

Forest operations management and the conservation of biodiversity in black pine forests.

The Life+PINASSA experience



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Photo: Jordi Bas



Basic concepts

A good **forest operations manager*** must know what they are managing. They must know how to interpret the plantscape and understand the relationships established between living things and their setting. This knowledge is indispensable to be able to apply management actions that are compatible with the conservation of biodiversity. The relationships between living things and the environment are complex and may be studied from different standpoints and using different levels of approach.

1.1 Environmental conditions determine the distribution of plant species

The environmental characteristics of a given place (temperature, wind, sunlight, type of substrate, humidity, etc.) condition the plant species that can live there; in other words, a given site will harbour species that have **adapted** to its environmental conditions.

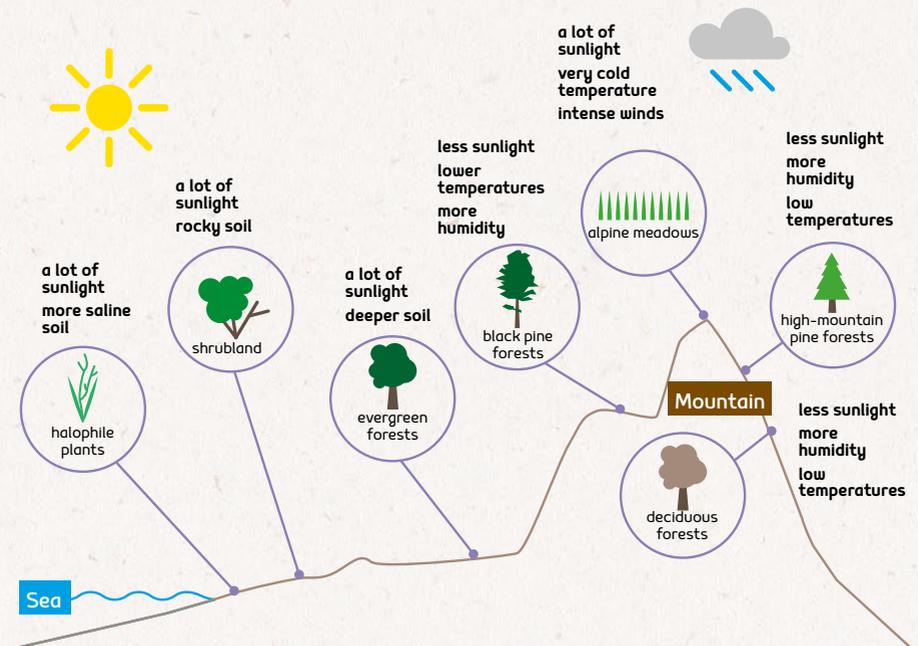


Illustration: LaTaula.coop

* **Forest operations manager:** the professional who plans and controls the performance of work to be done in a forest to accomplish certain objectives (environmental, economic, social, etc.).

1.2 Plant species are grouped into plant communities

Generally speaking, a **plant community** may be defined as a collection of plant species that live in and have adapted to a place under certain environmental conditions.

This plant unit, or plant community, may be characterised depending on its **phytochorion**, or in other words, depending on:

- The plant species that are part of it and the amount of each one of them.
- The ecological or environmental conditioning factors in which it prospers.

Examples of plant communities:

Holm oak woods | Oak forests | Black pine forests | Riparian forests | Shrubland | Wet grasslands | Alpine meadows | etc.

