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# Production and Management of Timber
## A Comparative Study of Sweden and Spain

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## ABSTRACT

Forest industry is becoming more important every day worldwide; Spain and Sweden are no exceptions. Sustainable forestry and biodiversity create restrictions on the amount of timber logging, but at the same time, the introduction of new species that grow faster, mechanization and new harvesting methods such as whole tree harvested helps to maintain a large amount of timber supply according to the demand.

In this paper Timber industry in Spain and Sweden were analyzed with emphasis in the management and production. These two countries have big differences between timber species, factor affecting timber quality and how timber industry counts for the total of the country economy. According to FAO, these two countries have similar are of forested land, but this does not result in similar amounts of productivity, exports and imports.



Key words: Timber, production, forest management, International trade, Spain, Sweden.

## RESÚMEN

Con el paso del tiempo, la industria forestal está ganando cada día más importancia a nivel global, Suecia y España no están exentas. La introducción de nuevas especies de crecimiento rápido, la mecanización durante la extracción de los productos madereros y nuevos tratamientos silvícolas, permite obtener una mayor producción del monte pero al mismo tiempo la idea de desarrollo sostenible junto con la biodiversidad son dos factores que crean restricciones a la hora de extraer madera.

En este trabajo se analizan las principales diferencias entre Suecia y España en la producción y gestión del monte con el fin de obtener madera estructural. Ambos países poseen diferencias en cuanto a las principales especies arbóreas, calidad de la madera e importancia de la industria forestal sobre el total de la economía del país.



Palabras clave: Madera structural, producción, Suecia, España.

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# 1. INTRODUCTION

## 1.1 General background in Europe; Historical context

Throughout human history, forest has been used for thousand years. The first forest uses were for hunting, gathering, fuel and charcoal. Protection against rain, wind and cold temperatures was necessary for humans and was achieved thanks to the wood as well as other natural resources. Romans grew tress not just for their fruit, as an example, Chestnut and walnut wood was used as building timber. Together with other evidence available for ancient Campania (Di Pasquale et al., 2010)

One strong theory is that Muslims expanded timber products and techniques of how to manage the forest, in Europe trough Spain (Kennedy, Hugh. 1996). In Central Europe, feudal lords began to use their forest as natural resources for construction and for hunting. Sweden and Spain have been no exception.

The industrial revolution in 17$^{th}$ century definitely started the development of Europe and during the end of 18$^{th}$ and the beginning of 19$^{th}$ century the European economy grew really fast. Due to the invention and development of the steam engine there were better transportation inland thought rivers and over the sea; Wood became a commercial product in Scandinavia. Europe and especially England could be supplied with timber of high quality. Between 1825 and 1865, the amount of timber exportations increased by ten times in Sweden (Royal Swedish Academy of Agriculture and Forestry, 2005). Increased deforestation and forest degradation was caused by overcutting due to various and sometimes interacting factors such as grazing, slash and burn agriculture and not at least, the mining and iron industries high demand of wood fuels. All together these factors led to a new view of the Forest Policy. Recent and throughout the 19$^{th}$ century an increased public demand of recreation and contact with nature together with increased environmental awareness are major reasons in policy changes from just timber uses to multiple-use in the forest.

The timber industry is one of the most important around the world that takes into account natural resources, providing wood for different products from paper to particleboard. Before cut down the trees, a forester must determine how valuable the product is and if it is safe to be felled or not. After this, logs will be transport to a sawmill factory and stored there before its entry into the mill. Once cut, timber can be treated with chemical to make it more resistant and reduce insect infestation and then it will be graded and sold.

In Europe, South Sweden and most parts of Spain the Temperate forest is one of the most important one. Temperate forest ecosystems seldom consist of just one tree species. Naturally pure stands can be found only on particular extreme sites (Mitscherlich, 1978 and Schmidt-Vogt, 1991). Temperate forests are instead normally based on mixed stands formed by deciduous, coniferous and broad-leaved species. Sweden is dominated by Boreal forest which is mainly formed by two conifer species, Scot pine *Pinus sylvestris* and Norway spruce *Picea abies*; and broadleaf specie, Birch, *Betula ssp.*

### 1.2 Definitions

Timber: is the wood of trees cut and prepared for use as building material (Hyperdictionary, 2012). Timber can also be called Lumber; both words are used to name standing trees and those ones that have been felled for construction uses. Sometimes it is possible to differentiate between unprocessed raw wood: timber; and cut wood packaged for commercial sale: lumber.

In this study we will exclude all non-timber forest products defined by The United Nations Food and Agriculture Organization (FAO) as:"products of biological origin other than wood derived from forests, other wooded land and trees outside forest". Mushrooms, forest plants and forest services such as recreation are included in Non-timber forest products (NTFPs).

### 1.3 Timber nowadays and future situation in a European framework.

Today, steel and concrete are the two most predominant materials used in construction of high buildings and bridges. But wood is still used as a major interior material in buildings, furniture, construction of small houses, etc. Paper is made by pulpwood which comes from this raw material. Timber worldwide demand is increasing each year, except years and time of recession, despite the fact that there are stronger and lighter new synthetic materials. The demand on natural forest is increasing especially in the Asia-Pacific region (FAO, 1999), which could lead to a great environmental and biodiversity problem in the near future. The timber available is decreasing because of exploitation, economic and environmental pressures.

Plantation forests are the best alternative to maintain a sustainable growth and high quality timber. Plantations already produce more of the world´s commercial timber (34%) than do old-growth forests (30%); following by managed second-growth forest (22%) and minimally-managed second-growth forests (14%) (Sedjo and Botkin, 1997). An old natural forest takes from 65 up to 300 years to mature, and these kinds of forest are being harvested at a huge rate. Figure 1, ten countries with largest area in primary forest, years 2000 and 2005. The main

reason of this deforestation is the conversion of forest to agricultural land: pasture and grazing. (FAO, 2010)

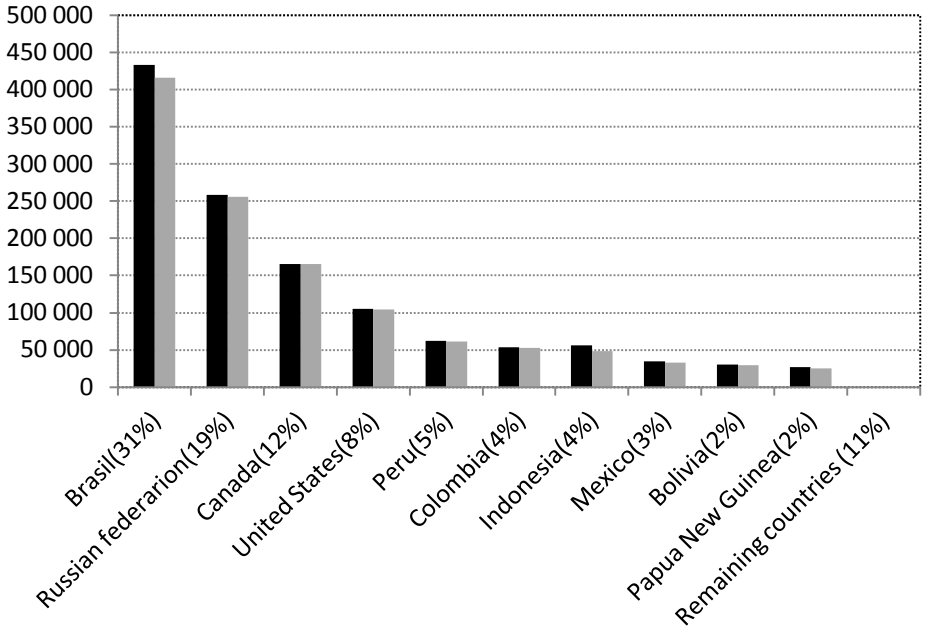


**Figure 1. Primary forest area (1000ha). Estimated 2000 ■ and 2005 ■ (FAO. Global Forest Resources Assesment 2005)**

According to Wood Resources International predictions, "the timber demand for industrial purposes will increase from 1600 million cubic meters to 2700 million cubic meters in 2030". We are approaching the point where global timber demand will be greater than the available supply. From the current level of 7 billions of people, the world population will exceed 8 billion by 2027(United Nations, 2011) which means more food needed, houses, furniture, etc… As the population keeps increasing, the demand for timber products increases as well.

