvian state owns one half, while most of the rest is private forest. About one third of private forests is owned by forestry companies, mostly funded with some foreign equity capital. Several of them own more than 100 thousand hectares and are significant players in the domestic roundwood market. The remaining two thirds, around 1 million hectares, are owned by 135 thousand private owners. This makes up the share of Latvian family forestry with average property size there being around 5 hectares.

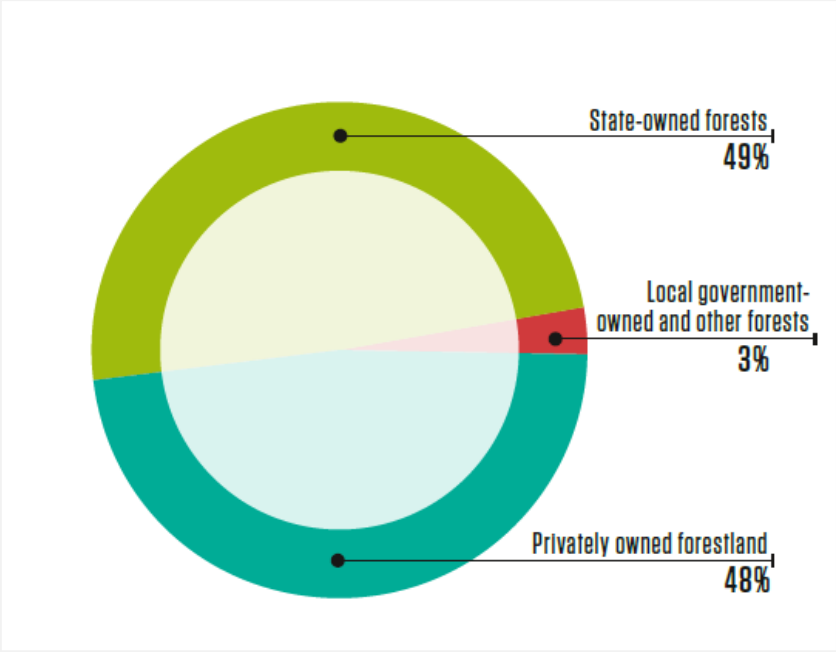

Figure 19: Forest ownership by status, 2018 (Source: LATVIAN FOREST SECTOR IN FACTS & FIGURES).

2.4.1. Private forest owners

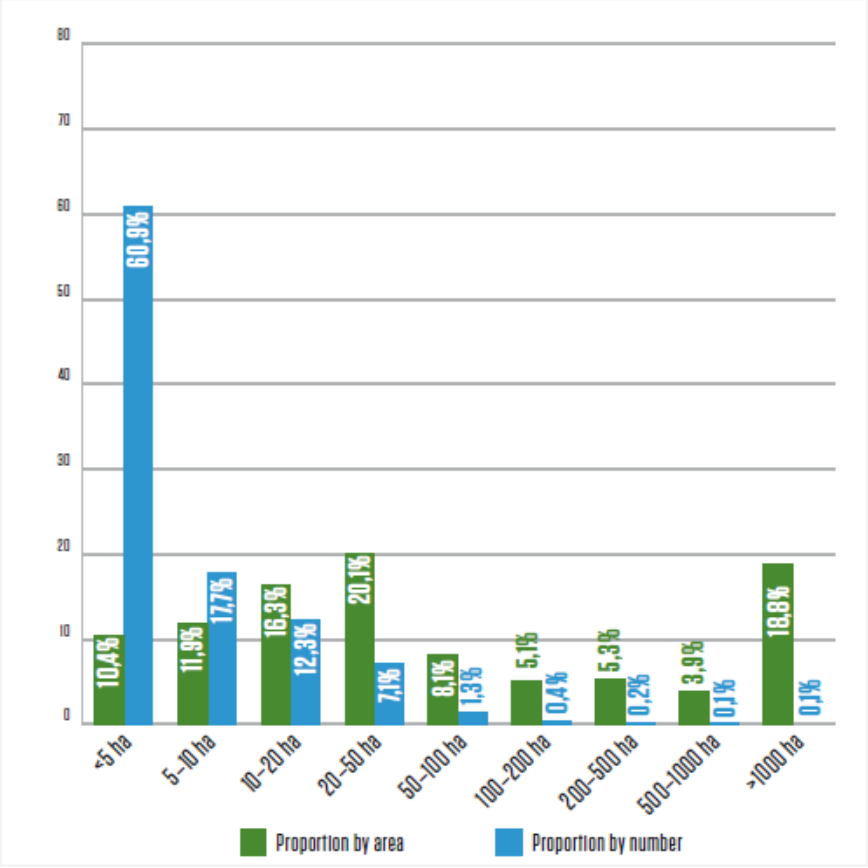

Figure 20: Structure of Private Forest Owners, 2018 (Source: LATVIAN FOREST SECTOR IN FACTS & FIGURES).

Private forest owners involved in family forestry are not well organized. Majority of the forest owners regained their properties from 1993 to 1995. it means that majority of the forest owners today have 13-15 years of forest management experience. During these years the level of knowledge on forestry as well as the attitude towards forest property has improved considerably. The data provided by the State Forest Service states that illegal felling has decreased during the past 7 years 10 times, and today constitutes a non-significant part of the total felling volumes in Latvia - less than 1%. A big part of the private forests has emerged from overgrowing of the abandoned agriculture lands. This fact explains the tree species condition in private forests. 14% of all private forests fall into some category of protected areas and 138 thousand ha are within NATURA 2000 areas.

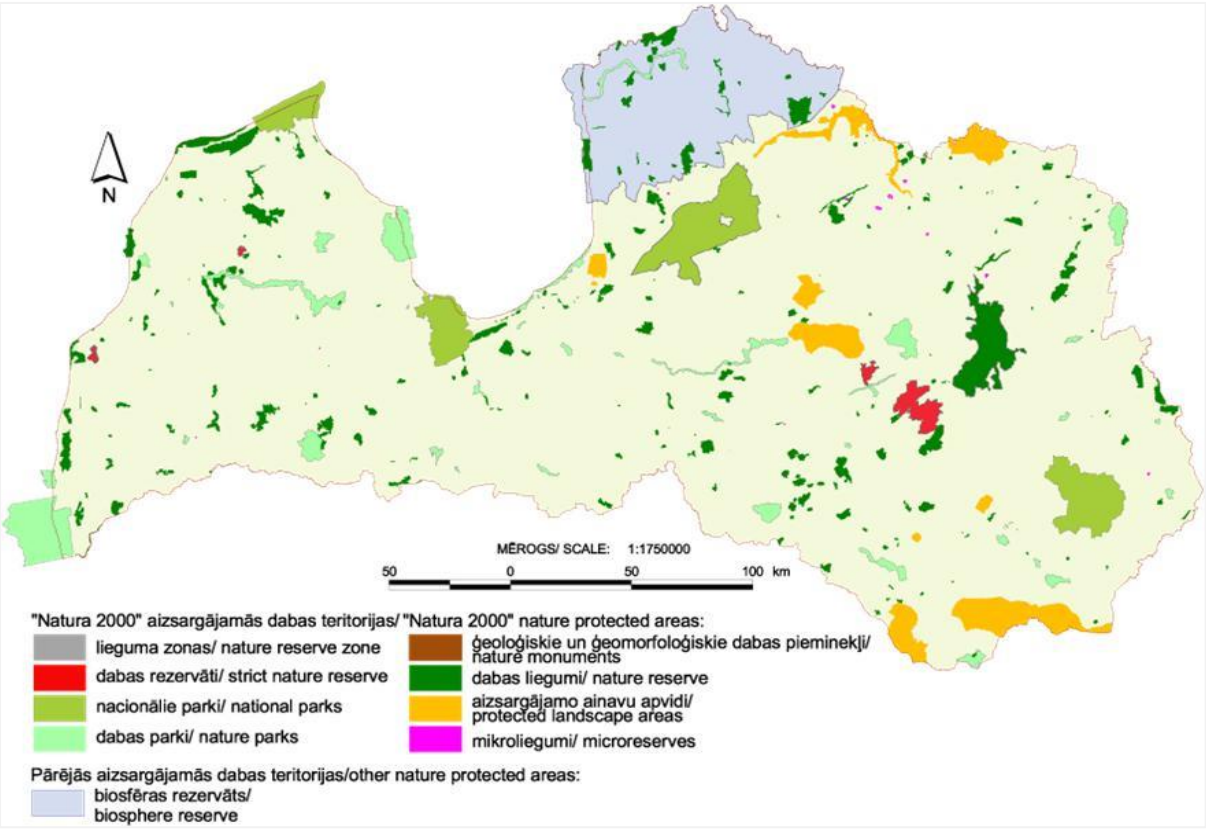

Figure 21: Protected nature areas (Source: Latvian Forest Owners' Association).

The forest owner cooperative has proven to be successful as a structure to organize forest owners and to optimize the benefit of their forests.

Forest owner cooperation exists now for 8 years in Latvia, but it still has covered (involved) only less than 1 percent of the forest owners and 1.5 percent of family forest land. However, the number of private forest owners in cooperatives is growing.

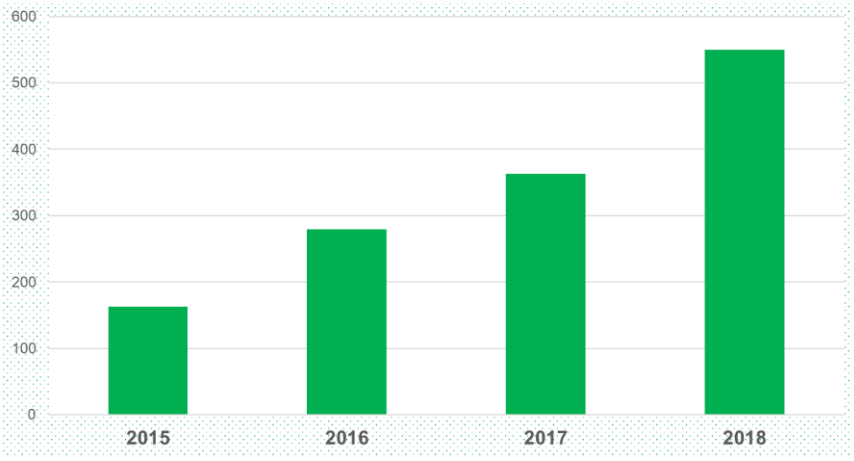

Figure 22: Members of Latvian Forest owner cooperatives (Source: MPKS Mežsaimnieks).

2.4.2. Identification of forest owners needs

Large number of forest owners, small size of holdings and generally low availability of advisory and support services has been for decades source of problems for private forestry in Latvia. Arrival of forest owner co-operation has already made some improvements. Forest owner co-operation opens up broad and diverse opportunities for Latvian forest land management, allowing the private forest owners to generate maximum income from the estate, while maintaining the recreational and environmental values. But it still has engaged only a small portion of all forest owners in the country.

Figure 23: Education of forest owners in the field (© Foundation Centre for Support of Forest Owner Cooperation).

Despite different formal and non-formal education possibilities for Latvian forest owners, most of them still lack forest management knowledge which impacts the quality of forest management decisions.

EU funded education programs have improved availability of educational seminars on forest related topics. But they are time consuming and not too many owners attend them. This shows as a definite need for easily digestible educational materials that can be delivered to everyone's desktop over the social networks.

What are the most visible negative outcomes facilitated by these problems? Most of regeneration cuttings are still today restocked naturally by less valuable tree species, such as aspen, grey alder and birch. Planting takes place in less than 20 percent of the cut area, which results in future forest of low economic value. Even though availability of EU funding has increased pre-commercial cuttings, most of the owners still do not perform them properly. Much still needs to be done to improve knowledge of the owners in the matters of general forest management and in connecting forest owners with long term partners that can assist in forest management, consulting and timber trade matters. Many businesses still operate intentionally benefiting from this lack of knowledge, buying wood cheaply and providing services at irrationally high costs. Awareness of risks related to environmental restrictions is still generally low.

Figure 24: Artificial forest restoration - pine plantation (© Foundation Centre for Support of Forest Owner Cooperation).

2.5. References and links to available literature

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2. Meža gadagrāmata (2018), publisher: SLO “Latvija aug”.

3. Bioeconomy in Latvia; MoA position, needs & opportunities. Dr.sc.agr. Ainars Nābels-Šneiders (2019)

4. https://www.zm.gov.lv/mezi/statiskas-lapas/nozares-informacija/publikacijas?nid=1087#jump

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SLOVENIA

Authors: Darja Stare, Nina Škrk, Mirko Baša, Špela Ščap, Matevž Triplat, Nike Krajnc

3.1. Forests and forestry in Slovenia

Slovenia is the third most forested country in Europe, after Finland and Sweden. 1,180,281 ha of forests cover more than a half of the country, forestation amounts to 58.2%. Most of the forests are located within the area of beech (44%), fir-beech (15%) and beech-oak (11%) sites, all of which have a relatively strong productive capacity. Growing stock and increment have been increasing for more than 50 years. Today the average growing stock amounts to 299 m3/ha, annual increment is 8.695.069 cubic meters of wood or 7.4 cubic meters per hectare. The share of growing stock of coniferous trees is 47% and 53% of deciduous trees. In 2017, the cut in Slovenian forests was almost 5 million m3 of trees, 66 % of which have been conifers and 34% deciduous trees. The cut falls behind the possible one according to forest management plans and it amounts to 75% of it (Poročilo Zavoda..., 2018).

Table 4: Slovenia's forests in numbers (Poročilo Zavoda..., 2018).

Surface area	**1.180.281 ha**
Number of naturally growing tree species	71
Growing stock	352.878.333 m^3
Annual growth of growing stock:	8.695.069 m^3
Annual harvest (2017)	4,984,635 m^3
Potential annual harvest (2017 forest management plans)	6.607.265 m^3

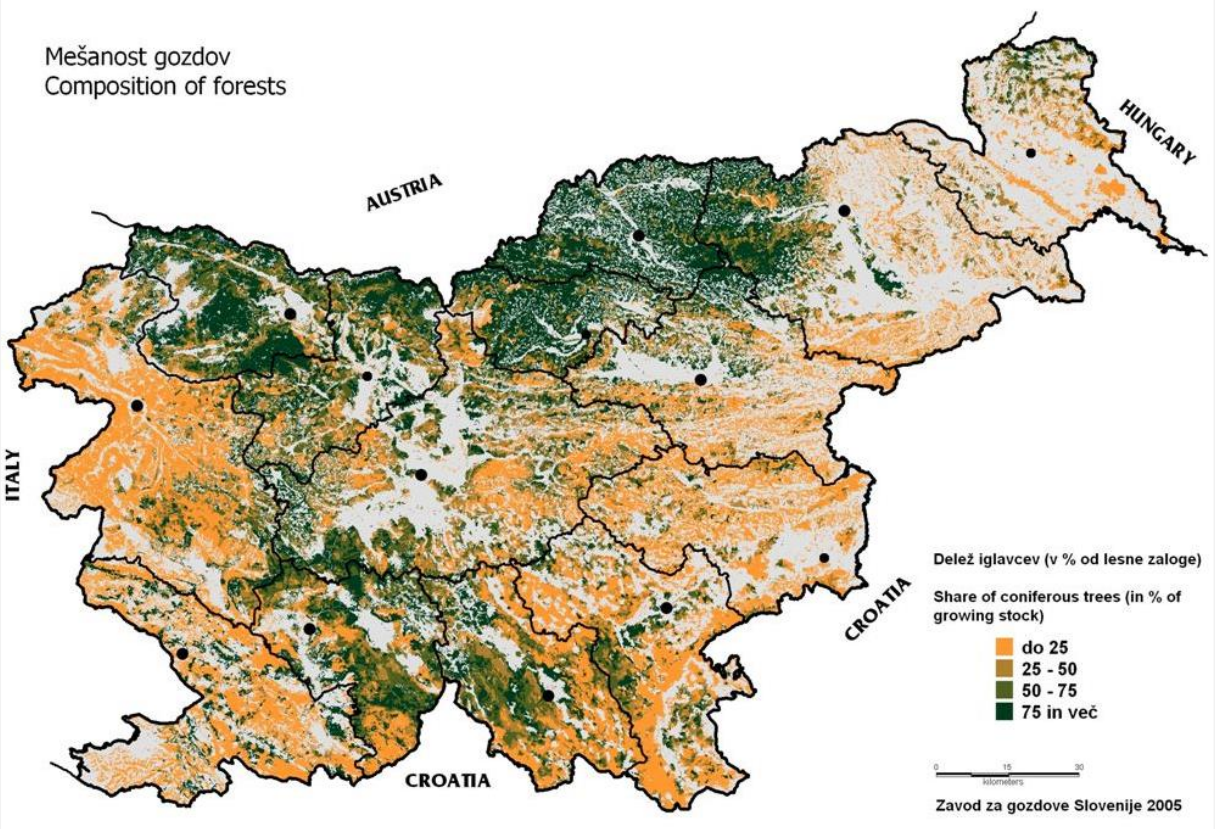

Figure 25: Composition of Slovenian forests (Source: Slovenia Forest Service, 2005).