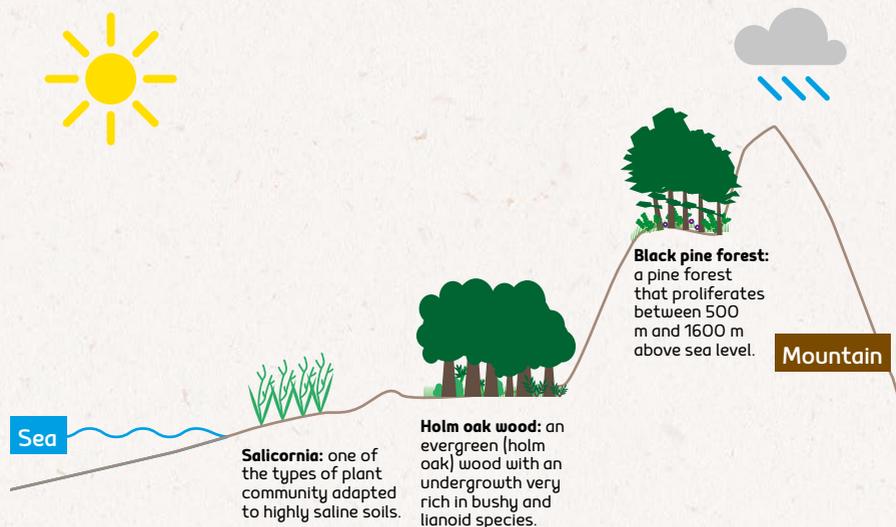


Illustration: LaTaula.coop

These examples of plant communities live in places they have adapted to. You will not find a holm oak wood at an altitude of 2500 m because the environmental conditions in such places are not compatible with the species of this community.

1.3 Plantscapes are dynamic: degradation and succession of plant communities

Plantscapes, consisting of a mosaic of plant communities specific to a given place, are dynamic. The alteration of a plant community by a **perturbation*** (landslide, fire, flooding, etc.) or by human action devoid of conservation criteria alters the environmental conditions that formerly permitted the existence of the species that made up the community. For example, very intense fires cause the arboreal strata to disappear, generating an open space which, in turn, leads to greater sunlight, higher temperatures and less humidity. The environmental conditions are no longer suitable for the species that live under the trees, whereupon they disappear and are replaced by other plant species that are better adapted to the new environmental conditions.

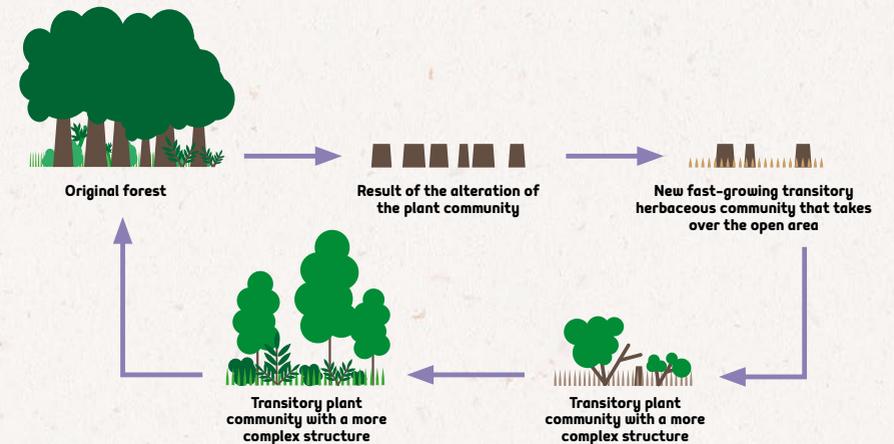


Illustration: LaTaula.coop

In this example, a **new plant community** compatible with the new environmental conditions has established itself following the alteration of the forest. Over the course of many years, this new plant community, which we could call transitory, will yield successive **transitory communities**** until the original forest is restored, provided that there are no far-reaching changes in soil conditions.

* **Perturbation:** any naturally occurring phenomenon that abruptly and transiently alters an ecosystem (to varying degrees). Or in other words, anything that triggers, interrupts or redirects its succession or regeneration process.

** **Transitory communities:** plant communities that evolve over time, with intermediate stages, towards the original community.



Photo: Jordi Bas

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More about the black pine and black pine forests

2.1 How to identify the black pine

Iberian black pine forests are sub-Mediterranean formations dominated by *Pinus nigra* subsp. *salzmannii*, a subspecies adapted to more continental climate areas in the Mediterranean region and therefore to conditions in which heavy winters with frequent frost and a broad range of temperatures prevail.