Reduction of forests represents a major environmental problem nowadays in developing countries, but reforestation in developed world can help us to act and reduce the impact that humans are causing to these lands. We need to have a good knowledge of what happened in the past with this forest and woodlands in order to be helpful and be able to preserve the forest.

As to the economic issue, in the medium and long term; Decreasing supplies from natural forest and an increase in demand for timber product will result in higher prices. This demand is lead by "Developed countries" (Japan, North America and Western Europe) and also by the

emerging economies in China and South East Asia. This situation makes timber plantation a really good investment option.

**Table 1. Roundwood balance in Europe for 20 the period 2009-2010. Units 1000m$^3$(UNECE/FAO timber databases, 2011)**

| | year | | |
|---|---|---|---|
| | 2009 | 2010 | Change (%) |
| Removals | 439221 | 480219 | 9.3 |
| Imports | 45830 | 57036 | 24.5 |
| Exports | 33111 | 48403 | 46.2 |
| Net trade | -12719 | -8633 | |
| Apparent consumption of which EU27 | 451940 | 488853 | 8.2 |
| Removals | 394043 | 428835 | 8.8 |
| Imports | 43058 | 53822 | 25 |
| Exports | 30172 | 45166 | 49.7 |
| Net trade | -12887 | -8656 | |
| Apparent consumption | 406929 | 437491 | 7.5 |

Russian Federation has been for many years the largest exporter of logs in the world; mainly demanded by Asia and Europe, even if they reduced their demand due to government log export taxes in 2007. The implementation of further tax increases has been delayed but not abandoned. (UNECE, 2010)

In UNECE regions, the global crisis affected demand for all forest products during 2009; but in 2010, timber harvesting in Europe, increased more than the global average, with almost 10% instead of 8% in UNECE regions. Most countries in Europe, except for Germany, increased their production and consumption of industrial roundwood in 2010. The main reason of this decrease in the German production was because the reduced demand for small hardwood logs by the medium-density fiber board's (MDF) industry and also due to the lowest hardwood log consumption in Germany since 2002(UNECE,2012).

As shown in Figure 1, excluding Russian Federation from this study, Sweden with 70,200 thousand m$^3$ is the leader country in Europe producing roundwood. Spain is in the 8$^{th}$ position. This indicates that both countries in this study have great impact in the European wood trade market. An interesting detail in figure 1 is that Latvia, who earlier not has been a major wood producing country, now is included in the top ten. The timber harvested was increased by 33% in 2010 over 2009. It is not proved whether timber harvests in this country is sustainable or not, at least for private forest owners, who will not be able to keep this amount of timber harvest over the time.

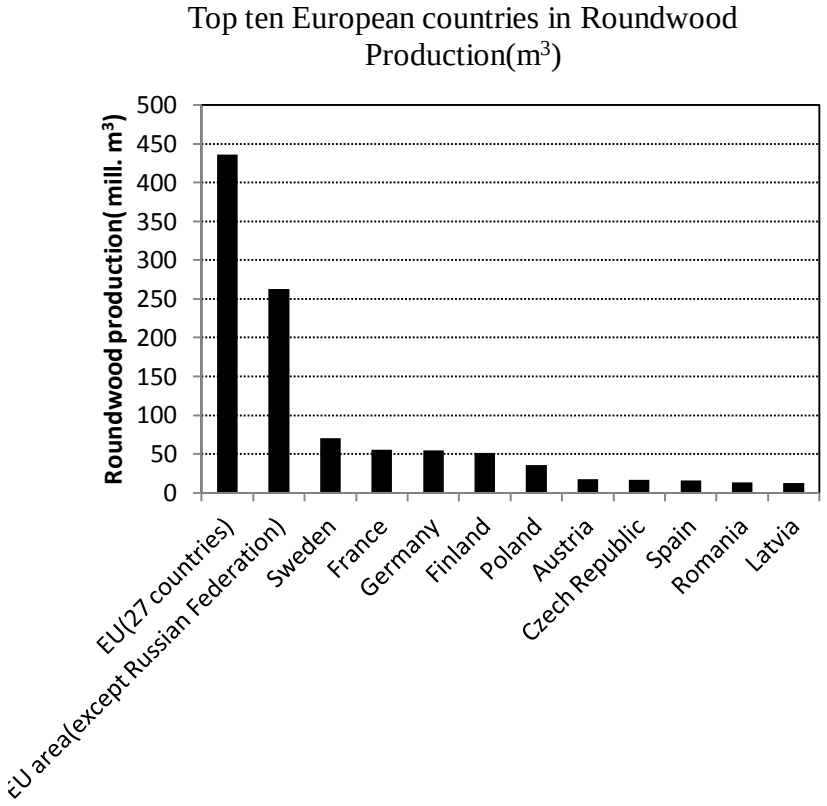


**Figure 2. Roundwood Production. Thousand of $m^3$ (FAO, Forestry 2010)**

### 1.3.1 Timber worldwide production and prices evolution

When discussing the current world Timber situation it is necessary to take into account that some data from many countries (especially developing countries) could be poor, missing or even unrealistic. A closer look into the results of Global Forest Resources Assessment 2010, (FAO, 2011) shows that UNECE (United Nations Economic Commission for Europe) region contains more than 40% of the world's forest and that just three countries(United States, Canada and Russia) contain 35% of the forest available for wood supply in this region.

In UNECE region, the volume of wood that had been harvested is lower than the annual increment rate of growth. One of the main reasons of this is the plantations for wood industry. This is often not the case in developing countries where the cutting is larger than the average growth. Nevertheless, wood removal is expected to increase by a rate of 6% during 2012.

According to FAO: "despite all the forest that are being planted nowadays, in the near future there will be a timber deficit amounting to 500 million cubic meters" (FAO, 2011)

This deficit is due to the population increment, which leads to more demand, protective forest by environmental activist, a really high deforestation rate, 1.8% each year of the total forest,

due to illegal logging, urbanization, agriculture including pasture for animals and bio-energy plantations such as sugar cane, palm oil.

In 2010 timber harvesting in the UNECE region increase at a rate of 8% comparing to the year before were timber had the record low; This was because of a higher demand of wooden products. In spite the trend of increasing cuttings the annual level of cutting show fluctuations, some years with higher variations than others. Year 2010 is still the second lowest harvesting year since 1966 in UNECE regions.

In discussion about wood prices and by looking at FAO data, it shows that there has been an increase in 2010 and keep going higher and higher until now, after the record high prices in January, 2008; even do the demand and timber harvesting was still low in European countries and United States. The main factor of this was the higher demand of logs of China and India and also because of the increases in prices such as gas, which leads to a greater cost in transportation for forest owners and producers.