76% of forests in Slovenia are in private property, 24% of forests are public (owned by the state or communes). Private forest estates are small, with an average area of only 2,9 ha. There is a large number of forest owners and co-owners, which present a serious obstacle to carrying out professional work in private forests, optimal timber production and utilization of forest potential. However, larger and undivided forest estates that are state-owned forests enable good professional management.

3.1.1. Managing

Main national documents that serve as the basis for forest treatment and management in Slovenia are (Caring ..., 2005):

- The Forests Act of the Republic of Slovenia (1993) which regulates protection, silviculture, exploitation and use of forests based on forest management plans;

- The Forest Development Programme of the Republic of Slovenia (1996) which defines the national policy on close-to-nature forest management, guidelines for the preservation and development of forests and conditions for their exploitation or multipurpose use.

Managing in Slovenian forests is based on the principles of:

- **sustainability** - sustained preservation of forests, sustained use of their goods and non-material functions,
- **close-to-nature conception -** exploitation of forests to such a degree and in a way as to ensure the preservation of all their natural constituents and
- **multipurposeness of forests** - a balanced significance of ecological, productional, and social roles of forests.

Forest tending is based on the principle of selecting trees according to the criteria of vitality, adaptability to the site, role in the ecosystem, health condition and quality. Based on the same principle trees are selected for possible cut in adult forests, the selection is done by district foresters in all forests regardless of their ownership, in co-operation with forest owners and on the basis of forest management and silvicultural plans. Clear-cut system as a way of forest management is prohibited. Realization of silvicultural work is the responsibility of the owner.

3.1.2. Key actors in Slovenian forestry

The Slovenia Forest Service (SFS) is a public institution, established by the Republic of Slovenia (The Act on Forests, 1993), which performs public forestry service in all Slovenian forests, irrespective of ownership. It is nearly entirely funded from the budget of the Republic of Slovenia whereas hunting reserves with a special purpose are mostly self-financed. It does not itself perform any felling, extraction, transport and selling of wood, nor forest trade. The principal tasks of the Slovenia Forest Service are forest management planning, silviculture and protection of forests, forest technology use, construction and maintenance of forest roads, public service at the field of wildlife management, education of forest owners, advisory service for forest owner, popularization of forests and forestry, management of hunting areas with special purpose. Among the most important fields of activities of a district forester is co-operation with forest owners in the form of advising, educating and training for carrying out

professional work of silviculture and forest protection. Realisation of silvicultural work is the responsibility of the owner (Caring ..., 2005).

The Slovenian Forestry Institute (SFI) is a public research institute. It conducts basic and applied research on forests and forest landscapes, forest ecosystems, wildlife ecology, hunting, forest management, and other uses of the resources and services forests provide; provides scientific knowledge on all aspects of sustainable development

Ministry of Agriculture, Forestry and Food - The field of forests and forestry at the Ministry of Agriculture, Forestry and Food is managed by the Forestry Division within the Directorate for Forestry, Hunting and Fisheries. It monitors the forest condition and develops system solutions for a sustainable development of forests ecosystems and biodiversity and all the environmental, production and social functions of forests (MKGP, 2019).

SIDG - In 2016 a new Slovenian state-owned company for managing forests in public ownership, *Slovenski državni gozdovi d.o.o.* (SiDG), has been established. SIDG is responsible for:

- timber harvesting,
- timber sales,
- transporting wood assortments,
- maintaining forest infrastructure (except forest roads),
- forest protection and silvicultural work,
- any other work which is necessary for the provision of social and ecological functions,
- other activities that are directly or indirectly related to state forest lands.

Company operates based on the system of public tenders, which are the basis for the selection of contractors to perform sylvicultural operations in state forests. Wood is sold directly to the consumers by SiDG (Slovenski ..., 2019).

Other: Faculty for Forestry and Renewable resources, Forest inspectorate, Forest enterprises, Agriculture and Forestry chamber, Private forest owners associations, Forestry societies and their associations.

3.1.3. Main issues

Forest resources are under-utilized because of property fragmentation, lack of knowledge and motivation in private part of forestry sector. Forest property is becoming even more fragmented as the number of forest owners is increasing. Most of the private forest owners are not interested in income from the forests due to small properties, which results in low cutting rates. Slovenian wood market is relatively small and fragmented. Another issue in Slovenia are constrains due to Nature Conservation as 50% of forests are situated inside the EU Natura 2000 ecological network.

Slovenian forests have been largely damaged in recent years due to wind, sleet, snow, followed by insects (mainly bark beetles) which are the most common reason for sanitary cut (72% of sanitary cut in 2017). Therefore, the necessary tending cut has been reduced, thus making planned forest management difficult and at the same time it weakens the bioecological stability of forests. Slovenia's forests are also threatened by fires, especially in the Karst region (Summary ..., 2016).

Table 5: Three biggest natural disasters in recent years.

Natural disasters	Year	Extent (% of forests)	Damaged wood (m^3)
Icebreak	February 2014	51	9.3 mio
Bark beetle attack	2015 – 2017	60	7 mio
Windbreak	11. – 13. 12. 2017	20	2.2 mio

Figure 26: Icebreak in Slovenia in 2014 (© Slovenia Forest Service).

3.2. Forest production chains

In private forests, the production of wood takes place through various harvesting systems. Below are presented the three most common methods of wood extraction. Several different factors influence the representation of presented harvesting systems, which is why some of them are more frequently used than others.

The most common and traditional system of wood production is a technology implemented in a combination of felling with a chainsaw and skidding with tractor. The process begins in a forest stand, where the following stages are carried out in a specific order: felling of standing tree, delimbing and cross-cutting. Felling is followed by skidding with an agricultural tractor, equipped with tree point attachment winch, or agricultural tractor that is specially adapted for working in a forest. Usually, this is a four-wheeled tractor that is additionally equipped with a strong safety frame with nets, front and rear blade, a remote-controlled double drum

built-in winch, chokers and wheel chains. Skidding takes place in a skid trail and continues to a truck road, followed by the last step – transport of wood.

In steep terrain, cable yarding is most commonly used. The harvesting system starts in a forest stand, where the forest worker fells the tree in the direction of cable line. This is then followed by yarding from a forest stand to a forest road, where the tower cable yarding crane is placed. A whole-tree method is used in which the worker fells the tree, but the processing and sorting of wood assortments takes place on a forest road with the use of a multifunctional processor head.

Fully mechanized harvesting system is primarily meant in coniferous forests to produce cut-to-length assortments. The harvester carries out the felling, delimbing, bucking and sorting of wood assortments. The harvester typically works in conjunction with a forwarder, which hauls the produced wood assortments to a truck road. Transport with different versions of forestry transport compositions is followed.

The combination of cutting with a chainsaw and skidding with a tractor is the most common form of wood production in private forests. In addition to the structure of forest stand, the slope of the terrain is one of the most important limiting factors in selecting the appropriate harvesting system. According to the terrain characteristics in Slovenia, the tractor skidding is the most common one, as it is suitable for 72% of the forest area in the country (Jakše, 2013).

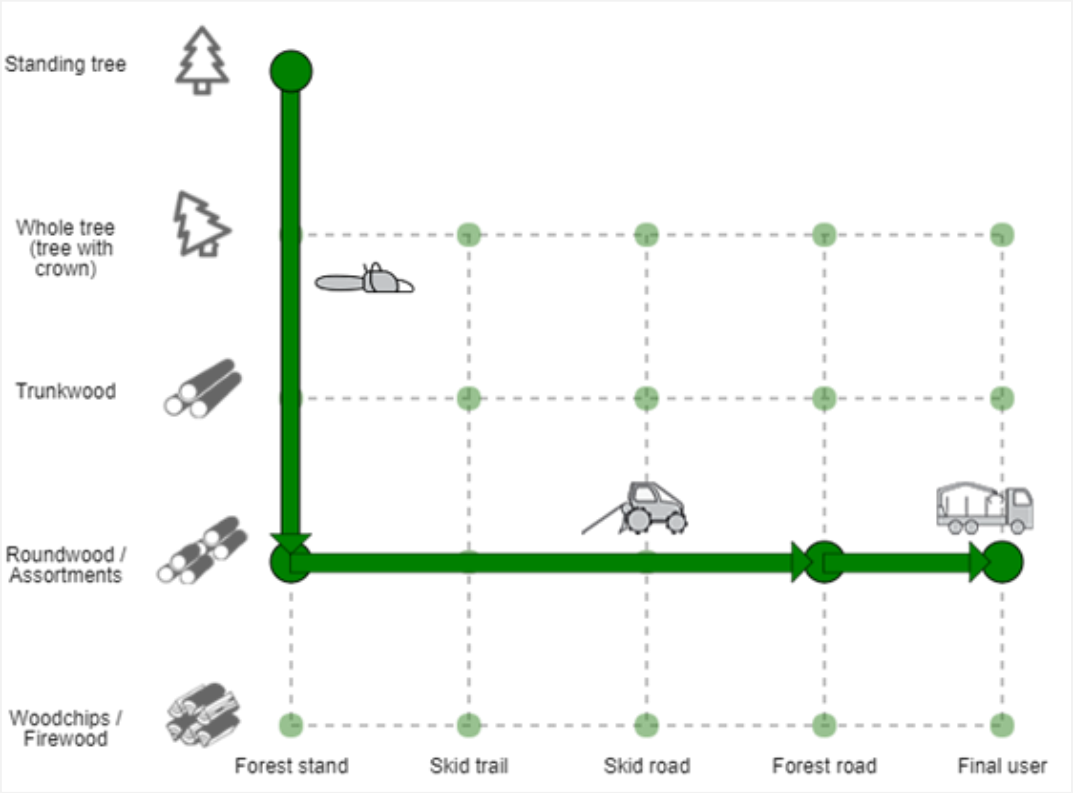

Figure 27: A graphic presentation of the most common harvesting system model in Slovenia (WCM, 2019).

Forest harvesting and collection are labour-intensive and cost-burdensome activities. Monitoring of forest operation costs is very important for economic analysis, on the basis of

which timber harvesting and operations can be rationalized along the entire production chain. This is very important, especially now at a time when a wide range of different technologies are available. The WoodChainManager is a Web-based tool composed of three user modules intended for the assessment of material costs of individual machines or the total costs of all selected machines in a forest harvesting system. Users can test the impact of individual technologies on the total material costs of the harvesting system and thus optimize operation processes. The basic tool for describing harvesting systems is the matrix, which visualizes cutting and hauling from the standing tree in the stand to the forest products at the end user Figure 27). The tool has built-in algorithms that prevent the selection of an illogical harvesting system. The selected method for calculating costs for individual machines is simple, but still reflects the state of the actually incurred costs. WoodChainManager offers cost calculations for a wide range of technologies, machines and appurtenant attachments. For all techniques, default values are provided for the calculation of costs. Users can adapt these default values relative to the characteristics of their own mechanization. Calculation of costs is crucial when deciding which technique to apply and enables optimization of forest operations (Triplat and Krajnc, 2019).

According to the current legislation (Forest Act, 1993), the owner of the forest and his family members may work in the forest and may be assisted in the form of neighborly help. Work in the forest can also be carried out by registered companies which meet the regulation concerning professional competences. The Ministry of Forestry prescribes the minimum conditions that must be fulfilled by work contractors in the form of a rule book (Pravilnik o minimalnih…, 1994). The regulation states the conditions of professional competence according to the type of service offered. By increasing the range of services offered, the strictness of the criteria of appropriate professional competences is also increasing. The Forestry Inspection issues and regularly updates the list of relevant work contractors in forests based on the submitted documents. Currently there are 1103 registered contractors in Slovenia, which perform several consecutive or only individual stages of wood production (Ministrstvo za…, 2019).

Kumer (2017) states that forest owners can be divided into two categories, namely the involved and absent. The involved forest owners are actively involved in wood production, while the absent owners do not show such interests. Research has shown in the past (Verderber 2010, Ahačič 2012, Žlogar 2016) that involved owners carry out most of the felling and skidding alone with the help of family members and in the form of neighborly assistance. The latter is mainly carried out by small landowners, who often do not have the necessary equipment and are not trained to work in the forest, so they ask for help from neighbors, acquaintances, and friends. For the same reason, they often decide to hire a forestry contractor. In addition to falling and skidding, they are mostly involved in the production chain with the transport of wood from the forest to the buyer (Žepič, 2010).

Based on the legislation in force (Pravilnik o izvajanju…, 1994), the Slovenian Forest Service is authorized to check the implementation of felling, skidding, handling of waste wood residues, transport and stacking of wood assortments. The Regulation lists the relevant guidelines regarding the timing of the work, the method of tree felling, the guide for the selection of appropriate wood harvesting technologies, and the restrictions on the method of stacking and storage of wood assortments and residues. The main task of the Slovenian Forest Service is to check the execution of works and the tidiness of workplace after the works. If the owner

fails to perform the foreseen work, the Service determines the works necessary to ensure the tidiness of work area.

The workplace must be tidied immediately after the harvesting is completed:

- all trees that have been severely damaged after felling and harvesting must be cut down,
- the branches and tops of conifers must be sawn and stacked on piles,
- in thinning or coppice harvesting, the branches of deciduous trees must be sawn,
- in the case of regeneration felling, wood residues must be stacked so as not to hinder the development of seedlings,
- in the case of a final felling, the residues must be stacked in a pile so that the surface is ready for planting,
- wood residues must be removed from skid trails, forest roads, from boundary stones, water sources, and from agricultural land and outer forest edges,
- all non-wood waste generated by the work must be removed.

The Forestry Inspection oversees the implementation of legal regulations relating to the forest or forest area. It performs control over all parts of the forests, checks compliance with the minimum conditions of contractors, and controls the traceability of wood assortments. The Financial Administration of the Republic of Slovenia is also authorized to verify the traceability of wood assortments. In the case of illegal acts, the forestry inspector can file a criminal complaint against the offender or carry out measures to eliminate irregularities.

All the works taking place in private forests are therefore regulated and supervised based on legislation and through the aforementioned institutions. The purpose of the control is to ensure compliance of the works carried out with the prescribed legislation relating to the forest area.