In Catalonia they extend from the central Pre-Pyrenees and the southern pre-coastal range to the Els Ports massif. In Terres de l'Ebre, this pine is known as "pi negral", in Catalan.

In suitable environmental conditions, it can grow as high as **40 m** and live for up to **800 years**. It is the longest-living Iberian pine tree.

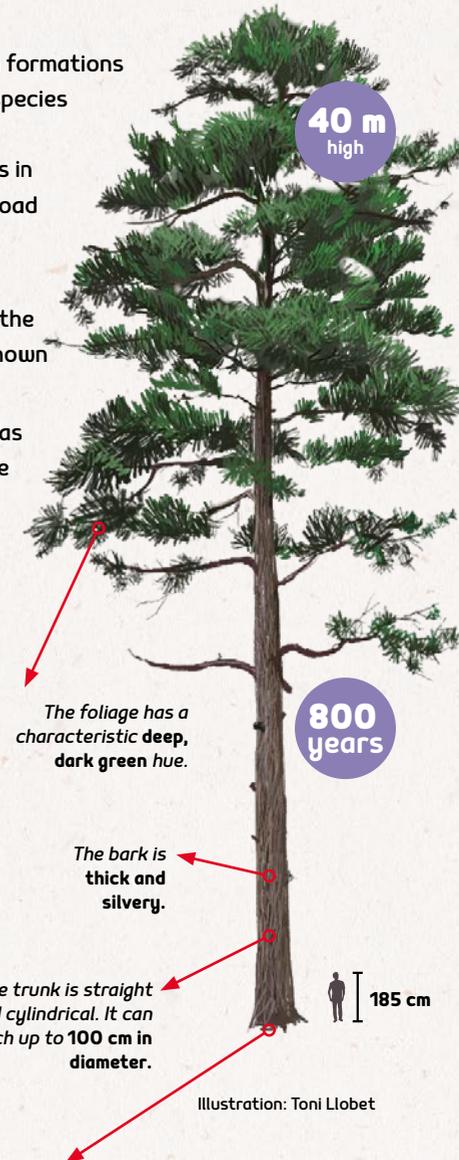
Iberian varieties or ecotypes:

pyrenaica: Pyrenees and Iberian North East

hispanica: Iberian centre and south

latisquamata: Albacete, Cuenca and Teruel should probably be included in the var. *hispanica*

There are also reforestations with the typical *nigra* subspecies, which originates from central and southern Europe. Leaves of 8-16 x 0.15-0.2 cm, stiffer and dark green, pine nuts larger than 5-8 cm and a laxer habit.



The main root is somewhat underdeveloped, although it has abundant and long secondary surface roots that anchor the tree firmly.



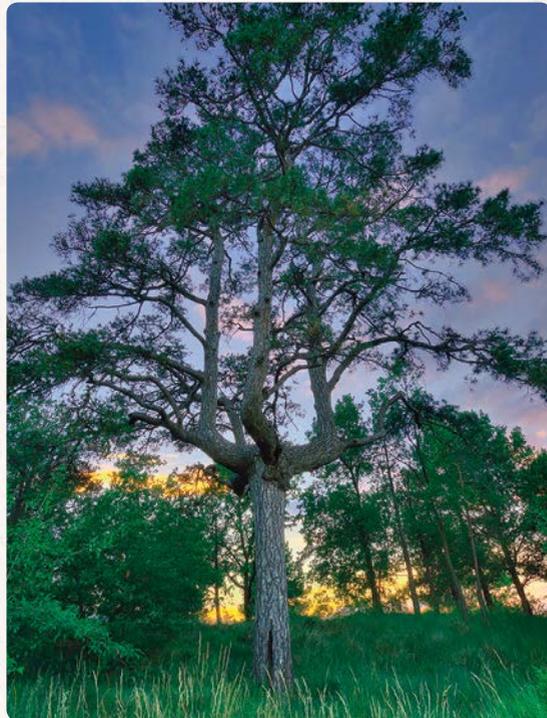
Illustration: Toni Llobet

The pine cones grow perpendicular to the branches. This characteristic, among others, makes it possible to distinguish between the black pine and other pine species, such as the white pine, whose cones grow at an angle to the branch.