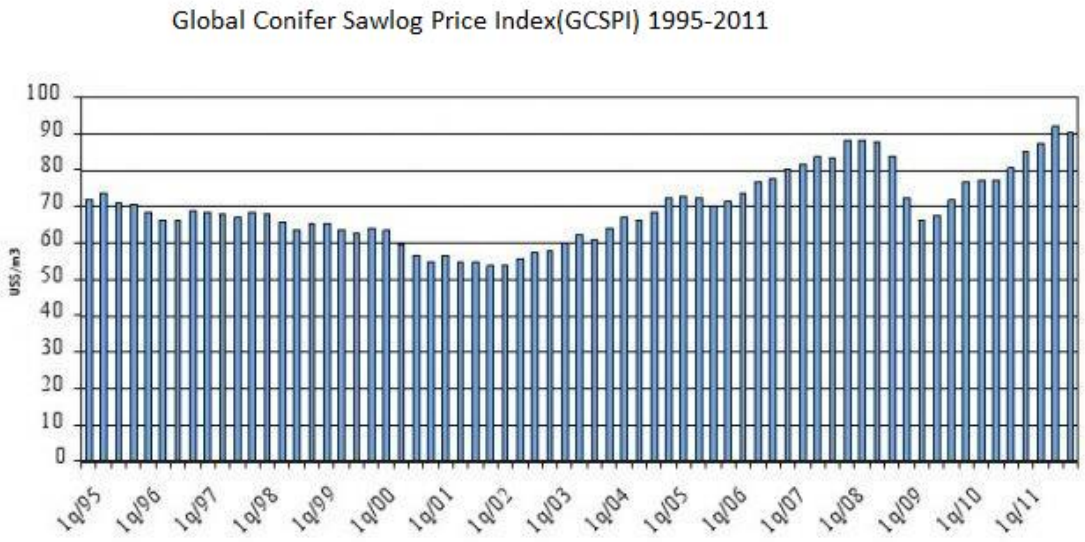


**Figure 3: Source: Wood Resources International LLC.**

When scrutinizing the data results for changes in prices over last years of different products, such as gold, silver, palladium, orange juice, pork, live animals, oil… can say that wood is the product which has increased the most (31.1%) until March 2012.( Invertia 2012)

## 1.4 Primary timber products categories

### 1.4.1 Roundwood

***Figure 4.*** **Industrial roundwood (logs)**

Roundwood is basically the stem of the tree when branches have been removed and the tree has been cut down. This wood can be with or without bark and can have many different shapes as round, split or square.

The FAO definition of Roundwood is:

"Wood in its natural state as felled, with or without bark; it may be round, split, roughly squared or in other forms." (FAO, Forest harvesting glossary.2010)

Industrial Roundwood is the wood material used to make wood products and paper without counting the wood for energy purposes. This industrial roundwood goes to a industry as a raw material to make pulp for paper, panel products, sawn wood, or logs for transmission poles.

Figure 4 shows the production of industrial Roundwood in the last 10 years, it have been affected by the economic crisis during year 2008 and 2009 and started to recover in 2010, as we can see in the graph below (Figure 4.World Industrial Roundwood Production). In other timber products, like, sawnwood, veneer and plywood the crisis affects their production as well.

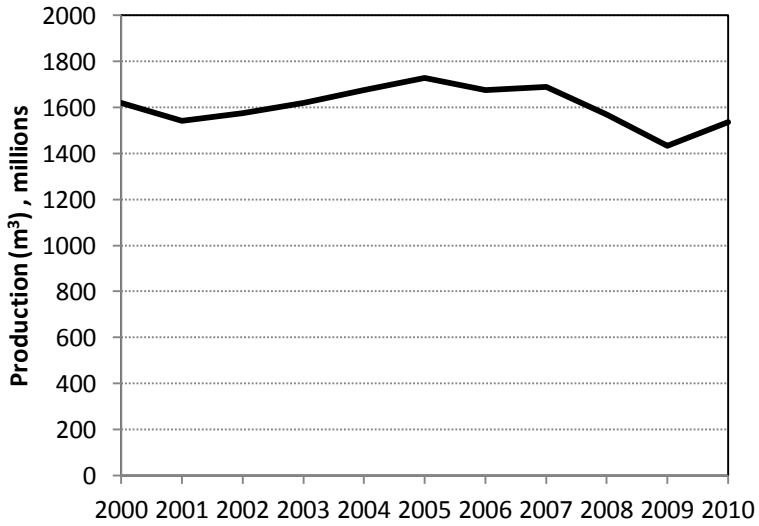


**Figure 5. World Industrial Roundwood production ($m^3$).(FAOSTAT, 2011)**

### 1.4.2 Sawnwood

The FAO definition for this material is:

"Sawn products produced from logs, can also be called lumber."

### 1.4.3 Wood-based panels

Veneer

The FAO definition for this material is:

"Thin sheets of wood of uniform thickness, rotary cut, sliced or sawn, for use in plywood, laminated construction, furniture, veneer containers, etc. In production, the quantity given excludes veneer sheets used for plywood production within the country."

Use for plywood or for surfacing furniture.

Plywood

Wood form of thin sheets of wood glued together

Fiberboard and particle board

The FAO definition for particle board is: "A sheet material manufactured from small pieces of wood or oilier ligno-cellulosic materials (e.g. chips, flakes, splinters, strands, shreds, schives, etc.) agglomerated by use of an organic binder together with one or more of the following agents: heat, pressure, humidity, a catalyst, etc." (FAO, classifications and definitios.2010)

In the case of Fiberboard, the definition according to FAO is: “A panel manufactured from fibres of wood or other ligno-cellulosic materials with the primary bond deriving from the felting of the fibres and their inherent adhesive properties” (FAO, classifications and definitios.2010)

**1.5 Timber harvesting**

Timber harvesting is carried out different from one country to another. From small land owners in the developing countries using hand tools to big companies in the developed countries using big and heavy machinery. Even rich developed countries show differences in the way of harvesting their forests. Traditionally, timber harvesting was a dangerous job. Nowadays, the mechanization in combination with safety measures has lead to a significantly safer and less hard job compared to hundreds years ago.

It is calculated that almost 90% of the harvested wood volume is cut by harvesters and transported by forwarder in Sweden ( Athanassiadis et al., 1999):In Spain, the use of machines in forestry operations is restricted to a small percentage compare to Sweden of the forest land. The reasons are due to less forestry traditions and a terrain with deep slopes on large forest areas.

Timber harvesting process has 5 different steps:

1- Felling: cutting the tree from the stump. The main tool used historically was the axe. The equipment and machinery used today in the western world for felling is for example: Chainsaw, harvester, excavator with harvesting head and a wheeler or tracked feller-buncher.
2- Processing: The main activities in this process are: take off the branches, cut the stem into small pieces and get rid of the top of the tree. Machinery use in this step: chainsaw, pull-trough delimber, gate delimber, a slasher, and a processor.
3- Extraction: taking out the tree from the forest area by pulling or transporting in a truck. When the trees are crawled out of the forest it is called skidding and the machine use is called Skidder, there are cable, grappler and clam skidders. If the trees are carried out in a trailer is called forwarding and the machine use is a forwarder. In deep slopes and in developing countries, local people can also use animals for extracting timber such as horses and oxen. New technology in problematic terrain includes helicopter, but it is really costly.

4- Loading: take the processed trees and load out onto logging truck. We will use a loader to load the trucks.
5- Trucking: Action of taking the loaded truck to the mill for processing.