3.3. Wood market

The forest owner can sell the wood in form of standing trees or as processed timber assortments. The selling of standing timber is when pre-labeled non-harvested standing trees are sold in contrast to processed timber assortments, which are sold on a truck road. By selling of standing timber, the felling and skidding is done by the buyer. When selling timber on a truck road, the harvesting of wood is carried out by the owner himself or with the help of qualified contractors (Winkler, 2003). Each of the presented selling methods has both positive and negative aspects.

In Slovenia, the main part of purchase of timber from private forests takes place on a truck road, where the owner sells processed timber assortments. In this kind of sale, quality and quantity of timber are determined on a truck road. Active forest owners, who have suitable working and protective equipment, carry out harvesting by themselves and consequently they avoid paying the contractors for harvesting. Selling of wood on a truck road has certain advantages, e.g. the selling price is determined individually for each type and quality of assortments, therefore no pre-estimation of quantity and sorting is needed; the forest owner has greater influence on wood production. On the other hand, the forest owner is good to

have a basic knowledge of the methods of measuring timber assortments, even during the harvesting. Incorrect log scaling and crosscutting can quickly lead to the devaluation of wood assortments. The need for this kind of knowledge is even more expressed in the purchase of wood assortments on the truck road. When negotiating the prices for individual wood assortment, the owner needs to be familiar with the methods of measurements and classifications of dimensions, quality and purpose of use of timber assortments. The need for prior knowledge of log scaling and cross-cutting of logs is the most prominent for assortments with the highest quality.

The use of standards is an important and necessary tool for timber trading, but when purchasing timber from private forests in Slovenia, their use it is not determined by law. In Slovenia, for timber trade extracted from private forests, the Slovenian national standards (SIST EN) are used. The timber is very often bought/sold on the basis of a classic manual measurement of assortments. The Slovenian national standards have been adjusted according to European standards. The SIST EN 1309-2: 2006 and 1309-3: 2018 standards determine measurement methods for round and sawn timber. The first standard specifies the requirements for measurement and volume calculation rules, while the second one defines the features and biological degradation. The classification of roundwood in terms of quality is defined in individual parts of the SIST EN 1927: 2008 standard.

In addition to the mentioned Slovenian national standards, for timber trade extracted from state owned forests, the legal act titled “Rules on the measurement and classification of timber assortments from forests owned by the Republic of Slovenia (Uradni list RS, št. 30/17)” is used. This act defines the methods of measurements and classifications of dimensions, quality and purpose of use of forest wood assortments extracted from state owned forests and also from private forests. Considering the fact that Slovenia is a prominent exporter of unprocessed roundwood, where the main importer of that wood (especially for coniferous sawlogs) is the neighboring country Austria, the ÖNORM 1021 (2015) standard and Austrian wood trade usages - ÖHO are in Slovenia currently very relevant for forest owners.

In Slovenia, the purchase prices of the forest wood assortments are regularly monitored through two different institutions. First, Statistical Office of the Republic of Slovenia (SORS) monitors the purchase prices of forest wood assortments on a monthly and annual basis and publishes them publicly through the SI-STAT database. The observation units shall be the forestry companies, agro-forestry cooperatives and other organizations that purchase wood from privately-owned forests. The analysis covers the purchase, which takes place directly from private owners through authorized organizations. The value of purchased wood equals the value of wood which was purchased on an agreed-upon price on the truck road. The price does not include the costs of organization of acceptance, transport, and VAT. The purchase prices, which are monitored by SORS, are collected by groups of forest wood assortments: sawlogs, pulpwood, other industrial roundwood and wood fuel (all divided to coniferous and non-coniferous). That database is a useful tool for monitoring current trends in purchase prices for a particular group of forest wood assortments.

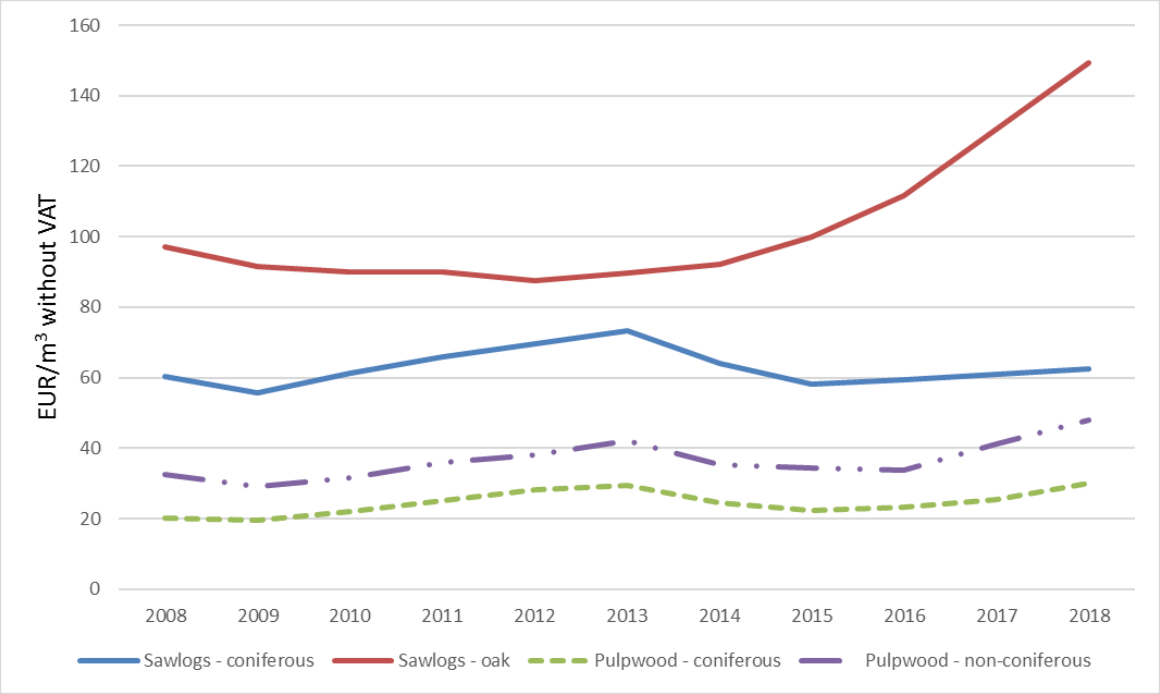

Figure 28: Purchase prices of roundwood from private sector on truck road (source: Statistical office of Republic of Slovenia, 2019).

The second source of data on purchase prices of forest wood assortments from private forests in Slovenia is Slovenian forestry Institute (SFI). In the beginning of the year 2017, SFI started to collect purchase prices of forest wood assortments on the truck road. The survey is carried out twice per year (or exceptionally more) in cooperation with forestry companies, agro-forestry cooperatives and other organizations that purchase wood from privately-owned forests. The forest wood assortments for which we monitored the purchase prices, are divided to different tree species (spruce, fir, red pine, beech, oak, poplar, other hard deciduous trees) and classified into the selected quality classes: sawlogs - classes from highest quality to lower quality, pulpwood, other industrial roundwood and wood fuel. The price does not include the costs of organization of acceptance, transport, and VAT. The analysis of the periodically acquired data shows clearly visible differences between individual forest wood assortment`s quality classes and price trends within the years.

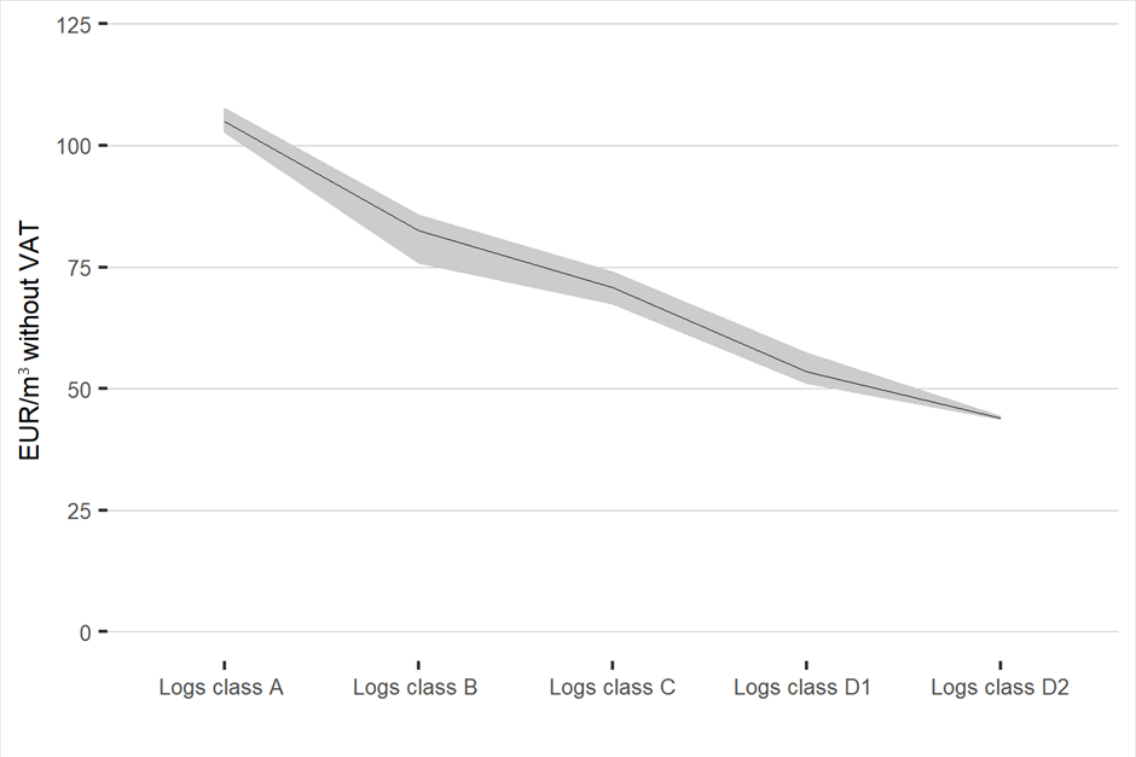

Figure 29: The average purchase prices of spruce logs in EUR/m3 without VAT from 2017 – 2019 (black line shows the average purchase prices and grey area shows the range between min and max purchase prices in the period of data collection) (source: SFI).

Import and export have an important role in development and status of roundwood use in Slovenia. In last 15 years (after 2004 when Slovenia entered the EU) we can see increase in roundwood export. Restoration of damaged forests had pushed the export to the record level (reaching more than 3 million m^3 in 2016). The quantities of forest wood assortments and wood products which are exported and imported from/in Slovenia are monthly collected by the Statistical Office of the Republic of Slovenia. The characteristics of the external trade of roundwood are best illustrated by the net external trade of roundwood, which is calculated in balance (export-import). Due to the imbalance between production and consumption, in the last decade, the external trade surplus in all categories of roundwood increased markedly, the largest was in the category of coniferous sawlogs, which amounted to 1.4 million m^3 in 2018 (Ščap, 2019). In 2018, the volume of exported roundwood from Slovenia amounted to over 2,6 million m^3. The main importing countries of unprocessed roundwood from Slovenia in 2018 were Austria (51%) and Italy (41%). The import of unprocessed roundwood to Slovenia has been increasing since 2016 and exceeded 0,5 million m^3 in 2018. The main exporting countries of unprocessed roundwood to Slovenia in 2018 were Austria (32%), Croatia (28%) and Bosnia and Herzegovina (26%) (Ščap, 2019).

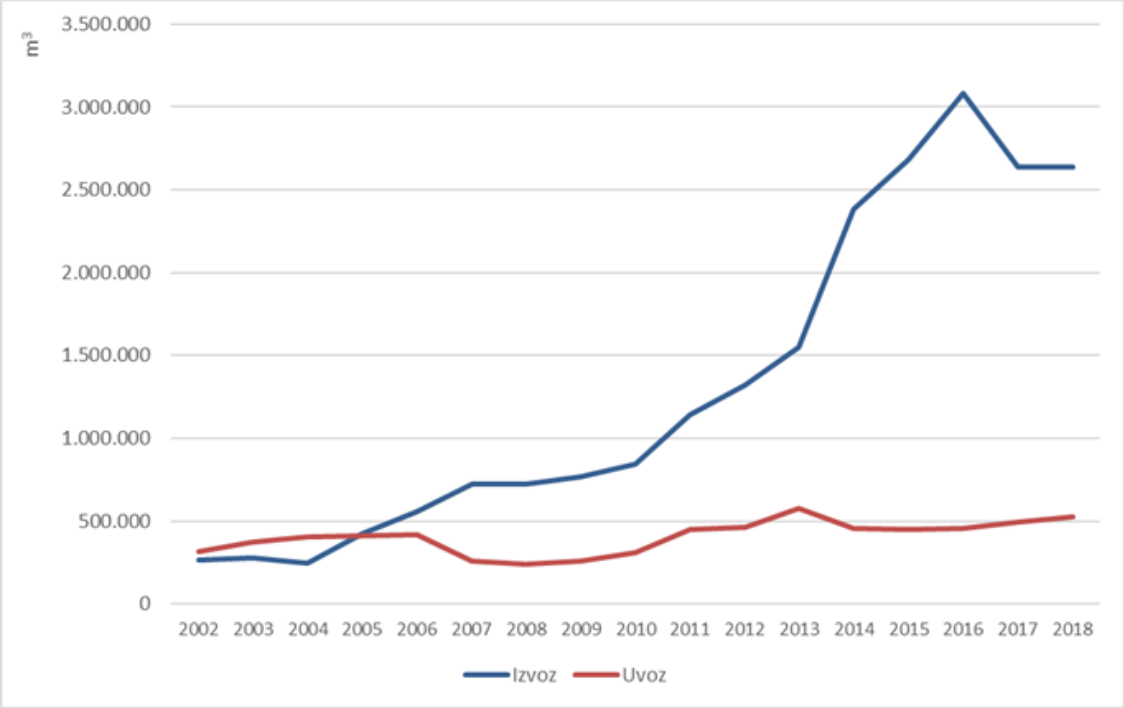

Figure 30: Export and import of roundwood in Slovenia (source: Statistical office of Republic of Slovenia, calculated by SFI).

3.3.1. The volume and the structure of timber removal in Slovenian forests

The structure of timber removal in Slovenian forests shows that in period 1999 – 2013 rejuvenation felling prevail (in average 38% of total felling). The volume of salvage logging was on average 27% and the selective thinning represents an average of 26% of the total felling in that period. A record level of felling (6.36 million m^3), which for the first time exceeded the allowable cut, was achieved in 2014 due to restoration of damage caused to forests by icebreak, which affected 9.32 million m^3 of trees. The volume of felling in all other years of the period 1999 - 2014 has otherwise lagged behind the allowable cut determined in the forest management plans reaching only 65% of its value. The allowable cut in 2014 amounted to 87% of the annual growth assessed for the whole country. The large volume of felling in Slovenian forests was continuing also in 2015 because there was a noticeable increase in sanitary felling of Norway spruce caused by bark beetles outbreaks, which was a consequence of ice damage in 2014. A very high volume of felling (6.1 million m^3) was achieved in 2016 due to restoration of damage caused by bark beetles. According to the Slovenia Forest Service, a total of 2.2 million m^3 of conifer trees were felled during the year 2016 due to damage caused by bark beetles. Another natural disturbance affected Slovenian forests in the middle of December 2017, where one fifth of forests were damaged by strong winds. Estimated damaged exceed 2.2 million m^3 of timber and this was the most extensive windthrow damage recorded in Slovenian forests in the last 20 years. Due to the frequent occurrences of natural disasters in Slovenian forests in the period 2014 – 2017, the felling increased significantly in that period. Of the total volume of felling in these years, salvage logging represents the major type of felling with average 63% of the total felling in Slovenian forests.