The pine cones are conical and measure between 4 and 8 cm long.

The pine cones contain seeds. The pine cones, which have adapted naturally to fire, burst open when they burn and disperse their seeds.

Leaves measuring 10-16 x 0.1-0.5 cm, slightly stiff but also flexible and not very pointed, and dark green in colour.



As black pines get older, the crown takes on a conical shape, as can be seen in this specimen from El Solsonès.

Photo: Jordi Bas



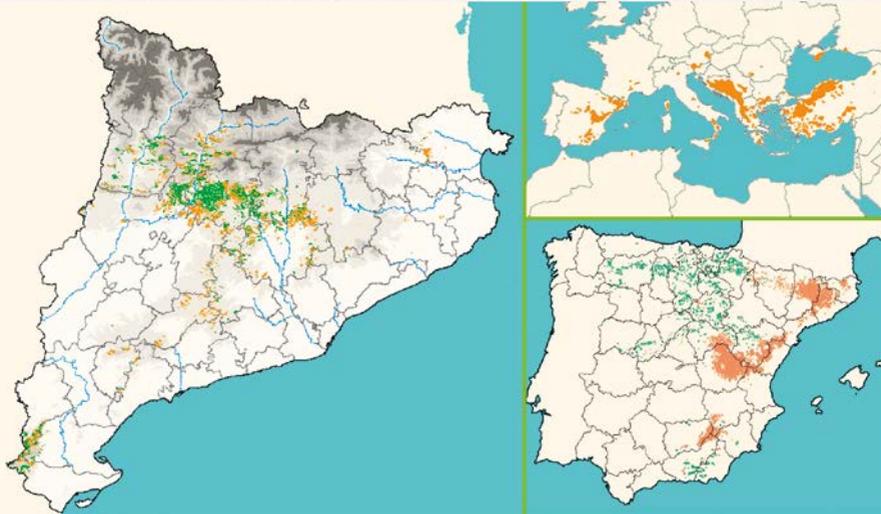
Example of a mature black pine forest in the Catalan Pre-Pyrenees. Photo: Míriam Piqué



Example of a young black pine forest. Photo: Jordi Bas

2.2 Where black pine forests grow

The **black pine** grows in the Mediterranean region and in continental areas. In Catalonia, black pine forests are to be found mainly in the Pre-Pyrenees and in high mountain areas of the pre-coastal ranges, as well as in the southern mountain ranges. In terms of extension, it is one of the most important species.



Catalan, worldwide and Iberian distribution maps. In the Catalan distribution map, the pure masses (green) can be distinguished from the mixed ones (orange). In the Iberian distribution map, the natural distribution areas (orange) can be distinguished from reforested areas (green). Source: Beltrán et al. (2012)

Distribution of black pine forests in the Iberian Peninsula by altitude. It should be remembered that in the previous chapter we said that environmental conditions determine the distribution of species.

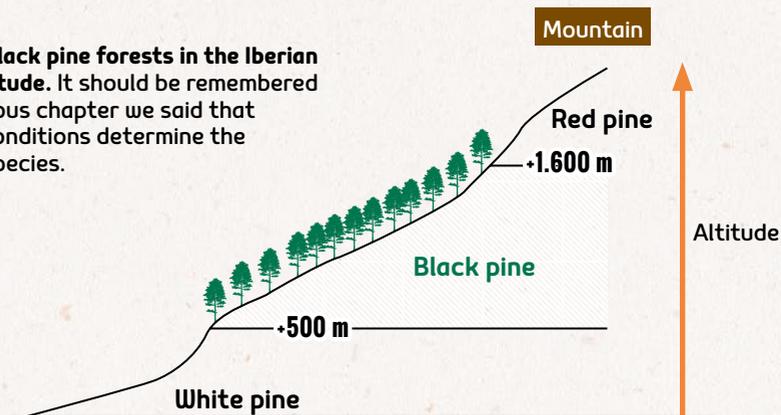


Illustration: LaTaula.coop

The **lack of humidity in summer** is a limiting factor for these forests. Black pines thrive in areas with substantial rainfall, where the soil is deep and on **shaded north-facing*** or **semi-north-facing slopes**. Growing in the shade makes them more vigorous. The black pine is sensitive to droughts. In prolonged drought conditions, the tree is debilitated and becomes more sensitive to pine processionary (*Thaumetopoea pityocampa*) which, in water stress conditions, reaches plague proportions.