Whole tree harvesting in a clear cut area has been made not too long ago. By this word I mean not just the removal of the stem as usual, but also the removal of the tops and most of the needles and branches of the tree. The reasons for the increased practice in Scandinavia is that these residuals in now of interest for biofuel and there to come have created a new assortment (GROT) on the market. This practice can be done because of the improvements in machinery and new technology. This practice can cause damage to the soil, erosion and siltation of water streams, euthropication of fresh water; reduce biodiversity in invertebrates and fungi. Especially if carried out in drastic and large manner and on low productive forest land (Birger Hjelm, 2012)

Stump harvesting is not a new technique. It has been going on since 100s years ago for fuel wood. Today there is an increased economical interest of harvesting stumps according to the increased market price of biofuel (Birger Hjelm,2012). In some cases, like in Scotland, this Stump removal was done for controlling pest insects. This stump harvesting can have the same problems for the soil as whole tree harvesting does.

### 1.5.1 Environment and nature conservation

Moreover, it cannot be forgiven that this mechanization with heavy machines can lead to problems and impacts on forest soils, effects on the growth of seedlings, animals living in the forest and air contamination due to the fossil fuels burning. The extraction of all these trees can originate problems in the quality and quantity of the water. In order to solve these problems, there are some cutting methods such as shelterwood cutting which is a better alternative than the common clearcut method (just allow in small areas, except in the North part or Sweden). It is prove that shelterwood cutting is better for the conservation of vascular plants, bryophytes and even animals like birds and small mammals (Åke Lindelöw, SLU, 2011). Nowadays, some trees are left after a clear cut to maintain biodiversity in different countries, e.g. Sweden. Another action to maintain biodiversity is leaving high stumps for insects, bryophytes, fungi, birds and small mammals. This is called tree retention and have positive effects compare with traditional clearcutting, like connectivity in the landscape and maintain ecosystem functioning.

### 1.6 Objectives

The overall aim of this paper is to make a comparative study between two different countries, Spain and Sweden with focus on their management and production of timber. The objective of this study is to describe different forestry aspects between Sweden and Spain such as:

- Main timber production species in both countries
- Production, Growth and yield.
- Timber Industry in both countries. Total forestry employment. Ownership of the forest.
- Main diseases affecting timber trees

## 2. MATERIALS AND METHODS

This project is a comparison between two European countries: Sweden and Spain. The data on which this paper is based on literature provided by SLU library and Escuela Técnica Superior de Ingenieros de Monets and from different Internet sources such as SLU Library e-ref, Dictionaries, Reference databases like Scopus, web of Science, electronic archives like Epsilon and wesites of FAO, FAOSTAT, UNECE, Eurostat and The National Board of Forestry (Skogsstyrelsen). Additional data collection is achieved by consulting teachers in the Polytechnic University of Madrid.

## 3. RESULTS AND DISCUSSION

### 3.1 Forest area in Spain and Sweden.

This study is focus on timber production differences between Spain and Sweden. Therefore, the forestry area is an important issue for the understanding of the differences between the both countries.

Sweden has the largest total growth in forest per year in Europe (if excluding the Russian federation). With a total land area of 41.3 million hectares, around 69% of the total land is forested (28 million hectares) and the main purpose of this area is production: “Forest area designated primarily for production of wood, fiber, bio-energy and/or non-wood forest products”(FAO,2010), with 74%; followed by multiple-use forest with a 15% (FAO, Forest Resources Assessment. 2010). Forest industry is important for the national economy.

“Sweden holds just below 1% of the world´s sawn timber, pulp and paper” (The Royal Swedish Academy of Agriculture and Forestry, 2009)

Sweden can be divided in three different zones according to their climate. Boreal zone (northern coniferous forest area), Boreonemoral zone (between the boreal zone and the Nemoral zone, both deciduous forest and conifer forest are present) and Nemoral zone (south of Sweden with deciduous forest). Apart from these regions, in the north western parts of Sweden, where the mountains are located there is a sub-Alpine zone who is dominated by birch forest.

Spain, contrary to what one would expect, is the second country in Europe regarding area of forest land (26 million hectares). With a total land area of 50 million of hectares, the forest land percentage is 52% of the total land area (Inventario Forestal Nacional III). From those 26 million hectares, only 18 comprise woodlands. The production supposed a 20% of the primary designated function. (FAO,2010)

In Spain the two main climate regions are: Nemoral zone (central and northern parts of Spain, dominated by deciduous and coniferous forest) and Mediterranean zone (dominated by high temperatures and species adapted to low quantity of water during the dry season) but in the mountains can be found the alpine and subalpine zones.

### 3.2 Timber production in Spain and Sweden. Growth and yield

Because of intensive use by rural population, the forest resources of Southern and Central Sweden by the mid 19th century are estimated to have been about 50% smaller than today (Nord, 1994). In the end of the 19th century the forest resources were degraded due to deforestation, fires, grazing and agriculture. The silvicultural methods were improved during the 20$^{th}$ century. In the 1960s and 1970s the main objective of these silvicultural methods was to increase the production of timber, but nowadays this production is in harmony with other forest practices such as recreation and environmental protection areas to keep biodiversity. Today, the timber resources grow faster than the rate of feeling. “The timber resources are now 60% larger than they were at the beginning of the 1920s” (Wibe, 1992)

Spain, have the largest biodiversity Reserve within Europe. The leading cause of disappearance of forest is fire because of warm and dry conditions during summer time. Each year, fire affects 120 thousand hectares (Global Forest Resources Assesment, 2010). The rate of reforestation in Spain is the highest in Europe with a 2.19 %( MARM), comparing with Europe average which is 0.51%. According to FAO, Spain is, after China, the second country

in reforestation. Spain consumes twice as much wood as it produces, but the country has the ability to double its production in a sustainable way in a long term by increasing the forest plantations and increasing short rotation species which means that Spain has the potential of not have to import wood from other countries in the future.

Between 1860 and 1930 the forest land decreased by 20% motivated by the policies of desamortization (sale of church lands by the government) and the felling of forest for farmland areas as a result of population growth. In 1940s Civil war, Spain had the lowest forest land area (around 20 million hectares) in the nation's history. Since that date, there was a reforestation due to massive rural migration. Intensification of agricultural holding resulted in the abandonment of not productive farmlands leading to natural forest regeneration or plantations of these areas.

The top three destinations of timber harvested are: sawing 36%, pulp 27% and trituration (reduction to powder by friction or grinding explain the word) for production of boards 25% (Avance Anuario de Estadística Forestall, 2009)

Figure 5 shows the production of roundwood in Sweden and Spain. Sweden has by far much more roundwood production than Spain (six times the Spanish production).

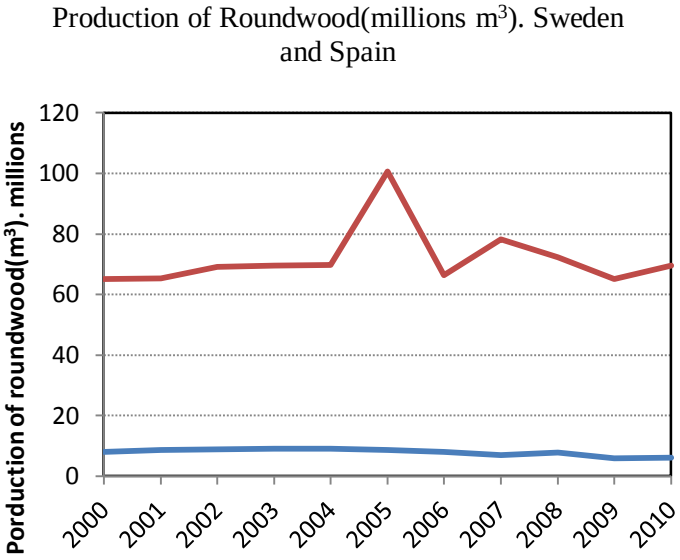


**Figure 6. Roundwood production (million m$^3$). Sweden■, Spain■** ***FAO, 2010***

A high amount of roundwood production in Sweden in 2005 is shown in Figure 5. The main reason was a storm in January 2005, when 75 million cubic meter where damaged and windthrown. 80% of the trees were Norway spruce and 15% Scot pines. The 5% left were deciduous trees.