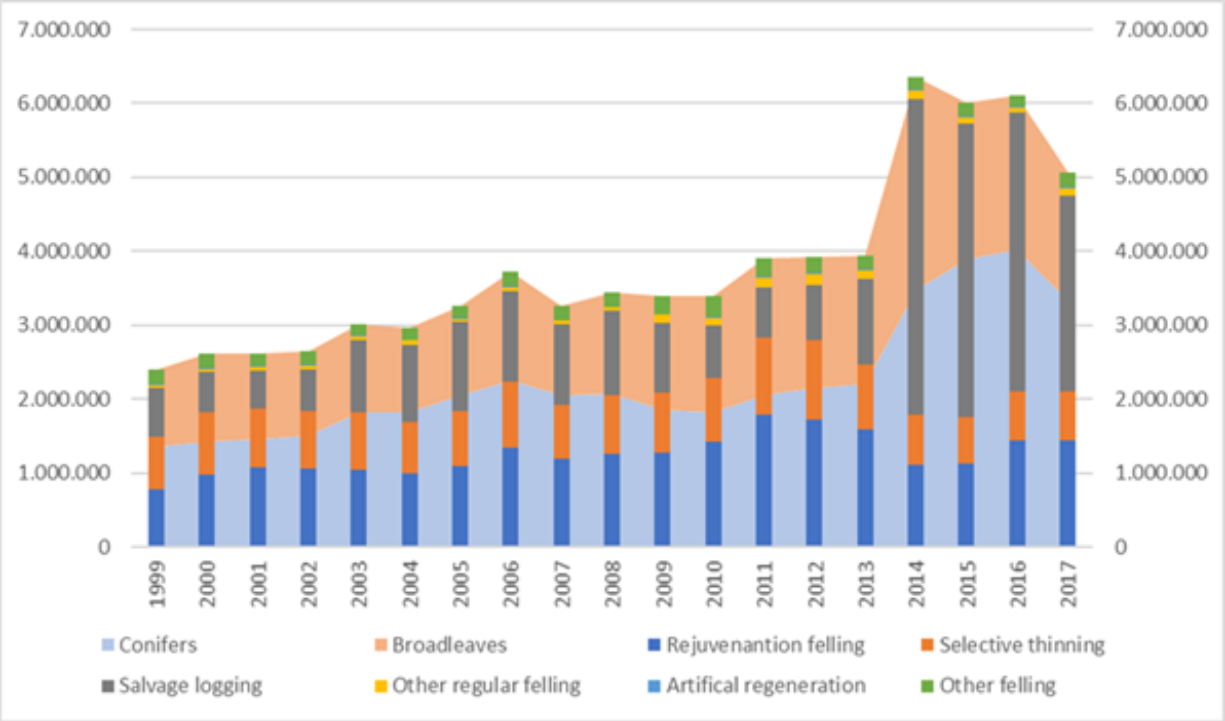

Figure 31: The structure of timber removal for the period 1999 – 2017 in gross m3 (source: SFS, calculated by SFI).

3.4. Forest ownership

Prior to World War II, Slovenian forests were predominantly peasant and landlord owned. In the 1950s, the structure changed: the large-scale forests were fully nationalized, and farmers were limited to up to 45 ha, and to private forests up to 5 ha. Nevertheless, in Slovenia, in socialism, unlike some other Eastern European countries, agricultural land and forests were mostly privately owned. In 1991, upon Slovenia's independence, legislation on denationalization was adopted. The law allowed the restitution of property that was confiscated after the war by farmers and other private forest owners, agrarian communities, landowners and the Church. The consequences of this law are now reflected in an increase in the diversity of private forms of forest ownership, an increase in the area of private forests and a large increase in the number of co-ownership relationships due to the transfer of property rights to all heirs.

Due to process of denationalization a share of public forests has decreased from 34% in 1996 to 21% in 2018, which put Slovenia among European countries with the lowest share of national forests. Today, 76% of forests in Slovenia are private property, 21% of forests are public (owned by the state) and 3% of forests are owned by local communes. The largest private forest owner is the church.

Table 6: Forest areas in 2018 and their ownership structure.

Forest area	Private forests	Public forests	Local communes forest	Total
ha	901,038	244,473	31,733	1177,244
%	77	21	3	100

To be a forest owner means, in addition to the enjoyment of property rights, also the fulfillment of certain obligations. The basic legal frameworks for forest management are set out in the Forest Act (Uradni list RS, No. 30/93), which commands multifunctional and sustainable forest management and gives equal importance to production, social and ecological (environmental) functions.

3.4.1. Private forest owners

The average private forest estate is small, and even this is further fragmented into several separate parcels. From the beginning to the end of the 20th century, the average size of private forest property in Slovenia decreased by 50%. In 1990, the average size of 2.7 hectares was approximately the same until today, despite the return of large state estates to private owners. Only 11% of private owners in Slovenia own a forest larger than five hectares. Although they manage more than half of privately-owned forest land, these owners are important primarily from an economic point of view, but not from a social point of view. The remaining 89% of private owners own forest holdings smaller than 5 ha, where, due to the small size (estates of less than five hectares), economic interest is poorly expressed. On average, private forest ownership consists of three spatially separated estates, and one third of private forest estates are owned by two or more owners. The size of forest estates is decreasing in the process of inheritance. For the great majority of these estates, forests are not of economic interest. According to the latest data there are already 314,000 (with co-owners even more) forest owners in Slovenia. The age structure of forest owners is unfavorable. The largest share (>40%) of forest owners belongs to the age group of 60-79 years. Together, these owners own the largest percentage of forests (>40%).

Table 7: Characteristics of non-industrial private forest owners

Forest area	Age		Gender	
	Average (years)	Range (years)	Male (%)	Female (%)
< 1 ha	59	19 – 82	48.9	51.1
1 to less than 5 ha	50	18 – 99	59.6	40.4
5 to less than 15 ha	52	19 – 84	69.8	30.2
15 to less than 30 ha	49	18 – 81	75.0	25.0
> 30 ha	47	17 – 75	67.4	32.6
Do not know	50	18 – 78	34.0	66.0
Total	51	17 – 99	59.0	41.0

The major fragmentation of forest property, the number of forest owners and co-owners and their increased heterogeneity, present a serious obstacle to professional work in private forests and mobilisation of forest potential. As a result, there is a lack in cost-effectiveness of wood harvesting and yields barely cover costs, so private forest owners do not invest in forestry equipment (especially in self-protective equipment). They are in general poorly trained in forestry and use forestry machinery irrationally. Private forest owners are often disorganized on the market and, due to the small quantities of forest timber assortments, are also very ineffective in the sale of timber (especially difficult to sell less quality timber). Furthermore, this reduces interests from owners for forest management. In small forest estates, younger development phases are frequently neglected, which leads to poor growth of stable and quality forests.

One of the important influencing factors affecting the activity of private forest management is the timber market, as forest owners can make very selective decisions about tree felling, and so they are waiting for a possibly good price for the wood. A good example is the auction of more valuable timber (in Slovenia since 2007). It is possible to sell high quality timber at auction and thus increase the economics of timber production and sale. High prices of quality wood can be an incentive for forest owners to increase logging and forest care. In the case of low timber prices in the market, forest owners generally choose not to logging.

In the last decade, forest owners are confronted with climate changes and adaptation to these changes will be needed. In particular, small forest owners are more affected by changes in the market and they are not so flexible in adaptation to fluctuations in prices. Lower activity of some forest owners is also strongly linked to the understanding of forest management and wood selling. Efficient use of wood and adding value to lower quality wood is another challenge for forest owners in an increasingly important field of the forest bio-economy. Wood mobilization from private forests in Slovenia is addressed by several political programs, e.g. the National Forest Programme, the Rural Development Program and the Wood Supply Chain Action Plan. But policy instruments are inadequate, or their implementation is insufficient. This was demonstrated, for example, after the last severe ice break in 2014 and subsequent bark-beetle calamities, which made the topic of wood mobilization even more prominent in political discourse.

Forest owners' cooperation

Since fragmented private forests dominate in Slovenia, it has long been pointed out that small private forest holdings need to be brought together and forest owners connected. 4 forms of forest owners' cooperation are currently recognized:

1. Informal cooperation: It can be a temporary form of cooperation where owners connect to achieve a unique goal, such as building a forest road or felling trees on a rounded surface.
2. Equipment cooperation: Owners share logging equipment and machinery as well as perform wood harvesting together. They manage the forest independently of one another. In Slovenia, such is the case of Machinery Rings.

3. Financial cooperation: Owners come together to act together on the market and thus achieve a better position (better price). In Slovenia, we know different forms of cooperation: forest owner associations, agrarian communities, cooperatives…
4. Participation in representation in the political process. The private forest owners connect so that they can defend their interests more effectively in the political process.

Many efforts in the past were mainly for the third form of cooperation. Namely the Forest Act in 1993 has set conditions for new organizational possibilities and forest owner associations (FOAs) have been recognized as an important mechanism to improve forest management in areas with fragmented ownership and to foster cooperation among small-scale forest owners. Since 2001, 29 FOAs have been established with more than 4000 members. However, this only represents around 1% of private forest owners in Slovenia. Research in 2015 (Aurenhammer et al., 2018) has shown that FOAs are currently unlikely to support an increased wood mobilization themselves. First, this is not their priority and second, they lack the within-network support that is needed to contribute to such an increase in wood mobilization. Better exchange of resources (in the networks) and development of capacities within FOAs and their cooperatives (organizational) would be needed for FOAs and their cooperatives to increase wood mobilization. In this respect they are, currently, not yet embedded sufficiently in networks that facilitate the wood mobilization from small private forest owners. Moreover, despite all the policy measures that support more active integration of forest owners for management and business integration, there is practically no business cooperation.

Education options

Regarding the Catalog of Qualifications System in the field of forestry and wood technology, prepared by Institute of the Republic of Slovenia for Vocational Education and Training, forest owners have the possibility to gain knowledge of forest management at the following education providers:

- Srednja gozdarska in lesarska šola Postojna/Secondary forestry and wood school Postojna
- Srednja lesarska in gozdarska šola Maribor/Secondary school for Wood processing, Forestry and Design, Maribor
- Višja strokovna šola Postojna/Vocational College Postojna
- Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za gozdarstvo in obnovljive gozdne vire/University of Ljubljana, Biotechnical Faculty, Department of Forestry
- Grm Novo mesto - center biotehnike in turizma/Grm Novo mesto - Center of Biotechnology and Tourism
- B&B izobraževanje in usposabljanje d.o.o./B&B Education and Training d.o.o.

An important role in the professional advice and training of forest owners is also played by the Slovenian Forest Service, which performs a public forestry service in all Slovenian forests, regardless of ownership. Between 2008 and 2015 around 300 training courses per year were conducted in the context of sustainable forest management (SFM) in Slovenia. The trainings touch upon numerous SFM related topics.

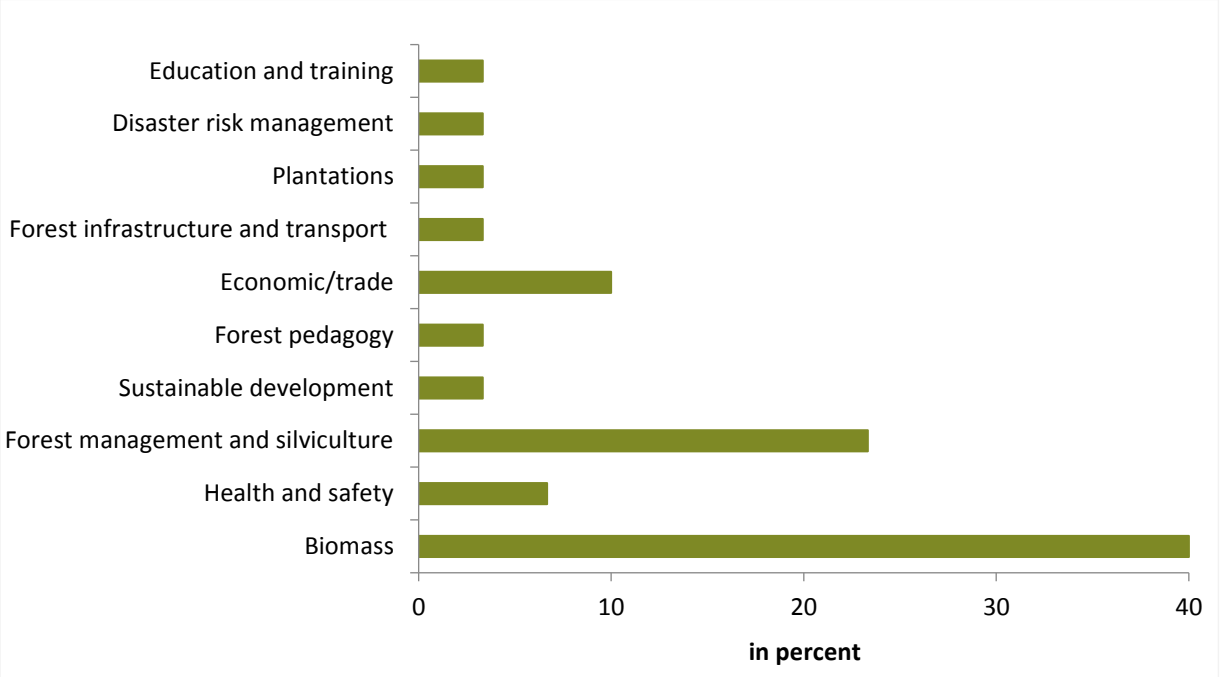

Figure 32: Focal points in sustainable forest management training courses in Slovenia (relative share).

Practical work, particularly in workshop settings, dominates the means of knowledge transfer in Slovenia (52%). In general, it appears that there is a good mixture of indoor and outdoor teaching approaches applied in SFM training in Slovenia as seminars, study circles (21%) and lectures/presentations (18%). Field trips (9%) round up the entire portfolio of teaching methods. Even if national providers of training programs relate to individual needs within national forestry sectors, SFM-related training programs should be updated according emerging issues. It is an important task to open the innovative forms of learning, combinations of topics and learning environments.

3.4.2. Identification of forest owners needs

The most commonly selling wood from private forests takes place on a truck road, where the owner sells wood assortments to company specialized for selling/buying wood. The sale of wood between the owner and the buyer frequently takes place according to numerous internal specifications of wood assortments, which are (in most cases) set in favor of the buyer. Since the owners are only occasionally involved in sale of timber, they lack knowledge in this area. There is no tool available for easy and quick assessment of timber quality, moreover there is no professional training of forest owners in assessment of timber quality or selling and buying wood.

In Slovenia, timber is very often bought/sold on the basis of a classic manual measurement of assortments. In private forests, Slovenian national standards (SIST EN) are used in timber

trade. The Slovene national standards are based on European standards. The SIST EN 1309-2: 2006 and 1309-3: 2018 standards relate to methods of measurement for round and sawn timber. In addition to the mentioned standards, the Rules on the measurement and classification of timber assortments from forests owned by the Republic of Slovenia (Uradni list RS, št. 30/17) are used. It defines the method of measurements and classifications of dimensions, quality and purpose of use of timber assortments. The usage of the rules is set by law in sale of timber from state owned forests, but it is also used in private forests as it is based on national standards. Considering the fact that a large part of the coniferous timber is sold abroad (Austria), the ÖNORM 1021 (2015) standard is currently very relevant for forest owners. But standards are not commonly used among smaller private forest owners. Therefore, a simple and useful tool is needed to enable private forest owners to learn easily on effective marketing of wood and forest services.