Pine processionary and burrowing insects (those that feed on wood) are the main plagues that affect black pine forests when the trees are weakened by drought.

The top photo shows a black pine forest affected by pine processionary.

The photo at the side shows a black pine trunk affected by burrowing insects.

Photos: AGS-CTFC

* **North-facing slope:** the shady side of a mountain, in other words, the side not facing the sun, meaning that there is less sunlight (more shade), temperatures remain lower and humidity is maintained better. South-facing slopes, on the other hand, face the sun and receive more sunlight.

2.3 The different types of black pine forests

The black pine can coexist with other species of trees (other pine trees, oaks, holm oaks, etc.). The species that grow near the black pine will depend on geographical setting and local environmental conditions.

- ▶ The greater the Mediterranean influence, the higher the numbers of **white pine, holm oak and holly oak**.
- ▶ At higher altitudes there will be a **greater number of red pines**.
- ▶ In sub-Mediterranean zones there will be **more oaks and maples**.

Forests in which the black pine coexists with other trees are called **mixed forests** (if the other trees account for more than 30% of the cover), whereas forests in which the black pine is virtually the only arboreal stratum species are called **pure forests**.



Example of a mixed black pine and oak forest.

Photo: AGS-CTFC



Example of a pure black pine forest.

Photo: Jordi Bas

It is also important to take the so-called **singular stands*** into account. A singular stand is one that is distinguished from other forests of the same species by dint of some exceptional value:

- The trees are very old (and normally very large).
- Outstanding conservation, social or productive values (dead-wood dynamic, animal species associated with maturity, etc.).

Moreover, we must also consider the relative nature of the singularity according to the territorial scale, such as massif or region. Forest stands with the same characteristics may be singular in one place but not in another.

The basic element for determining a forest stand's singularity is **the abundance of old trees**, which should be at least well above the usual average age. The other elements are complementary and make it possible to increase the forest's singularity in qualitative or quantitative terms, for example by calculating an index that allows us to measure the degree of singularity.



Example of a singular stand in the Els Ports massif.

Photo: Jordi Camprodon

* **Stand:** a stand is a piece of land which for some reason, particularly on account of the plants that grow there, is distinguished from its surrounding area.

2.4 The dynamics of black pine forests

The black pine is a habitat of **priority community interest** (See the publication “9530 Pinares (sud-) mediterráneos de *Pinus nigra* endémicos” [Annex I of the Habitats Directive]). Due to big forest fires, the black pine has fallen upon hard times in Catalonia and in the Mediterranean area in general. This explains why it is to be found in **Special Protection Spaces***.

It is a sensitive and endangered habitat, which is why the European Union (EU) is particularly interested in preserving it. One way of doing so is by means of the Life programme, co-funded by the EU.

Aspects to be taken into account regarding the dynamic of black pine forests:

- ▶ Black pine forests have the ability to form **stable, well-developed communities** thanks to the black pine's great longevity.
- ▶ **High-intensity perturbations** that trigger a sudden change in environmental conditions (such as big **forest fires**) have a very negative impact on black pine forests. After a big fire, black pines fare much worse than other pine trees (which die, but their pine nuts can withstand the flames and germinate) and quercines (holm oaks and oaks, which reappear easily). The black pine, on the other hand, disappears.
- ▶ The black pine is a **species adapted to low-intensity fires** when it is in adult age, thanks to its thick bark, which protects it, and its high crown. These fires **spread across the ground** but do not reach the treetops and therefore do not escalate. **They are good fires for the black pine habitat**, since they reduce the black pine's competition for resources and the amount of plant fuel accumulated in the undergrowth. Low-intensity, high-frequency fires improve forest conditions for the prevention of big fires and the regeneration of the species.