The Swedish total annual growth of productive forest is 111 million cubic meters and the average annual productivity is 5.3 cubic meters per hectare (Skogsstyrelsen, 2011). The total standing volume in Sweden´s forests has increased considerable. The current stock is around 3 billion cubic meters, of which 40% represent Scots pine, 42% Norway spruce and 12% birches. (Swedish National Forest Inventory, 2011)

In Spain, total annual growth of productive forest is 46 million cubic meters and a total standing volume of 921.9 million $m^3$ (Inventario Forestal Nacional III). Spanish forest has a growth rate of 2.5$m^3$ per hectare and year. This value is low compare with the Europe average, 5.1$m^3$ per hectare and year (UNECE statistical database,2011). The reason of this low yield is, primarily, the characteristics of our native species, unsuitable for timber production. When excluding the Mediterranean regions and just taking into account the Nemoral regions (also called Atlantic regions) which covers 70% of timber production of the total production of Spain, the average annual productivity of forest would be 7.6 cubic meters per hectare. This last value will make more sense in order to discuss our data. Spain has the climate and the site index to create average annual production greater than 10/12$m^3$/ha if we choose the right land and species (Portillo Rubio, 2002).

Most parts of Sweden(except Southern parts) and northern Scandinavia have relatively low productive forestland (compared to central and southern Europe) due to the large areas of wetlands, marshlands with nutrient deficient soils and low temperatures and winters with short day length that makes their growing season shorter for production. This leads to a slow vegetation growth. On the other hand, in southern parts of Sweden, where the climate is milder and soils are better for the tree growth, the annual productivity is higher.

### 3.2.1 Timber Forestry Industry. Trade flows.

This study excludes the chemical forest industry, based on pulp production and instead focuses on the forest timber industry and its mechanical wood processing products. The most important products of mechanical wood processing are: sawnwood, plywood, fiber boards and other boards.

The forest industry is an important sector in the Swedish economy. The sector has played an essential role in the development of Sweden turning into a welfare state. Of the total Swedish industry´s exports sales, (value and employment), the forest industry accounts for around 11 %. (The Swedish forestry industries, 2010).

In Spain, forest industry makes up for 2% of Spain´s gross domestic product (EUROstat, 2011). The main forestry resource is the Cork Oak tree, leading this country in second place of production of cork, after Portugal. The yield of its forest is not sufficient for the country timber demand so the import is high. Therefore, it could be affirm that, from a perspective of wood supply and demand, Spain is a deficit country. Along with the sustainability criteria (do not cut more than it grows) there are other factors that explain the low wood extraction percentage. According to Tolosana 2011, these factors are:

- Spanish orography, the slope is a limiting factor for forest harvesting.
- Ownership of the forest land and forest management
- Harvesting and transportation of timber costs. There is not a clear logistic line in the harvesting-industry developed

The forestry related industries, have not been studied in such a rigor as other areas like agriculture (Rodríguez Barrio et al., 1990. Alonso Serrano 2000). The main reason of this could be bad forestry data for Spain in the past.

Table 2 shows how forest products affect the economy in Sweden and Spain (FAO/UNECE, 2010).

**Table 2. Forest products in Spain and Sweden.FAO/UNECE databases, 2010**

| | % of GDP | Imports | | Exports | |
|---|---|---|---|---|---|
| **Countries** | | **Quantity[1)]** | **Value[2)]** | **Quantity[1)]** | **Value[2)]** |
| Sweden | 4 | 72,4 | 1548 325 | 11,3 | 2758 714 |
| Spain | 2 | 18,4 | 4245 522 | 23,7 | 4878 024 |

1) million cubic meters 2) thousand US dollars

Forest industry in Sweden remains the most important of net exports with a total sawnwood products production of more than 17 million $m^3$ in 2010, 70% are exported, which means around 11.5 million $m^3$. (Swedish forest industries federation, 2010). The total Imports are 422255 $m^3$ which means that the Apparent Consumption (Production+ Imports- Exports) is 11 million $m^3$. The Imports of forest products is small comparing with the exports meaning that forest industry has a huge contribution to Sweden trade balance.

Spain, with a total sawnwood production of 2,038 million $m^3$, sawnwood products exports of 150.843$m^3$ which counts for 7,4% of the total sawnwood. Timber industry is not as important in the economic way as in Sweden. 20% of the industrial roundwood was imported, especially non-coniferous timber (Avance Anuario de Estadística Forestal, 2009). The present annual consumption of sawnwood in Spain is 3,2 million $m^3$.

Table 3 shows the production, exports and imports trade of the three major timber products roundwood, sawn wood and wood based panels in Sweden and in Spain in 2010. (FAOstat, 2010).

**Table 3.** ***Timber products production and trade of three major timber products. FAOstat, 2010***

| | | **Production($m^3$)** | **Imports($m^3$)** | **Exports($m^3$)** |
|---|---|---|---|---|
| **Spain** | Roundwood | 15648323.00 | 1957599.00 | 1391238.00 |
| | Sawnwood | 2038294.00 | 1324400.00 | 150843.00 |
| | Wood-based panels | 3326263.00 | 1018004.00 | 2018912.00 |
| **Sweden** | Roundwood | 70200000.00 | 6734039.00 | 1256041.00 |
| | Sawnwood | 17100000.00 | 422255.00 | 11371077.00 |
| | Wood-based panels | 800763.00 | 1104538.00 | 222604.00 |

In 2010, there were 150 sawmills in Sweden with a production greater than 10000$m^3$/year. The sawnwood exports were 11.4 millions of cubic meters with a total value of 24.4 billion sek. The principal markets were United Kingdom, Egypt, Germany and Denmark. (National Official Statistics. Swedish Industries Federation, 2011)

In Spain, most of the forestry related companies are small. With 1 415 enterprises of sawmilling and wood related; sawmills commonly located near forest to reduce the transportation costs. Spain has a total of 15 714 wood industry and cork related companies ( Instituto Nacional de Estadística, 2009). Spanish forestry Industry has found a relief-niche from the crisis thanks to foreign trade of cork related products?. In 2010 exports was raised by 3% and the main markets are Portugal, Italy, France and Holland.

Nowadays Timber Industry in Sweden and Spain take into account the ecological aspects such as biodiversity when planting and harvesting due to the re-evaluation of the forest policy. This is not only causing changing's on the amount of felling but also helps for a sustainable forest management.

#### *3.2.1.1 Employment*

In Spain, 37 600 of full time employed persons working with forestry related jobs (limited to those working primarily in forestry). The majority are men (32 000) and just a small part are women (5 600). Most of the employees are under 50 years old (31 400) in 2010(UNECE, 2010).

In Sweden, forest industry provides direct employment to around 70 000 people. Together with its subcontractors, forest industry creates in total ca. 200 000 jobs. (Swedish forest industries Federation, 2010).With a total of 26 100 employees in forestry jobs(those working

primarily in forestry), 23 600 are men and 2 400 women. Comparing with Spain, in Sweden the number of employees older than 50 years old is 12 500 and just 13 600 are below 50. (UNECE, 2010)

Looking at the results and knowing the population of both countries, it can be said that the forestry sector has a great impact in Swedish employment.