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SPAIN

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4.1. Forests and forestry in Catalonia

The total surface of forestry in Catalonia is 1,348,000 hectares, representing a 42% of the total surface. It increments approximately a 4% annual. The forestry landscape in Catalonia corresponds to a mosaic type of distribution between agriculture and forestry. This contributes to a better wildfire prevention and improves the biodiversity conservation. The three main type of species are Scot's pine (40%), Aleppo pine (30%) and holm-oak (20%). Only the 25% of the forest is public, 70% of which is regulated under forestry plans. Only the 30% of the private forests are regulated through forestry management plans. The forest exploitation has increased during the last decade (mainly conifers) and it's expected to keep scaling thanks to the biomass mobilisation, forestry uses and new application of wood products (120 million of m^3 per year approximately) but is not enough to cover the natural increase of the forest surface. The purposes of the exploitations are biomass production (40%), sawmills (30%), timber (20%) and other products (10%). Very important resources for the Catalan markets are also the mushrooms market, being the black truffle production the most relevant, cork production and pine pinions, representing an average of 60 million euros per year. Regarding leisure uses, 40% of the total Catalan forest is under the Nature 2000 Network, 11% which are Natural parks. People can enjoy from a rich biodiversity and rare species thanks to the geographic complexity of the territory and the specific Mediterranean climate conditions. The tendency is to have more and more a homogeny landscape due to the rural areas abandonment, thus the government and the responsible organisms are working hard on the conservation of the agricultural uses and the natural dynamics of the forests. The forestry primary sector represents the 0.03% of the GDP and the overall economic activities from the forest are representing the 1.6% of the total Catalan GDP (2% of the Catalan employment).

4.2. Adapted prevention management of wildfires in private forests

Wildfires are a permanent threat in the dry regions of the Mediterranean Sea. Although, wildfires are increasing due to climate factors and also the abandonment of the uses related with forestry, rapidly climbing from the southern parts of Europe to the Central and Northern parts year by year. In Catalonia, in the last 30 years a lot of efforts from the public bodies, private associations, owners and research centers has been put together to prevent the risk of the fires and mitigate its effects afterwards. The result is a strong knowledge on prevention and mitigation in cooperation with different bodies responsible of the management. Also, the private owner plays an important role in this equation as the responsible of their own forest and the maintenance of its quality and favorable conditions against fires. From Catalonia we propose to share this knowledge as a measure to pre mobilise the actors and to provide the adapted management techniques used here to be applied in other European regions, which are facing nowadays, or we'll be facing in the close future the same problematics.

4.2.1 Situation with private forest owners

The situation in Catalonia with the private owners has positive and negative aspects. As mentioned above, there's the need to increase the communication between private owners and the organisms. The benefits of a managing plan and the new sustainability techniques are not enough known by the owners. Also, the profitability of the forests and the high costs in comparison to the possible incomes is not strong enough to make the forest management an easy ongoing process. This is as well related with the industry sector, which should be improved on its diversification and be able to manufacture added value products from the Catalan forests resources. The positive aspect is that in Catalonia there's a strong number of organisms providing services to the private forest owners (publics and privates) despite it's not representing a relevant economic activity. The 64% of the surface of Catalonia is covered by forests, 75% is owned by private owners. Only the 30% of this private forest is managed under a recognised plan by law. All the Catalan forestry sector is regulated by the Catalan Government, divided in two different directorates: a) Department of Agriculture, Livestock, Fishing and Food; b) Department of Territory and Sustainability. These Departments are acting with the support of the science centers (financed in part by them), which are developing techniques and solutions to be applied in the current situation of the forest. Here you can find a list of the main:

- Ecological Research and Forest Applications Centre (CREAF)
- Forest Science and Technology Centre of Catalonia (CTFC)
- Catalan Wood Institute (INCAFUST)
- Catalan Cork Institute (ICS)
- Research Centre of Agri-food Technologies (IRTA)

Despite the research centers are having a strong link with the owners, those who are daily dealing with the owner are the private forest associations. In Catalonia, at Catalan level, there are:

- Forestry Consortium of Catalonia (CFC)
- Catalan Federation of Forest Owners Associations (BOSCAT)
- Association of Local Entities of Forest Owners in Catalonia (ELFOCAT)
- Mushrooms and Truffles Producers Association

An also there's more than 20 local associations aiming to manage special interest spots and acting to preserve them. All these mechanisms are collaborating together to keep the forestry sector as much profitable and healthy as possible.

4.3. Forest works recommendations

4.3.1 Mosaic landscapes and different uses

The climatic and biophysical characteristics of the Mediterranean context make the variables affecting the fire very well represented during hot summers and dry. In these conditions, the vegetation is in a favorable condition for the appearance of wildfires once a forest fire has begun.

If the fire in the Mediterranean basin has been part of its natural and cultural landscape since very ancient times, what has changed over the last decades to turn wildfires into one of the main risks and priorities for the protection of people, houses and forests? Why, despite all the effort in an extensive and expensive system of extinction, we continue to suffer from wildfires?

The answer includes social, economic and ecological factors that affects the rural and urban landscapes of the Mediterranean.

The Mediterranean landscape has been used and influenced by human society and its activities for thousands of years. The composition and structure of the landscape has had a close relationship with the socio-economic needs of each civilization and moment. Over the years, landscape transformation has been dominated by agriculture (converting forest lands into fields) and livestock (deforestation of forest lands for pasturing).

In many places, these dynamics resulted in a mosaic landscape formed by crops, pastures and forests, often fragmented and with low density (with trees separated and without much presence of scrub) which were used to make timber and wood. These forests suffered from fires already caused by lightning or by human negligence.

However, fires could rarely spread through wild surfaces, since the lack of continuity of forest spots or the low density of trees and vegetation under the umbrella did not allow to generate fires of great size or high intensities with big flames able to burn the crowns of the trees, which at the same time were easier to control. Sometimes it was usual to let the fire burn, because it helped to reduce scrub and regenerate the pastures (unless it was near to affecting villages or crops).

In many Mediterranean regions, the degradation of the soil after years of livestock and forestry overexploitation and the high risk of erosion have led to the reforestation of the lands, with great success. Whales, entire river basins, urban settlements, crops and even tourism have benefited from this enormous effort.

During the last century, several changes in society are affecting directly on forests and on the risk of wildfire. The rural exodus, abandonment of fields and pastures, the transition to the fossil-based energy model and the lack of profitability of the Mediterranean timber in a globalized market, it has allowed the natural reforestation and expansion of forests. This should not be negative, and it’s allowing to recover the forest area and associated biodiversity, sometimes, to a level that has not been recorded in hundreds of years.

The difficulty comes out when this process occurs in a disorderly manner on forests that had been managed before. Without any element that selects or eliminates vegetation, forests are densified, appearing many small trees with small diameter touching each other and competing for the resources (light, water and nutrients).

The undergrowth grows without the herbivorous effect of livestock, nor the presence of natural fires caused by lightning which controlled the growth. At overall, the forest becomes more vulnerable to pests and dangers, to drought, to the possible effects of climate change and, of course, to high-intensity forest fires that can burn entire trees in a vicious circle. In these new forest conditions, the wildfires acquire a new magnitude and degree of intensity and virulence, as they have sufficient accumulated and available fuel to burn. This generates

wildfires with a huge power and with a huge capacity for propagation and destruction. Also, they are very hard to be extinguished, leaving a highly damaged ecosystem.

Therefore, while fire is an inherent part of many of the Mediterranean's cultural ecosystems and landscapes, the changes in uses that lead to a loss of the agricultural mosaic and the accumulation of forest fuel in forests are the cause of the great forest fires which burn high surfaces in high intensity. This could be a reflection and also a consequence of the current relationship forests and society.

The important social, economic and environmental impacts of great wildfires face risk managers, including forest managers, firefighters and territory uses managers, to a new dimension of the phenomenon that must be approached in an integrated way. Apart from having an effective extinction system, without acting on the propagation capacity and the vulnerability of people and property, it will not be possible to effectively reduce the risk of wildfires.

The cause that a fire generates a great wildfire corresponds essentially to the conditions of the environment and the capacity of response of the extinction devices. In this case, apart from the topography and meteorology more or less favourable to spread the flames, the amount and distribution of forest fuel is the most determining factor. This will be mainly influenced by the continuity of the wooden mass and the distribution of the vegetation within the forest.

Dense forest formations, with continuous vegetation strata, can generate high-intensity fires burning through the crowns of the trees and even propagating through fire sparkles over long distances and generate a secondary focus that becomes part of the fire. Great wildfires in a mosaic landscape can create fires capable of skipping fields and continuing propagating. However, if the forest landscape does not have as much fuel load, the spread of the fire is easier to control.

The development of preventive measures as the reduction of fuel, improvement of the access, the ability to self-protect housing, the emergency plans of municipalities and inhabited areas, the best preparation and provision of the means of the system, the extinction and correct coordination of the actors involved in the emergency management highly improve the response capacity. Their priority is always to protect people and goods first. Often the extinction bodies must disregard the fire to protect the people and houses from the flames, a situation that favours the free spread of the forest fire promoting its growth and reach. Thus, if the propagation risk is not handled properly, the situation could turn into incontrollable at any moment, regardless of its origin.

While not acting on the territory's capacity to generate and sustain fires beyond the capacity of extinction, the only way to avoid the potential of large fires will be acting on fuel loads. That means generating resistant forest structures to fireworks, distributed throughout the landscape and in areas close to vulnerable elements.

New knowledge about certain patterns of fire behaviour, which are repeated according to the meteorology and topography of the site, allow us to identify more strategically where we must act on the vegetation and to anticipate the movements of the fire when it occurs. In fact, promoting the consumption of agricultural products (for the maintenance of the mosaic landscape) and forestry (boilers of biomass, wood, woods, livestock at the undergrowth) is

the most effective way to have landscapes adapted to fire disturbance and "quench" fires before they start. On the contrary, without acting on the fuel at a landscape scale and reducing the vulnerability of settlements, the technological limit of means of extinction is the risk threshold that as a society we must assume.

Therefore, from an ecological point of view, it's not always necessary to associate the fire with a damaging and negative element for the forest. It will depend essentially on its intensity and frequency, and if it can compromise the ecosystem's recover ability or environmental services such as control of the erosion that forests offer. Precisely the loss of forest cover makes soil extremely vulnerable to erosion, especially if there are episodes of torrential rain after fires (for example, the cold drops in autumn). However, naturally, burnt land is often occupied by several plants and shrubs adapted to the effect of flames, either by the germination of the seed bank or the regrowth of vegetation.

In addition, in the Mediterranean cultural landscape, the fact that many of the forests often grow in old farmland also limits the erosion of the soil. However, if the fire frequency in the same place is high enough to condition the recovery of vegetation, soil degradation and desertification processes can begin. In the case of low intensity fires that do not affect the crowns of the trees, the effects on the soil are minimal. It will be necessary, therefore, to guarantee the ecosystem's ability to recover vegetation cover on burnt land.

Once again, low-intensity fires, beyond certain black marks at the base of trees, have no more effect on the landscape level, and even they help to generate types of forests where it's easier to travel and make use of them at recreational level. There's also no negative economic repercussions and it can increase the land productivity through the elimination of competition or allowing more presence of ruminant species and other herbivores able to be hunted.

In high intensity fires on productive pines, we will have to wait for the recovery of the adult forest to be able to go back to the wood exploitation. On the other hand, burnt wood may also be sold, though, normally, at a lower price. The cork trees, even regrowth, suffer a serious damage since the blackened bark from which the cork is extracted loses a lot of its value. The pick-up of mushrooms and hunting, for example, can be seriously affected by a great wildfire.[1]

4.3.2 Forest Management Recommendations at National Level

Sustainable Forest Management is the administration and use of forests in such a way that it maintains its biodiversity, productivity, regeneration capacity, vitality and its potential to fulfil, now and in the future, relevant ecological, economic and social functions at local, national and global level, without causing damage to other ecosystems. To carry out this management, the most indicated and effective is to have a forest management instrument (FMI), which is a document that aims to provide to the landowner all the necessary information and the planning of the actions for the correct forest management of the land. There are different types of FMI according to the characteristics of the forest, in order to adapt them to each one. Apart from providing the owner with this ability to act within the

[1] Plana, E.; Font, M.; Serra, M.; Borràs, M.; Vilalta, O. 2016. El foc i els incendis forestals al mediterrani; la història d'una relació entre boscos i societat. Cinc mites i realitats per saber-ne més. Projecte eFIREcom. Edicions CTFC. 36pp. TRANSLATION: *Fire and forest fires in the Mediterranean region; history about the relationship between forest and society. 5 myths and truths to know.*

parameters of the SFG, these documents also provide a set of very important fiscal and management advantages.

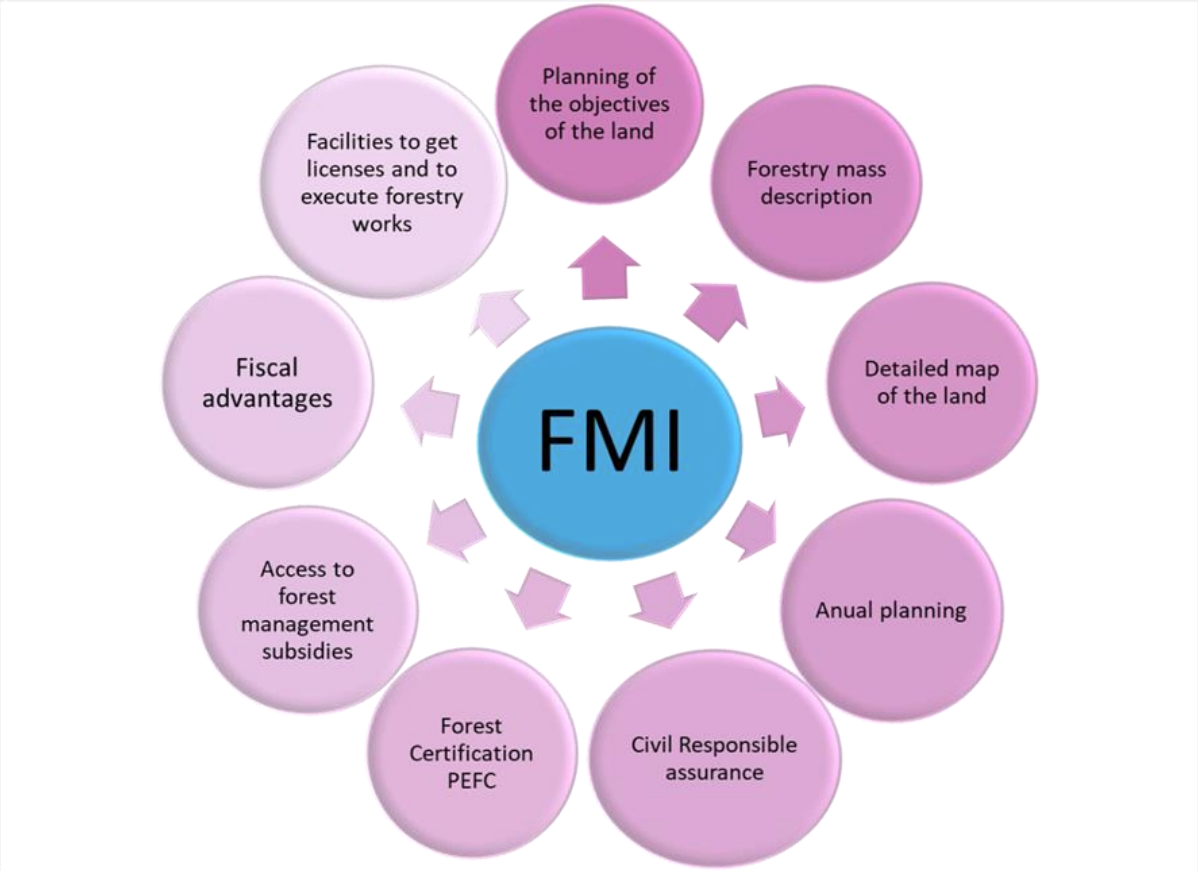


Figure 33: Forest management instruments and its benefits. From Erasmus+ Eforown project

In Catalonia, the Guidelines for Sustainable Forest Management of Catalonia (ORGEST) have been developed, which are multifunctional guidelines for the management of forests that aim to establish management models for the masses according to the selected objectives, and to achieve the integration of the rest of the objectives of sustainable forest management. ORGEST is based on the identification and definition of forest typologies and the definition of silvicultural models. For each one, management models have been established which show the set of actions to be carried out in the forest mass.

In the Catalan territory there are the following recommendations:

1. Forestry typologies in Catalonia:
    a. Wooden typologies in Catalonia.
2. Support Indicators and parameters for the sustainable forest management:
    a. Great wildfire risk integration into the forestry management.
3. Forestry management models:
    a. Fire wood.
    b. Common ash, silver birch, European aspen and hazelnut tree woods.
    c. Sessile oak, Pedunculate, Pyrenean oak and African oak woods.
    d. Stone pine woods.

e. Conifers plantations.
f. Scot's pine woods.
g. Aleppo pine woods.
h. Holm-oak woods.
i. Pyrenean oak woods.
j. Austrian pine woods.
k. Chestnut tree woods
l. Beech tree woods.
m. Cork tree woods.
n. Management models for mushrooms production in Scot's pine woods.

4. Cartography:
    a. Pure and mixed formations in Catalonia based on the Spanish Forestry Map.
    b. Map of the lithological types of importance based on the Geologic Catalan map 1:50.000.
    c. Map of types of wildfires in Catalonia.
    d. Many other related cartography and data.

4.4. Methodology to identify strategic management spots (strategic areas)

Fire is an intrinsic element of the Mediterranean climate, and the forest has evolved in this context. In the Atlantic climate, softer and more humid, fires are less frequent disturbances.

In the current context of climate change, both conditions of vegetation (drought stress) and meteorology (high temperature, low humidity, strong winds) are generating more episodes where all factors favour the development of forest fires. High intensity fires (Large Forest Fires - GIF) are also more numerous and caused by a large amount of combustible material. In fact, due to the change in uses, plant growth is the result of the undergrowth recolonization.

There are two main resistance strategies from species to fire:

- **Resistance:** being able to withstand the fire and stay alive.
- **Resilience:** being able to recover the space after the fire, with a rapid regeneration from resistant seeds, seeds from unburned areas or from regrowth of undead plant parts.

The cork oak uses a resistance strategy. This species has a very thick and insulating crust that allows it to withstand high temperatures, thus protecting gems. This allows it to easily bounce back after a fire.

The white pine uses a resilience strategy. This species has some serotine pineapples that open and release seeds when they are exposed to a source of heat (for example, a fire). Since fire eliminates all competition, these seeds can germinate more easily and cover large areas shortly after a fire.

4.4.1 Typology of fires

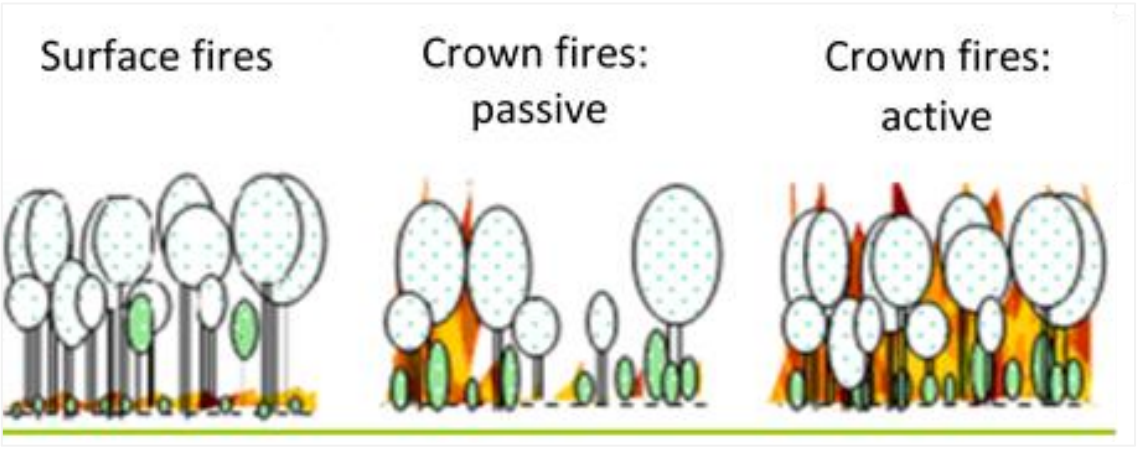


Figure 34: Most common fires typology according to the propagation pattern (Source: Piqué et al, 2011).

There are different types of forest fires according its propagation pattern:

Undergroud fire: under specific conditions like those characterizing peat bog ecosystems, fire spreads through the underground organic matter and roots. Even though flames are not visible, the fire can stay active for long periods.

Surface fire: the flames are spread through the fuel located at the surface and through the taller undergrowth.

The active crown fire is the one that represents the greatest threat. It generates high fire intensities, launching massive secondary fires and flame lengths at a very high fire propagation speeds.

Torching fire: fire spreads from the surface strata and into the crown of a single tree or small parcel of trees.

Crown fire: initiated as a result of the convection heat transmitted by surface fire to the Crown of the trees (Van Wagner, 1977). It includes two subgroups:

- **Passive:** the tree crown burns individually; the heat of convection is not enough to keep the propagation between crowns.
- **Active:** fire spreads through the tree crown and also through the surface continuously. It needs the convection heat to keep this spread between the cups.

New types of great wildfires due to climate change reasons:

Large high intensity forest fires due to extreme aridity already take place. Many mountains are suffering from very extreme climatic conditions and begin to be outside of their optimum climatic range. This means that the vegetation is very dry and, therefore, very available to burn. This type of forest fire has been seen, for example, in Fort McMurray, Canada (2016) and in Las Maquinas, Chile (2017).

Forest-fire structure relationship and incidence of forest management in the fire behaviour:

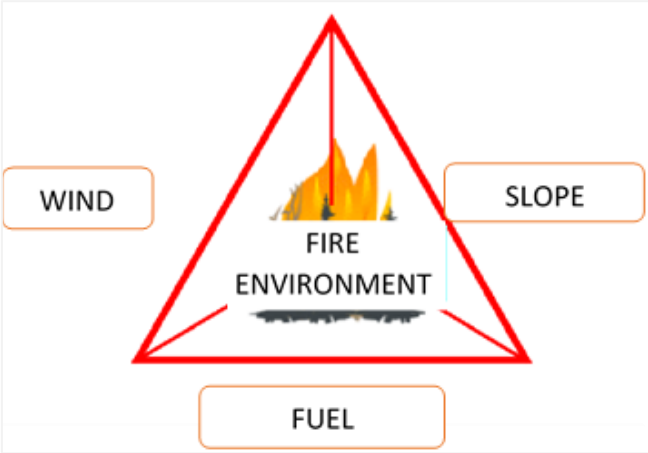


Figure 35: Fire triangle.

Of all the factors conditioning the behaviour of fire (fire triangle), only fuel can be modified to reduce the risk of large forest fires. With forest management, a forest can be configured with discontinuities between layers of vegetation necessary to prevent (or hinder) the passage of surface fire to the crown of the trees with the most frequent environmental conditions.

The structures where fire cannot generate the necessary conditions to become a layer fire are structures of low vulnerability (type C). The objective of forest management is to integrate forests into this structure C. The way to do it will be different depending on the species and the location of the forest. High vulnerability structures (type A) are the most unfavourable case, where propagation to layers is very likely. And the intermediate case (type B) are structures that generate passive fires of layers under normal environmental conditions.

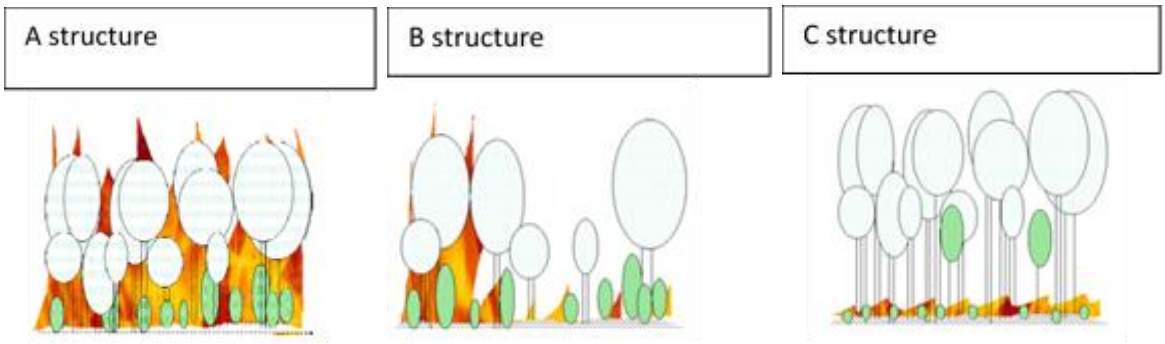


Figure 36: Different fire structures.

Different types of fuel in the forest:

Air fuel: formed by the crown of the trees of the dominant or codominant stratum of greater height.

Fuel of scale: air fuel of a height greater than 1.30 m which is not part of the dominant or codominant stratum. It includes small trees, shrubs, lianas or fallen trees.

Surface fuel: air fuel, not exceeding 1.30 m. It can be thickets, herbaceous vegetation, branches, fallen trunks, silvicultural remains.

4.4.2 Main silvicultural treatments for fire prevention:

Thinning: The objective is to reduce competition between tree feet and generate vertical and horizontal discontinuity between tree crowns. The most common thinning is the low thinning which extracts the dominant feet and generates a greater vertical discontinuity, maintaining the tree cover and not favouring the scrub.

Brush out: it allows the reduction of the surface and fuel of scale mass and generates vertical discontinuity with the crowns (the undergrowth will be less dense). Thinning is usually selective (biodiversity) and of intensity variable according to initial discontinuities.

Selection of sprouts (sprout species): The objective is the partial reduction (more or less intense) of the regrowth with the objective of reducing competition between feet and generating vertical and horizontal discontinuity and promoting a well-developed tree canopy.

Pruning: The lower branches of the feet are removed to raise the crowns and generate a greater vertical discontinuity. It has to be done only when pruning decreases, the vulnerability of the structure, it's not a general recommendation.

Slash managing: The objective is to accelerate the incorporation into the soil of the plant material resulting from the silvicultural actions, and at the same time avoid increasing the vulnerability of the stand. The concrete technique is a cost-efficiency choice always following the specific regulations on fire prevention (for example: leaving 20 m free from slash for each band of the main roads)

Figure 37: Image before and after the treatments.

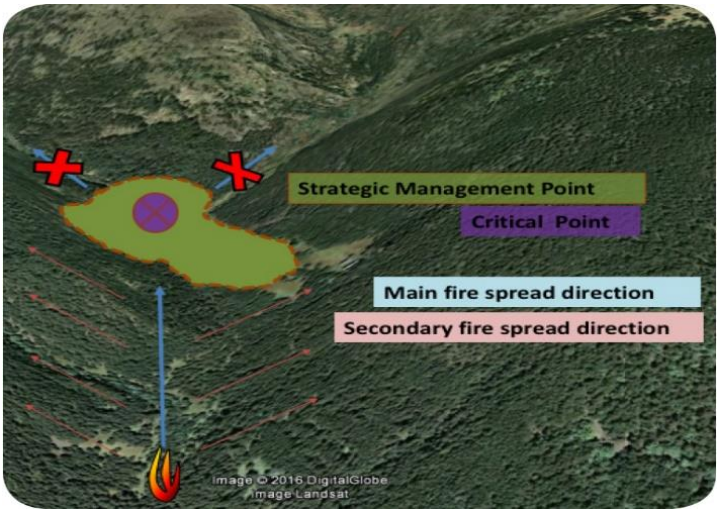
The principal techniques are:

- To cut the logging residues into small pieces. The slashes of branches, trees and bushes of more than 5 cm of diameter are cut into pieces of less than 1 m and left to the ground without making accumulations larger than 50 cm.
- To stack and burn the slashes. The residues are put in places without continuity with the trees or the bushes and burnt in a controlled way, until their elimination. Specialized personnel and additional fire prevention and extinguishing measures are required. Alternatively, the residues could be burnt extensively to the stand, with greater planning and execution efforts by highly specialized personnel.
- Chipping or shredding the slashes, at stacked or at extensively way. The accessibility and mobility of the machinery, as well as the cost, limits the application of this technique.

Figure 38: Wood residues after a clear cutting.

Fire prevention planning and efficient treatment location:

The territory planning is key element to an efficient prevention of large forest fires. One of the most used tools for territory planning to prevent potential fire damage is fire simulators, for example, FlamMap, FARSITE or WFA. The simulations help to anticipate the behaviour of future fires and therefore to locate those areas where it may be more interesting to invest in management efforts in order to prevent high intensity fires and potential great wildfires.



Strategic management points (SMP): Locations where the modification of the fuel and / or the preparation of infrastructures allow the extinction services to execute attack manoeuvres to limit the potential of a great wildfire. For each type of fire, opportunities are generated with common characteristics and, consequently, SMPs with similar locations, objectives and characteristics.

Figure 39: Location of a Strategic Management Point (Plana, E., Font, M., Serra, M., 2016. FOREST FIRES, Guideline for communicators and journalists. eFIRECOM Project. CTFC Editions. 32pp).

Management Promotion Areas (MPA): Locations with large areas where active forest management is a priority. It can have a specific or multiple objective (production, recreational, cultural, etc.) but the basic objective will always be the risk reduction of the great wildfires (potential losses). These areas are not directly related to extinguishing manoeuvres, but they are useful to reduce the propagation capacity of a fire and indirectly generate a larger range of fire control opportunities. A MPA can change the overall behaviour of a fire.

Fire simulators are tools for decision making, but they do not generate ideal solutions. Experience and knowledge about fire behaviour is essential to understand the simulator results and, therefore, to decide the efficient location of forestry prevention actions.

4.4.3 Prediction of future forest fires by means of analysing the historical ones:

Analyzing fires occurred in the past in a determined region can be useful for predicting future fires and their development, even though the prediction task is extremely demanding. Differently from floods, fires do not affect a defined area such as a basin or a watershed. Moreover, they do not occur in recurring periods like those determined by storms' regimes. Fires spread freely over the land where fuel is available. Moreover, their ignition, spread and extinction are influenced by anthropogenic factors. This makes difficult the estimation of a fire's likelihood in a specific place. The prediction is based on a combined study of local topography and weather conditions. A given fire in a determined place evolves following spread patterns similar to historical fire events that occurred in a location with same topography and weather conditions. Fire's intensity varies depending on fuel moisture. The only sure statement that can be made about a fire is that a high fire risk (usually due to human causes) and a wide fire spread capacity (a function of the fuel load, distribution and moisture) increase the chance that large fires occur. Identifying the "fire type" to which a specific fire event belongs to allows to predict the development of the specific fire, with the goal of designing efficient prevention and extinction strategies tailored on the fire' characteristics. Three "fire types" can be defined according to the fire spread drivers, namely the factor with more influence on the development and spread of the fire:

Topographic fires: the spread drivers are the reliefs and the local winds (mountain or valley breeze).