### 3.2.2 Ownership of the productive forest land

In Sweden, 50% of their productive forest land is owned by family enterprises and 25% is owned by private companies; other private forest accounts for 6% of the total productive forest land. The State-owned companies have 14% and State and other public-sector forest have 3% and 2% respectively (Swedish Forest Agency, 2008). Most of the state forest belongs to Sveaskog (State owned company). In Spain the situation is different. With 34% owned by Public sector and 66% by private owners (IFN III). The available data lack however detailed information of the private owner's structure in Spain.

## 3.3 Timber species

The main hardwood producers in Europe are France, Germany, Poland Spain and Italy; (FAO, 2010) However, Sweden is characterized by the production of timber mainly from softwood.

Spain:

The major timber species used in Spain are: Eucalyptus (*Eucalyptus globulus)*, Scots pine (*Pinus sylvestris*), maritime pine(*Pinus pinaster*) and Radiata pine(*Pinus radiata)*; all of them with a production close or greater than one million cubic meters. (IFN III)

The Atlantic region in Spain counts for more than 70% of the total production of timber and firewood in the country**.**

### 3.3.1 Blue-gum Eucalyptus

| | |
|---|---|
| **Scientific name** | *Eucalyptus globulus* Labill |
| **Genus** | Eucalyptus |
| **Family** | Myrtaceae |
| **conifer/broadleaf** | Broadleaf |
| **native/introduced species** | Introduced |
| **Soil type** | All kind of soils except lime soils. |

Blue-gum eucalyptus is an exotic deciduous tree species introduced from Australia where it is native. It is a fast growing species. The priest Father Rosendo Salvado sent seeds to his family in Galicia around 1860 for ornamental purposes. There is also the River red-gum eucalyptus (*Eucalyptus camaldulensis.* Dehn) but this species is not as commercially important in the industry as the Blue gum eucalyptus.

Eucalyptuses are sun-loving species and can reach to more than 100m height in their native distribution. Wet environments and lack of frosts are important factors for the good growth of eucalyptus. The Eucalyptus species in Spain grows well on almost all soils but needs good drainage. Leaves are 10-30cm long and their bark, peeling in large strips is really characteristic. It has a very strong root system. Easy natural regeneration but the amount of adult's stems at the end of the rotation periods will be low due to moisture and soil conditions.

Eucalyptus and poplar trees are the most productive species in wood quantity in Spain nowadays. In the case of the Eucalyptus, the annual increases range from 4 to 30$m^3$/ha/year, with an average of 10-15$m^3$/ha/year; although, it depends on the site index, site preparation, cutting at non-optimal rotation ages, fertilization treatments and pest control. (FAO, 2010).

Eucalyptus rotation period goes from 13 to 18 years. Their main industry uses are pulp for paper: 85% of the eucalyptus production is pulpwood (Riesco, 2004), fire wood and recently is used for poles, and fence posts but their wood is not suitable for lumber.

In Spain with an annual cutting of 4, 2 million $m^3$, Eucalyptus is the major broadleaf species in terms of wood volume production in the country followed by Poplar (Ministerio de Agricultura, 2009)

The total imports of Eucalyptus products have decreased during 2008-2010 due to the increment in the growth of these species in Spain and the global crisis (figure 6.).

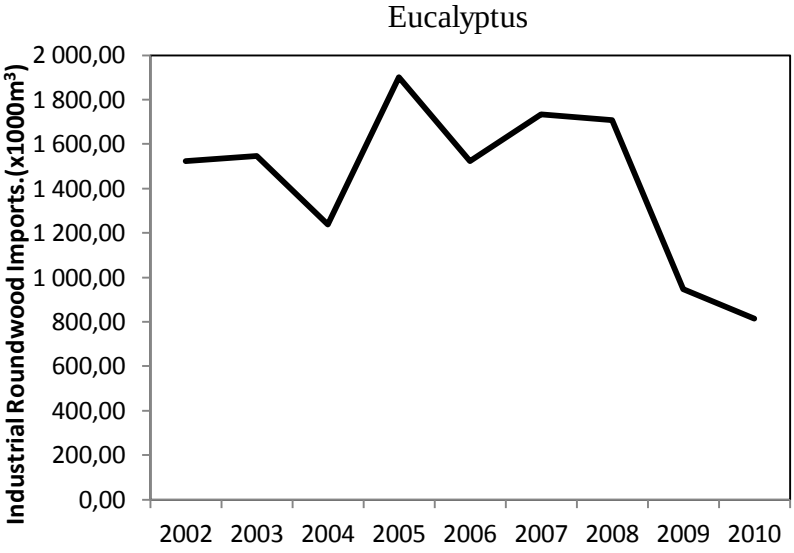


***Figure 7. Industrial* roundwood Imports from Eucaliptus in Spain. Thousand of cubic meters (Eurostat, 2010)**

### 3.3.2 Monterey Pine

| | |
|---|---|
| **Scientific name** | *Pinus radiata* D.Don |
| **Genus** | Pinus |
| **Family** | Pinaceae |
| **conifer/broadleaf** | Conifer |
| **native/introduced species** | Introduced |
| **Soil type** | All soils except compacted soils, shallow or poorly drained. Really good in siliceous and deep soils. |

The Monterey Pine is an introduced conifer native in the Central Coast in California, USA. This Pine was first introduced in Spain in the middle of 19$^{th}$ century by the botanist Charles de Yarza. Soon after the introduction of this tree it started to spread and nowadays it is the most important exotic conifer planted in Spain. Most of the plantations are in North Spain; Galicia and Basque regions are the main autonomous communities planting Monterey pine.

This specie can tolerate the drought and low temperature relatively well compare to Eucalyptus who is sensitive to low temperatures and needs wet environments. The Monterey pine can reach 30m height. One of the main characteristic is that it has their needles (10-15cm long) is in groups of 3, instead of two as most other pine species.

Comparing to Eucalyptus, where most of its wood goes for pulpwood production, Monterey pine timber mainly goes to sawmill and board industry. The radiate pine has a versatile

(having varied uses or serving many fuctions) wood suitable for many industrial uses. Veneer industry; sawmill industry, structural and glued panels.

The rotation periods varies from 28-44 years with an average annual increment ranging from 8.1-19$m^3$/ha/year depending on the site quality (Sanchez et al, 2003). It is a fast growing species comparing to other pine species, but not as fast as Eucalyptus

### 3.3.3 Maritime pine

| | |
|---|---|
| **Scientific name** | *Pinus pinaster.* Ait. |
| **Genus** | Pinus |
| **Family** | Pinaceae |
| **conifer/broadleaf** | Conifer |
| **native/introduced species** | Native |
| **Soil type** | No lime and compact soils, prefers sandy soils. |

This native sun-loving species is the most harvested conifer in Spain. The Maritime pine is an evergreen tree which can grow up to 40 meters height on good sites but the normal height ranges from 20-30m. The needles, in groups of two, are long, 10-27cm long.

It is a common species in the Mediterranean regions. This tree appears from sea level to 1500m. It is very resistant to drought but not as tolerant for low temperatures.

It can be considered as a fast growing species, at least in the Atlantic region, where the rotation periods are from 40 to 50 years. The main uses in these regions are pulpwood for pulp and paper, timber for construction and particle boards. In other regions the rotation period goes from 80-120 year and the main uses are really good quality timber. It can live up to 300years.

A recommended planting density is 1200-1400 stems per hectare. At the end of the rotation period, after thinning, a common density is 600-800 trees per hectare. Maritime pine can be seen in mixed plantations with Oak or birch.