Wind driven fires: wind direction dominates the spread direction.

Convection fires: heavy fuel load is responsible of the fire spread. When we know the specific location and the "fire type", we can identify the "Strategic Management Points", areas where fuel treatments are needed in order to ensure safety and efficiency of extinction efforts. In these areas fuel treatments are envisaged as an opportunity to promote a lower fire behaviour (get fire into the suppression capacity) and ensure safer fighting operations.[2]

[2] Plana, E., Font, M., Serra, M., 2016. FOREST FIRES, Guideline for communicators and journalists. eFIRECOM Project. CTFC Editions. 32pp.

The controlled burns as a tool for fuel reduction and consequently the risk of great wildfires:

The controlled burns are a forest management technique to aid in the suppression and mitigation of forest fires by burning the accumulated fuel material of different origin (either naturally or the residues of a treatment). These burns are made under specific weather conditions. Those responsible for executing them know at any moment how the fire is behaving and how it will behaviour in its course. This technique, directed by trained and competent personnel, is safe and efficient.

Two remarkable key points:

- They can be an alternative to conventional treatments (hand tools or machinery).
- They can be done directly with a forestry objective or in combination with conventional silvicultural treatments, such as thinning or pruning.

Advantages:

- High yield (ha/wage) and high value (€/ha).
- The controlled burns are comparable to a natural disturbance, intrinsic in the Mediterranean ecology, but happened under controlled conditions.

Disadvantages:

- They can generate dense smoke that can cause problems near urban areas.
- An inherent risk of forest fire must be assumed. The preparation of the action area and the means of extinction support are essential.

4.5. Global organisation of the wildfire prevention in the Catalan society and at EU level

Sustainable forestry documents in Catalonia:

A sustainable forest management plan is a forest management instrument that aims to provide key information of the suitable actions for the correct forest management of a property within a period from 15 to 20 years, but with the option to extend it later. This document should guarantee the following:

- Improvement, sustainability and multifunctionality of the forest systems.
- Creation of an adequate forest division of the land.
- Consideration and integration of land management plans, mainly in the field of control and prevention of forest fires.
- Introduction of silvicultural techniques to guarantee the regeneration of the tree mass and minimize the risks of erosion and fire.
- Definition of the infrastructures to improve the realization of the exploitation, and the management to be carried out in the following years depending on the forest typology of each plot.

This is regulated by the Forest Ownership Centre, depending directly from the Catalan Government.

Different Forestry Management Instruments in Catalonia:

Forest Management Instruments are documents suitable for all types of forest. For this reason, there are different types of documents according to each specific condition. There are currently five types of forest management instruments in Catalonia:

- Forest Management Project for public lands higher or equal to a 250 hectares.
- Forest Improvement and Management Technical Plan for public or private lands higher than 25 hectares.
- Forest Management Simple Plan for public or private lands equal or lower than 25 hectares.
- Joint Technical Plan for a Forest Improvement and Management for public or private lands sharing a forestry coherent territorial frame.
- Forest Management Plan at Municipal or Extra Municipal level for all the lands under the same municipal territory or even at wider scale, but always on its totality.

Main actions undertaken in relation to forest fires prevention, monitoring and restoration at EU level:

- **Directorate General of Environment**

Many specific forest fire prevention regulations were emanated as of 1992 by DG Environment. In 1998 the Commission's Expert Group on Forest Fires was created with the aim of exchanging information concerning lessons learned and forest fire prevention practices and developing as well as maintaining the European Forest Fires Information System (EFFIS). EFFIS is jointly managed by the EU Joint Research Centre (JRC) and the DG ENV and aims to provide EU level assessments for situations before and after fires, to support fire prevention through risk mapping and to promote preparedness, firefighting and post-fire evaluations.

- **Directorate General of Agriculture and Rural Development**

This DG has been supporting the financing of fire prevention and restoration actions through rural development programs until 2006. In 2007 a new regulation on rural development came into force, which among other aims had the goal of providing the legal basis for supporting the restoration of forests and fire prevention activities. The new regulation also requests Member States to classify areas according to fire risk in their forest protection plans as well as setting the measures for preventing fires and for restoring damage from fires in the areas characterized by high or medium risk.

- **Directorate General of Humanitarian Aid and Civil Protection**

Every year before the beginning of the forest fire season, the European Commission's Emergency Response Coordination Centre (ERCC) organises meetings joined by representatives of all European Member States that are joining the EU Civil Protection Mechanism to exchange information on the state of preparedness related to the occurrence of forest fires. EU Civil Protection Mechanism was set up on 2001 to enable coordinated assistance from the participating states to victims of natural and man-made disasters in Europe and elsewhere. Over the summer period, the ERCC is in contact on a weekly basis with the representatives of the countries that are at high risk of forest fires. When forest fires occur and when national capacities to respond are exceeded, European countries can show solidarity by providing assistance in the form of water-bombing aircrafts, helicopters, fire-

fighting equipment and personnel. To provide a joint and coordinated response, countries frequently channel assistance and exchange of real-time information through the EU Civil Protection Mechanism. The EU Civil Protection Mechanism was activated more than 55 times (including prealerts and monitoring requests) since 2007 to respond to forest fires within and outside European borders.

- **Directorate General of Research**

DG Research has supported forest fire research since the late 1980s with the aim of strengthening research activities and initiatives in various fields related to forest fires. An example of the action of this DG is the FIREPARADOX Project which had the overall goal of developing a scientific and technical basis for integrated land and fire management practices and policies.[3]

Main legal frame for forest fires prevention, extinction and restoration in EU context:

- Council Regulation (EC) No 1698/2005 of 20 September 2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD).
- Council Decision of 20 December 2004 amending Decision 1999/847/EC as regards the extension of the Community Action Programme in the field of civil protection.
- Commission Regulation (EC) No 2121/2004 of 13 December 2004 providing some detailed rules for the implementation of the Forest Focus Regulation.
- Proposal for a Regulation of the European Parliament and of the Council concerning the Financial Instrument for the Environment (LIFE+). 29.9.2004, COM (2004) 621.
- Communication from the Commission "Financial perspectives 2007 - 2013" 14.07.2004, COM (2004) 487.
- Communication from the Commission "Reinforcing the Civil Protection Capacity of the European Union". 25.03.2004, COM (2004) 200.
- Regulation (EC) No 2152/2003 of the European Parliament and of the Council of 17 November 2003 concerning monitoring of forests and environmental interactions in the Community (Forest Focus).
- Council Regulation (EC) No 2012/2002 of 11 November 2002 establishing the European Union Solidarity Fund.
- Regulation (EC) No 805/2002 of the European Parliament and of the Council of 15 April 2002 amending Council Regulation (EEC) No 2158/92 of 23 July 1992 on protection of the Community's forests against fire.
- Council Decision of 23 October 2001 establishing a Community Mechanism to facilitate reinforced cooperation in civil protection assistance interventions.
- Regulation (EC) No 1485/2001 of the European Parliament and of the Council of 27 June 2001 amending Council Regulation (EEC) No 2158/92 of 23 July 1992 on protection of the Community's forests against fire.

[3] Plana, E., Font, M., Serra, M., 2016. FOREST FIRES, Guideline for communicators and journalists. eFIRECOM Project. CTFC Editions. 32pp.

- Council Decision of 9 December 1999 establishing a Community action programme in the field of Civil Protection.
- Commission Regulation (EC) No 1727/1999 of 28 July 1999 laying down certain detailed rules for the application of Council Regulation (EEC) No 2158/92 of 23 July 1992 on protection of the Community's forests against fire.
- Council Regulation (EC) No 1257/99 of 17 May 1999 on support for rural development from the European Agricultural -Guidance and Guarantee Fund (EAGGF) and amending and repealing certain Regulations.
- Commission Regulation (EC) No 804/94 of 11 April 1994 laying down certain detailed rules for the application of Council Regulation (EEC) No 2158/92 as regards forest-fire information systems.
- Commission Regulation (EEC) No 1170/93 of 13 May 1993 laying down certain detailed rules for the application of Council Regulation (EEC) No 2158/92 of 23 July 1992 on protection of the Community's forests against fire.
- Council Regulation (EEC) No 2158/92 of 23 July 1992 on protection of the Community's forests against fire.[4]

4.6. Summary of the key concepts:

- The Mediterranean basin is an area ecologically adapted to forest fires. The vegetation of the Atlantic zone does not have the same adaptations or the same fire resistance and resilience capabilities.

- Climate change has generated a greater frequency of climatic events favourable to the development of great wildfires, a trend that is rising all around Europe. The combination of drought, wind and low humidity, together with more abundance of vegetation due to changes in uses (rural abandonment) causes high intensity fires and a bigger propagation capacity, generating fires that often exceed the extinction capacity.

- Only one factor (the fuel) can be intervened to influence the behaviour of the forest fire. For this reason, it's key to know those forest structures which can lead to a wildfire (tree crown active fire), and those which can resist its effects. Thus, forest management must be aimed to generate and maintain forestry structures of low vulnerability to tree crown active fires.

- Preventive silviculture is the most widely used tool to prevent extreme fire behaviour. To increase the efficiency of these treatments (thinning, pruning, residues management, etc.), it's required to previously know the types of fires affecting one

[4] Plana, E., Font, M., Serra, M., 2016. FOREST FIRES, Guideline for communicators and journalists. eFIRECOM Project. CTFC Editions. 32pp.

specific area. The treatments must be designed and located according to the extinction strategy pre-established by those responsible for firefighting.

- Controlled burns are a fuel management alternative to reduce the risk of great wildfires.

4.7. References and links to available literature

To know and learn more:

- https://forest.jrc.ec.europa.eu/en/
- http://www.lessonsonfire.eu/
- http://efirecom.ctfc.cat
- http://www.unisdr.org/files/11705_91358948mediatraininghandbookEnglis.pdf
- http://www.unisdr.org/files/20108_mediabook.pdf -
- http://emergency.cdc.gov/cerc/resources/pdf/cerc_2012edition.pdf

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SWEDEN

Authors: Tomas Nordfjell, Back Tomas Ersson and Marine Elbakidze

5.1. Forests and forestry in Sweden

The total land area in Sweden is 40.8 million ha, and of this 28.3 million ha (69%) is defined as forest land. This forest land is divided into productive forest land (23.6 million ha; with a yield of minimum 1 m^3 solid wood volume per ha including bark per year) and non-productive forest land. During the period of 1955 to 1975, the total forest growth in Sweden was about 80 million m^3 (solid stem volume including bark and tops of trees) per year. Between 1985 and 1995, the corresponding yield was close to 100 million m^3, and since year 2010 the annual growth is about 120 million m^3. The annual harvest, including non-utilized windthrown trees, has in general been 10-30 million m^3 lower than the growth. This has resulted in a total growing stock that increased from about 2 billion m^3 in year 1955 to more than 3.1 billion m^3 today (Figure 40).

Figure 40: Sweden's total standing forest stock is steadily growing (© Back Tomas Ersson, SLU).

Of Sweden's productive forest land, 22% is younger than 20 years, and 40% is 20-60 years old (Figure 41). The corresponding proportion for forests 60-100 years old is 19%, and 12% of the Swedish forests is 100-140 years old. About 7% of the productive forest land is over 140 years old. The proportion of old forest is higher in the northern than the southern parts of the

country. In total, the dominating maturity class is “thinning forests” (40%) in Sweden, and about 33% of the forests have reached the lowest legal age for final felling.

Figure 41: As much as 40% of the Swedish forest is 20-60 years old (middle aged stands), and mixtures of Scot’s pine (Pinus sylvestris) and birch (Betula spp.), or Norway spruce (Picea abies) and birch, is common (© Tomas Nordfjell, SLU).

The Swedish forest are dominated by a few conifer species (Figure 41). The growing stock consists of 41% Norwegian spruce, 39% Scot’s pine, and 12% birch. Aspen (*Populus tremula*), alder (*Alnus spp*.) and Lodgepole pine (*Pinus contorta*, an exotic species), constitute together about 5%, and oak (*Quercus robur*), and beech (*Fagus sylvatica*) less than 2%. Other species constitutes together the remaining 1% of the total growing stock. The proportion of forest stands dominated by broadleaves have however increased slowly since about 1995.

The current forest policy gives equal priority to production and environmental objectives. The regulatory parts in the Swedish Forestry Act concern regeneration after final felling, rotation periods as well as considerations related to ecological, social, and cultural values. Maximum sustained yield of wood by using even-aged forest management systems is in focus in the current Swedish forest management (Elbakidze et al. 2013). Additionally, tree retention is practiced and set-aside areas are managed to maintain ecological, social, and cultural values of forests as providers of post-modern products in terms of tourism and amenity migration. However, the main end-user is the export-oriented forest industry focusing on value-added production for environmentally concerned markets.

In Sweden, the terms ‘‘sustainable harvest level’’, ‘‘allow-able cut’’, or ‘‘harvest level’’ are used interchangeably to characterize the long-term harvest level estimated in the framework of strategic planning (Eriksson 2008). The harvest level includes wood volumes originated from both final felling and commercial thinning. For determination of the sustainable harvest

level, the Forest Management Planning Package (FMPP) is used (Jonsson et al.1993). The FMPP, being a Decision Support System, is a set of tools for analyzing the wood resource (Jonsson et al.1993). The goal of forest management is to find a reasonable compromise between an even flow of wood from the entire forest management unit and maximum net present value (NPV) based on stand-and-by-stand optimal harvest programs. The FMPP focuses on forestry for timber production (Jonsson et al. 1993). A Geographic Information System (GIS) including a stand register is used to perform hierarchical forest management planning with strategic, tactical, and operational steps. The input data for the FMPP is gathered in a special forest inventory designed for acquiring data as a base for FMPP analysis (Jonsson et al. 1993).

Figure 42: A typical mature Swedish conifer forest. The overstory is dominated by Scot's pine (Pinus sylvestris), a pioneer species, while the understory is dominated by Norway spruce (Picea abies), a climax species (© Back Tomas Ersson, SLU).

The ongoing climate change has increased the problem of soil damages at harvesting operations. In the past, most of the harvesting operations in the central and northern parts of Sweden were performed on frozen ground that also was covered with snow. Today, this can still be done in the northern part of the country, but not so often in the central parts and seldom in southern Sweden.

5.2. Forest production chains

Most harvesting operations in Sweden are done with a harvester and a forwarder (Figure 43). The machines are most often owned by contractors that have 1-3 harvesting teams (each team comprising a harvester, a forwarder and 2-4 operators). Many forest companies do however also have their own harvesting machines operated by their own personnel. About 20% of the harvesting managed by forest companies is done using their own machines. Also, the harvesting on private forest holdings is most often done with harvesters and forwarders owned by contractors or forest companies.

Figure 43: A harvester (left) and a forwarder (right) on final felling sites (© Tomas Nordfjell, SLU).

However, family owners in Sweden currently face several challenges:

(1) Continued intensification of conventional forest management hinders the adoption of innovative forest management alternatives more resilient to multiple risks (Andersson & Keskitalo 2018). For example, the demand for Continuous Cover Forest management is rising among family owners (Sonesson et al. 2017), but most Swedish foresters have no knowledge how to meet this demand (Figure 43);
(2) Forest management in family holdings is commonly undertaken by professional foresters, who focus on developing conventional wood production systems wherein family owners are chiefly considered as suppliers for the timber and pulp industry;
(3) Family forest owners often lack time, financial means and/or knowledge to apply new approaches to forest management (Bjärstig & Kvastegård 2016). Shared ownership, small forest holdings and long distances to forest holdings are also considered to limit uptake of innovations;
(4) The vague conceptualisation of new values is a challenge for their operationalisation by professional forest planners (Widman & Bjärstig 2017).