<u>Sweden</u>

The major timber production species in Sweden are Norway spruce (*Picea abies*) and Scots pine (*Pinus sylvestris*) both species represents 78% of the total standing volume in Sweden (figure 6.).

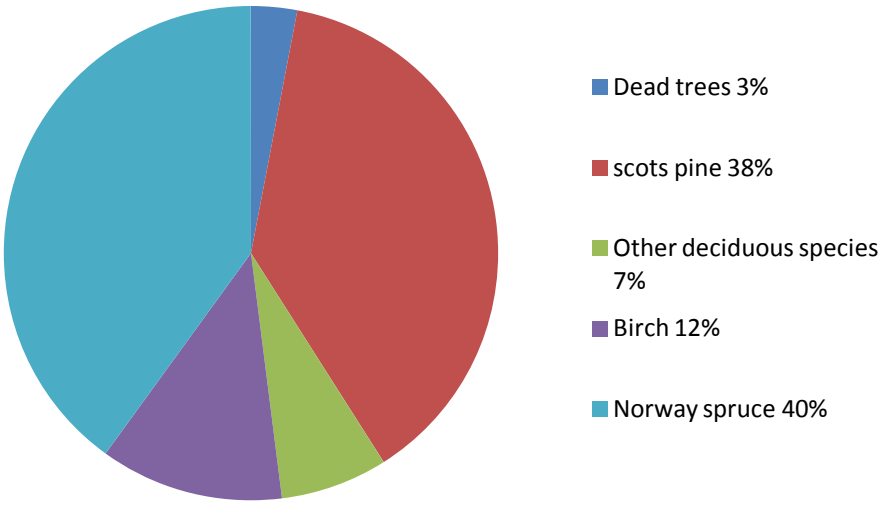


**Figure 8. Total Standing Volumen of different species in Sweden (The Swedish National Forest Inventory 2004-2008).**

### 3.3.4 Norway Spruce:

| | |
|---|---|
| **Scientific name** | *Picea abies* (L.) Karst. |
| **Genus** | Picea |
| **Family** | Pinaceae |
| **conifer/broadleaf** | Conifer |
| **native/introduced species** | Native |
| **Soil type** | Good adaptability. Grows best on moist deep loam soils. Does not do well on dry and deficient soils. |

The Norway spruce is a native evergreen conifer tree in Europe. This tree is the most widespread spruce in Europe and one of the most common and economically important in Europe and Scandinavia. The tree grows slowly during the first 25 years. It can grow in ideal conditions up to 50 meters tall but a more normal height is 25 to 30 meters. The needles are 1-2.5cm long and hard. It is one of the two major species in Sweden, with a 40% of the total standing volume (The Swedish National Forest Inventory, 2010). In Spain, it is only planted for ornamental purposes in parks and streets.

It has a typical pyramid crown. This tree can be called the “European spruce” because of its native distribution. Its natural range extends along the Central and Northern Europe. Norway spruce colonizes bare grounds or light masses of other species. It is hard to grow other species in the understory of this tree stands due to the dense crown that these trees have which leads to a dense shade and lack of light.

The main usage of this tree timber is for construction (recognized to have good quality easy to work with, strong and straight) and pulpwood. Planting Norway spruces on farmland is common in Sweden. Norway spruces has been the most common Christmas tree in Sweden with about 80% of all sold Christmas trees (3-3.5million trees) (Johansson,2011).

Normally spruces grow in pure stands, but it can be mixed with other species (ex. birch, beech, aspen) or in mixed stands with Scots pines. In Sweden, the growing rate varies too much due to the length of the growing season (Bergh et al., 1998, 1999) and the nutrients constraints in the soil (Tamm, 1991). The production of stem volume varies from 7-10 $m^3$/ha/year in the Southern parts of Sweden down to 2-5 $m^3$/ha/year in the Northern parts. The rotation period is between 70 and 120 years.

### 3.3.5 Scots pine

Finally we must not forget Scots pine, which is the only major timber species that grows in both Spain and Sweden.

| | |
|---|---|
| **Scientific name** | *Pinus sylvestris* L. |
| **Genus** | Pinus |
| **Family** | Pinaceae |
| **conifer/broadleaf** | Conifer |
| **native/introduced species** | Native |
| **Soil type** | Indifferent but prefers sandy and acid substrates. |

This conifer tree normally grows up to 25 meters height and has thin red bark at the upper part of the stem and in the branches. The needles are eight cm long and hard.

Pinus sylvestris is an ecologically wide-ranging species (Ceballos and Torre, 1979; López, 1982; Costa et al., 1997). It has the largest natural distribution area and the most widely used in Europe and Asia (Santiago Vignote, 2010). It extends from South to North, Sierra Nevada, Spain (South of its Natural distribution) till North of Norway.

This tree can reach 30-40 meters height on good sites, otherwise, on average sites it grows to about 25 meters height. The stem is straight and cylindrical. In dense stand the crown are allocated to the top of the stem, which leads to a good quality wood for timber. The commercial rotation period varies between 60-120 years, The annual growth in Sweden is 1,5 to 7 $m^3$ per hectare and year depending on the site (Vignote, 1985). The normal growth in Spain is $3m^3$.

In Sweden Scots pine represents 38% of the total standing volume (Swedish National Forest Inventory, 2010). It is the dominant tree in northern Sweden. While in Spain just appeared in the mountains, 1000m above the sea level, it can in Sweden can be seen in all altitudes.

The wood is used for sawnwood products in both countries but in Sweden it is also used for pulp.

In Sweden, Scot pine is commonly managed when natural regenerated under a shelterwood system. Then it is important to know the good seed year in order to do the regeneration cut.

### 3.4 Factors affecting timber quality in both countries. Diseases and pests.

The five factors affecting wood quality, according to Tord Johansson are:

1. Mammals and other animals (moose, which browse and even kill young trees and greatly reduce the quality of future sawn timber from the survivors in Sweden, wild boards, deer grazing, other cervidae grazers, rabbits, field vole, birds like woodpecker)
2. Climate, such as damaged trees after wind thrown in big storms.
3. Mechanical damage, such as the rot after pruning.
4. Insects.
5. Fungi.

Focusing on these two last factors, Insect and Fungi; it is possible to describe the main diseases and pests in timber trees.

The number of new insect's species in Sweden and Spain are increasing every year. This is because higher volume of the trade and also due to the increased long distance travelling. Insect species will hereby come to Europe from everywhere but mostly from Asian (DAISIE, 2010). Gardens are a really hot spot to find introduced species. The reason of this is that there is a lot of potential host trees for the insects, gardens are located within the area where most people live. Trees can be reduced their resistance, so insects are more successful to live there and move to another place after establishment.

### 3.4.1 Sweden

Norway spruce is the most disease resistant spruce.