Figure 44: Because of several challenges, the path towards sustainable forest management on Swedish family holdings is unfortunately not as straight forward as this forest road in central Sweden is (© Back Tomas Ersson, SLU).

5.3. Wood market

The wood market in Sweden is rather similar over the country, even if small variation exists. The market is better, with higher prices, close to forest industries than far away. There is a market for the main wood assortments (saw logs and pulpwood) in the whole country, but the market for energy assortments exists at present only in the more dense populated south part of the country or very close to combined heat and power plants in the rest of the country. The market for processed firewood is very local with the highest interest close to small towns and villages.

5.4. Forest ownership

In total, 50% of the productive forest land is family forests (Non-Industrial Private Forest owners), 22% is owned by private forest companies, and 28% is owned by others including a state-owned forest company, the state, and the church (Skogsdata 2019).

5.4.1. Private forest owners

There are some 200 000 families in Sweden owning more than 5 ha of forestland (KSLA 2015). The average holding is 50 ha, but the variation is large. About 68% of the holdings are between 5 and 50 ha, 31% between 50 and 400 ha, and 1% are larger than 400 ha (Lidestav & Nordfjell 2002). The total number of owners (about 320 000 owners) is larger than the number of family forest holdings. This means that many forest holdings are owned by more than one person, often married couples in a family, or siblings that together have inherited the holding. Roughly one third of the forest holdings are owned by one person, one third by married couples together and one third with other relatives. Less than 30% of the forest owners have some kind of commercial agricultural business in connection with the forest holding.

Only 14% of the forest owners have purchased the forest holding on the open market. The majority have bought or inherited the holding from their parents or other relatives. Sixty percent of the forest owners do wish that their children should take over the forest holding in the future. About 50% of the forest owners are members in a forest owner association. This proportion is higher (57%) for owners of holdings in the size between 50 and 400 ha compared with owners of smaller (41%) or larger (45%) holdings.

Family forest ownership has a long tradition in Sweden. Present-day family forest owners are heterogeneous. Traditional forest owners working their own property are becoming a minority, the number of non-residential owners is growing, and co-ownership of forest land has increased (Lidestav & Nordfjell 2005). These and other changes have led to shifts in the values that family owners have traditionally associated with their forests –many studies show that the motivations and objectives of family owners in Sweden cover a broad range of issues from tourism development, amenities, biodiversity conservation, to economic efficiency (Huggosson & Ingemarson 2004).

5.4.2. Identification of forest owners needs in Sweden

This identification is focused on the typical Swedish family forest owner.

5.4.2.1. A State of-the-art description of common goods that forest owners sell and common services that they buy, and problems related to this

Most forest owners buy services from wood trading organizations and forestry contractors. Most private forest owners, including those who earn the majority of their income from forestry, buy services for many forestry works tasks.

To secure reasonable agreements, it is important to be a competent service buyer. If not, ecological-, societal-, cultural-, and historical values might be damaged. The forest owner's goals might not be reached, or values that really matter for the forest owners might be downplayed. The cost for the service might be too high, or the income and quality of performed work might be too low. The situation is also similar when the forest owner wants to sell wood or other goods and/or services. Thus, when buying services and selling goods/services, there is a need for competence as well to get the best possible price and agreement.

Timber and other wood products

Final felling is an important source of income for many non-industrial private forest owners. For most forest owners, the majority of the forest income comes from the selling of timber and other wood products. One of the most important economic decisions that forest owners do is choosing which forest company to buy harvesting services from and to sell the timber to. Most of this income is related to final felling (Figure 45), but also thinning operations generate income (Figure 46). Most often, the forest owners buy the service of harvest planning from the wood-purchasing company. This fact can, however, sometimes lead to sub-optimal planning that does not take into account the owner's actual goals and values. Sawlogs is the most important wood assortment that generates the highest income per m^3 and in total. Pulpwood is the second most important assortment. A third assortment is low quality timber and logging residues for industrial heat and electricity production. Logging residues (Figure 47) are only collected from final fellings, but the residues' value is sometimes so low that they are not collected but left on the logging site.

Figure 45: Final felling is an important source of income for many non-industrial private forest owners. Most often, the forest owners buy the service of harvest planning from the wood-purchasing company. This fact can, however, sometimes lead to sub-optimal planning that does not take the owner's actual goals and values into account (© Back Tomas Ersson, SLU).

Figure 46: A high proportion of wood from thinning operations is pulpwood. However, second thinning often result in a higher share of sawlogs (© Tomas Nordfjell, SLU).

Figure 47: Logging residues from final felling is also a forest product that can generate income. However, the economic value of it is rather low (© Tomas Nordfjell, SLU).

The above-mentioned assortments are most often harvested (Figure 48) and extracted to roadside by contractors with harvesters and forwarders (Figure 49) working for the company or organization that bought the timber. Nevertheless, some contractors have also broadened their business model by becoming wood-trading middlemen (i.e. locally marketing their services directly to forest owners, and then selling the harvested wood to industrial customers).

Figure 48: Commercial (first) thinning of a mixed conifer-deciduous stand using a small 4 wheeled harvester in northern Sweden in November 2017. Commercial thinning is performed yearly on over 300,000 ha in Sweden, Pulpwood is typically the main product produced during commercial thinning (© Back Tomas Ersson, SLU).

Figure 49: A large forwarder extracting sawlogs and two logs destined to become utility poles on a clearcut in northern Sweden (© Back Tomas Ersson, SLU).

There is also a local market for processed firewood. This assortment is most often harvested and processed by the forest owners themselves, and then sold to the final consumer.

It is becoming increasingly important that also private forest owners communicate with local inhabitants when harvesting is planned close to houses and towns (Figure 50).

Figure 50: Harvesting close to houses and villages requires specific attention and the forest owner might feel restricted from managing the forest according to his/her actual goals (© Tomas Nordfjell, SLU).

In situations with large storm-felled areas (Figure 51), there is a specific need for cooperation with neighbouring forest owners, and with the companies buying the wood.

Figure 51: Large storms creates a need of well-planned harvesting operations that includes several forest holdings in the same operation (© Tomas Nordfjell, SLU).

Silvicultural treatments

- **Mechanical soil preparation**

Most stands after final felling are treated with mechanical soil preparation (Figure 52). Almost all mechanical soil preparation is done by contractors. If the stand is reforested using direct seeding sowing can also be done simultaneously as the soil preparation.

Figure 52: Mechanized site preparation using a Bracke T26 two-row disc trencher in northern Sweden in late November 2018. The trenching unit is mounted on a large forwarder, and the trenching can be performed as long as the soil is not significantly frozen (slight frost and snow is not a problem) (© Back Tomas Ersson, SLU).

- **Tree planting and direct seeding (sowing)**

Tree planting or manual sowing are tasks often performed by the forest owners themselves. Nevertheless, it is also commonly performed by specialised contractors (Figure 53).

Figure 53: Manual planting of Picea abies seedlings in southern Sweden by a silvicultural contractor using a large diameter planting tube. The lower parts of the seedlings are treated with a non-toxic wax which prevents predation by Hylobius abietis (pine weevil) (© Södra Skogsägarna).

- **Pre-commercial thinning**

Pre-commercial thinning is a task often performed by the forest owners themselves. But it is also commonly performed by specialised contractors (Figure 54).

Figure 54: Motor-manual pre-commercial thinning (PCT) in a young pine (Pinus sylvestris) stand. PCT is a service commonly performed by contractors and bought by Swedish private forest owners from forest companies (© Stora Enso Skog).

Other goods and services

- **Hunting rights**

The selling of hunting rights is a significant income source in especially southern Sweden and close to cities. In total, about 80,000 – 90,000 moose are shot annually in Sweden (Figure 55). Moose hunting is heavily regulated, and the hunting is normally organized in hunting teams. Hunting team hunt moose together over a larger area which might consist of both family forests and forest company forests. Commonly, such hunting areas size 1,000 to 8,000 ha, most often with the larger areas in the northern part of the country. Forest owners with hunting rights can hunt by themselves, but also sell on the open market the hunting right to hunting teams. This is normally done on a yearly basis, and it is general easy to find buyers for moose hunting. Hunting rights can also be sold for other species like roe dear, wild boar, different kinds of birds and other small game. However, the market for selling such hunting rights varies immensely within the country.

Land owners often merge their hunting territory with that of their neighbours to form larger management units or lease out the hunting rights to other hunters. In areas with a large proportion of private forest owners, hunting has the highest economic turn-over (Boman & Mattsson, 2012). Hunters without their own forest can lease hunting rights from private or corporate forest owners either by themselves or by joining a hunting club. There are also hunting management associations which manage the species populations, infrastructure for hunting and the development and performance of the hunting teams (Boman & Mattsson, 2012). The most popular species to hunt are moose, roe deer, wild boar, hare, and ducks.

Figure 55: Moose hunting rights can be sold on the open market and generate an income for the forest owner (© Tomas Nordfjell, SLU).

- **The right for companies to establish windmills on the forest property**

There are presently many new windmills being established on Swedish forest land, and it is forecasted that this expansion will continue the coming decade (Figure 56). If large windmills are placed on the land of a forest owner, they can give a substantial and long-lasting income for the forest owner. However, if a forest owner only get a power line corridor on the property, this gives only a small compensation, This situation has in many areas created local conflicts between forest owners getting an important income and those who mostly only loosing forest areas due to power-line corridors and other infrastructure needed.

Figure 56: Many windmills in Sweden are erected on forest land. If done correctly using appropriate judicial agreements, leasing forest land to wind power companies can be a lucrative source of income for private forest owners (© Stora Enso Skog).

- **Berries and mushrooms**

Because of Sweden's custom of right to roam ("Everyman's right"), Swedish forest owners cannot receive income from selling access to berries and mushrooms. Historically, berry harvesting played an important role in Swedish rural areas. As a sign of the past use of lingonberry, the "red gold of the forest," and some regional trains have been called "lingonberry trains" (Swe: krösatåg) since 1985. The term stem from the time of a "lingonberry boom" (Swe: lingonruschen) in Småland, when berries were exported to Germany at the end of the 19th until 1914 when the WW1 began. There were debates in the Swedish Parliament on how to regulate the harvest of non-wood forest products (NWFP) in private forests, and, at present, the governance of the wild berries harvesting from private forests is under discussion again (Sténs & Sandström, 2013). Nowadays, the growing berry industry brings foreign berry pickers to private forests for collecting wild berries. The Right of Public Access is important for Swedish people that enjoy different traditional outdoors activities and have strong support from the general public (Sandell & Fredman, 2010). However, there are suggestions that the "Right of Public Access" in Sweden should be reviewed in order to differentiate between the collection of NWFPs for personal and commercial purposes (Sandell & Fredman, 2010).

- **Administrative services**

Long term forest planning: it is common that forest owners have forest management plans that are revised at 10-year intervals. This service is often bought from a forest owner associations or a forest company, but private consultants and other organizations also offer this service.

Financial and legal advisory services when filing taxes, bookkeeping, or selling or bequeathing forest properties: these services are often offered by forest companies or forest owner associations through affiliated/cooperating consultants and/or financial/judicial firms. These firms may also provide legal services when selling rights to companies for establishing windmills or similar on the forest property.

5.4.2.2. A State-of-the-art description of where to find information needed for buying of services and selling of goods

The chief organizations in Sweden who provide information to forest owners who buy and sell services and goods are as follows:

- Skogsägarföreningar (Forest owners' associations): mainly Norra & Norrskog, Mellanskog and Södra (Figure 57 top; there are also numerous smaller associations like Nätraälven, Västra Värmlands och Dals, etc.). These cooperatives are essentially wood purchasing middlemen, although Norra & Norrskog own their own sawmills, and Södra owns its own sawmills and pulpmills. Forest owners become members through shares that are paid for by a small proportion of the money earned when wood is sold to the association. The associations pay dividends to members after profitable years and provide extensive consolatory services for private forest owners.
- LRF (the Federation of Swedish Farmers): essentially a lobby organization for private landowners in Sweden, but it also owns many companies that provide services for private landowners. The forest owners' associations are members of LRF.
- Skogsstyrelsen (Swedish Forest Agency): this government agency provides services both free-of-charge (eg. nature conservation) and pay-for-use (eg. forest management plans) to private forest owners.
- Forest companies (like SCA, Stora Enso, Holmen, BillerudKorsnäs, etc., Figure 56 bottom): these companies generally own wood processing industries, and provide extensive consolatory services for private forest owners, often from an FSC (Forest Stewardship Council)-based point-of-view.
- Private consultants/NGOs (including local consultants and NGOs like SNF, the Swedish Society for Nature Conservation): these companies and organizations provide consolatory services for private forest owners, often from a profit- or agenda-based point-of-view.
- Hunting organizations (e.g Svenska Jägarförbundet): These organizations provide forest owners with hunting- and game-related information.

Figure 57: The four largest Swedish forest owners' associations (top) and the four largest Swedish pulpwood-purchasing forest companies (bottom).

5.4.2.3. Innovation needs related to buying services and selling of goods

The problem a forest owner has with selling wood is that it is very difficult to compare the alternatives from different buyers. One reason for this is that the profit is a combination of the price of wood and the cost for the harvesting operation. It is feasible to compare the price of wood between buyers, but it is very challenging to compare the different buyers' harvesting costs. Also, it is difficult for forest owners to acquire and compare the costs of silvicultural services like tree planting, sowing and pre-commercial thinning.

The forest management plans (long-term forest planning) is often supplied by the same organizations that buy the harvesting right for roundwood. This creates a competitive advantage in relation to other buyers of roundwood, a situation which in the end might be disadvantageous for non-industrial private forest owner.

Today, there is increasing demand among Swedish private forest owners for silvicultural systems that avoid clearcutting, i.e. various forms of Continuous Cover Forestry (CCF, eg. Plenterwald, Dauerwald, etc., c.f. Pukkala 2016). However, both theoretical and practical knowledge of such silvicultural systems is poor among forest owners, foresters, and contractors in Sweden.

In stands with high environmental values (Figure 58), Swedish forest owners have the opportunity to sell their harvesting rights to the State (for e.g 25, 50 or 100 years via Skogsstyrelsen's "Komet-project"). However, there is a significant need for more competence among Swedish private forest owners in regard to what economic benefits biodiverse forests/stands with high environmental values might provide.

In general, there is a need of increased competence related to selling of hunting rights. This includes also in many cases the need for increased cooperation between forest owners to create attractive hunting areas of suitable size. The need for legal services in relation to selling rights to companies for establishing windmills or similar on the forest property is something rather new, which opens up for new business possibilities regarding this service.

Most of the organizations listed in 5.4.2.2 also have their own agendas, and the suggestions they give might not always be in line with the goals that the forest owner might have.

Storms often create a need for unplanned harvesting operations. There is a competence need regarding cooperation between forest owners and wood buyers and contractors in such cases. Such competence should already be available before such situations occur, when rapid decisions and actions are needed.

Silvicultural treatments like tree planting and pre-commercial thinning are work tasks often performed by the forest owners themselves, or by family members. It is however increasingly common that this service is bought, and there is a competence need when buying this service.

Private forest owners need to improve their competence in communicating with the local inhabitants when a harvesting is planned close to houses and towns. If not, conflicts often occur with the general public.

Figure 58: A mature pine stand with high environmental values (old trees and significant amounts of dead wood in various stages of decay) in central Sweden (© Swedish Society for Nature Conservation).

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