***Table 4. Main timber diseases, species. Source: different sources.***

| | **Insects** | | | **Fungi** | | |
|---|---|---|---|---|---|---|
| **Species** | ***Ips typographus*** | ***Tomicus* ssp *Tomicus minor*, Hart. *Tomicus pipiperda* L.** | ***Ips cembrae* (Heer)** | ***Heterobasidion annossum L.,*** | ***Melampsora pinitorqua(*Braun*)*** | ***Geminiella abieties,*** |
| **Norway spruce** | Yes | Rarely | No | Yes | No | Yes |
| **Pinus silvestris** | Occasionally | Yes | No | Yes | Yes(if an Aspen stand is near) | Yes |

Insects:

- ***Ips typographus* L. (European spruce beetle).** This beetle attack standing living trees. They use pheromone to attract more individuals of the same species and attacked the tree in a big number to kill the tree before it can produce resin to kill the beetle. It attacks the parenchyma cells. It is the most serious insect pest on mature spruce trees, especially after a big storm when dead and weak trees provide spots for their nests.
- ***Tomicus ssp*. (Pine shoot borer**). There are two species, *Tomicus minor* (lesser pine shoot beetle) and *Tomicus piniperda*(common shoot beetle). These insects does not kill the tree but reduced their growth. When trees are killed by fire, these insects are attractive to them for reproduction. After reproduction, they will fly to the next living pine stand while the spruce beetle does not like trees killed by fire.(Åke Lindelöw,SLU,2011)
- ***Ips cembrae* (Heer)** Now coming to Sweden, normally affects dead larch trees, so it is not affecting timber trees yet. Important species in Central Europe.

Fungi:

- ***Heterobasidion annosum* L.** It is the most severe biotic cause of damage to forest in Sweden. It affects the tree root, mainly on Norway spruce but also any type of conifer plantations and natural forest. Can affect from one tree to other trought the rotten roots. Avoid thinning during warm season and reduce the stump ph? after clear cutting spraying.
- ***Melampsora pinitorqua.*** This fungi can attack shoots of Scot pine if there is an aspen stand next to it.
- ***Gremmeniella abietina***

Other fungi that seriously affect conifers in Sweden are: *Cronartium flaccidum* and *Lophodermium seditiosum* (Skogsstyrelsen, The Swedish Forestry Model)

### 3.4.2 Spain

The climate conditions in Spain makes for most of the insects the forest to a really good environment to live in. As the temperature gets warmer in Sweden, new insects who like warmer conditions starts to occupy the land, as an example; *Ips cembrae* have been seen in South Sweden. *(*Åke Lindelöw, SLU, 2011).

Main insect's diseases species affecting conifers in Spain:

**Table 5.** ***Insects affecting three pine species in Spain***

| **Tree species** | **Insects** | | | | |
|---|---|---|---|---|---|
| | ***Thaumetopea pityocampa,*** Denis and Schiffermuller | ***Rhyacionia buoliana,*** Den et Schiff | ***Pissodes notatus*** | ***Ips sexdentatus,* Böern** | ***Tomicus piniperda,*L** |
| **Monterey pine** | ***Yes*** | ***Yes*** | ***Yes*** | ***yes*** | ***Rarely*** |
| **Maritime pine** | ***Yes*** | ***Rarely*** | ***Yes*** | ***Rarely*** | ***Yes*** |
| **Scot pine** | ***yes*** | ***Yes*** | ***Yes*** | ***Yes*** | ***Yes*** |

**Table 6.** ***Fungi affecting timber species in Spain.***

| **Tree species** | **Fungi** | | |
|---|---|---|---|
| | ***Armillaria ostoyae*** | ***Cyclaneusma minus,* Butin** | ***Armilaria mellea,* Vahl** |
| **Monterey pine** | ***Yes*** | ***Yes*** | ***No*** |
| **Maritime pine** | ***No*** | ***Rarely*** | ***Yes*** |
| **Scot pine** | ***No*** | ***Yes*** | ***yes*** |

Insects:

- ***Thaumetopea pityocampa*** *(*Pine processionary). This insect is found in most places of southern Europe. It is a caterpillar, feeding on pine needles. They do not kill the trees except for young ones, but makes them weakness and they can even dry out. Attacks the pine trees between October and April-May.
- ***Rhyaciona buoliana***. This insect is a driller of terminal buds and shoots. Attacks many types of pines: Pinus pinea, Pinus sylvestris, Pinus halepensis and Pinus radiate.
- ***Pissodes notatus***. This insect is a stem driller. This insect is really hard to control because all Pissodes are red-listed species in many countries of the European Union.

Attacks all pines species, and they prefer weak, young and weak trees that have been affected by any meteorological or edafic issue.

- ***Ips sexdentatus***. Stem drillers that attack weak pines. The risk of this insect is related with the amount of piles of trees or dead trees on the ground inside a mass or near to it.
- ***Tomicus piniperda***. Borer of terminal buds. Attacks young pines with thick bark and prefer weak trees. The tree stands situated in poor sites and soils, and stands with many stems per hectare are the most exposed for this insect.

Other insect like *Hylobius abietis*(pine weevil). This bark driller insect is not causing big problems in Spain but it does in Europe. Attacks Pines, Picea and Pseudotsuga stands.

Fungi:

- ***Armillaria ostoyae***. The fungus primarily attacks young stands. Trough the root the pine will dry really fast.
- ***Cyclaneusma minus***. Defoliator of Pine needles. Can cause serious damage to Pinus sylvestris and Pinus radiate stands in Spain.
- ***Armilaria mellea***. The fungus attacks primarily the thick and structural roots. The tree root system cannot absorb water or nutrients after the attack so the plant will eventually die.

Finally, the Pine wood nematode cannot be forgiven, which is nowadays starting to cause serious problems in Spain and Portugal. This nematode goes from one tree to other using a beetle as a vector. Then the nematode invades the stem and the needles of the tree causing the tree dead.

**Eucalyptus**

Eucalyptus main diseases in Spain include one caused by an insect and two by fungi.

- ***Gonipterus scutellatus***, Gyllenhal. It is the most recognized defoliator insect of Eucalyptus nowadays in Spain. The insect reduce tree growth and the following weakness of the tree making them more susceptible to pathogens.
- ***Botrytis cinérea***, de Bary. This fungus attacks many different vegetal species. Young stands of Eucalyptus and greenhouse plantations are affected. The fungus infects plants through colonized senescent tissue or through injuries in the plant. Can cause the dead of

the tree.

- ***Armilaria mellea**, Vahl*

In order to control de population of these insects there are many ways to act. The main problem is that some of these species are red-listed species. Logging is the main threat to many of these species. As an example, in Sweden, where spruce bark beetle can be a pest if affects many trees, there is a regulation to control the population. The Forestry act determines that the volume of down trees by windfall must not be bigger than $5m^3$/ha. But the certification system, (FSC/PFSC) recommended at least $3m^3$/ha. The global trend in both countries, especially in Spain is to increase the utilization of forest certificate timber.

3.4.3 Control of pest insects and fungi. Preventive and curative measures

- Pheromone traps: eg, Ips cembrae
- Remove damaged trees
- Remove wood piles after a clear cut during summer season
- Remove fallen trees, weakened and burned.
- Do thinning and pruning during winter seasons
- Use of Insecticides. Precautions should be taken of overuse due to the negative effects of being non selective (it kill all insects) and species being resistant.
- Biological control. Selective method. You need permission in Sweden. e.g. Bt (*Bacillus thuringiensis)*. (Åke Lindelöw, SLU, 2011)

# 4. CONCLUSION

The most important aspects on management and production of timber in Spain and Sweden are as follows.

Timber production and the overall forestry industry in Sweden have an important impact in the economy. Most of these products are exported. In Spain the forest products does not count as much due to the relatively minor timber production and trade, leading to the necessity to import timber from other countries. Spain is a deficit country from a timber supply and demand perspective.

The main timber species in Sweden are Norway spruce and Scot pine while in Spain blue-gum eucalyptus, Monterey pine, Maritime pine and Scots pine so the only main timber species that both countries have in common is scot pine.

The timber production and quality in both countries can be negative affected by many factors: climate such as wind throw by big storms or droughts, animals grazing and browsing the forest stand, and fungi or insects.

Highlight the difficulties of searching for Spanish data while Swedish data was really easy to find and very well enlightened

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