* **Special Protection Spaces:** these are systems that protect certain areas and ecosystems (National Park, Natural Park, Nature Reserve, Landscape of National Interest, etc.).

2.5 How black pine forests have been transformed in the course of history

The presence of species of the *Pinus* genus has prevailed in Catalonia since **before the last glacial period** (12,000 years ago).

At the same time, **interaction with man over many millennia** has had a large impact on the structure and the distribution of black pine forests, mainly due to the **transformation of forests into grazing or farming areas** and use of the **products they yield:** wood, firewood, coal and glue.

It is this **transformation into farmland and pastures** that has had the greatest affect on black pine forests. Transformation into farmlands has been more or less constant over history, with a marked increase during the 19th century prompted by demographic escalation and the **Spanish confiscation***.

Black pine wood has been widely used in the construction of buildings and ships throughout history, thanks to its straight trunks, high strength and the durability conferred by its natural resins. Nowadays, it is very likely that you will be able to see black pine rafters in very old houses.



Exploitation of black pine forests in Els Ports in the 1960s.

Photo: Fototeca Forestal Española DGB-INIA

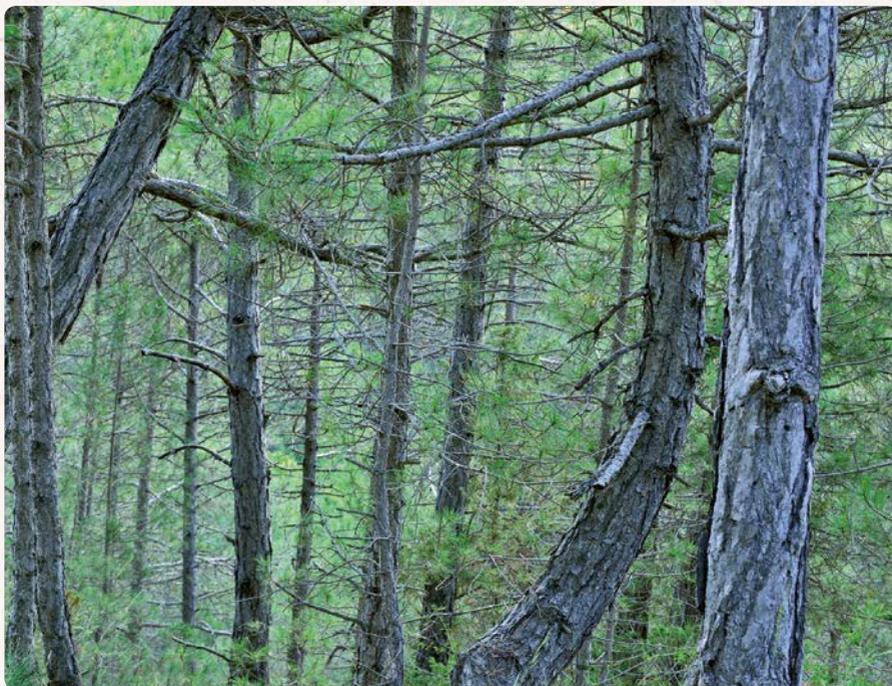
* **The Spanish confiscation:** the so-called “confiscation” was a historical, economic and social process undertaken at the end of the 18th century, consisting basically of the confiscation of lands and properties in church and municipal hands which were then sold through public auction.

Black pine forests were heavily exploited until the 1970s on account of the **social changes related to industrialisation**.

Since then, mainly **due to rural abandonment**, forest management and use has tapered off, spawning an increase in the surface area of woodlands and biomass in forests.

In parallel, the widespread abandonment of the use of grazing land and the use of firewood led to **an increase in mixed formations with quercines (oaks, holm oaks and holly oaks*) in the undergrowth of black pine forests**.

All these factors have triggered different situations, most of which share a common pattern: a greater accumulation of biomass in forests, particularly in the form of small trees and thick undergrowth.



Example of a current pine tree forest (with small trees and thick undergrowth).

Photo: Jordi Bas

* **Holly oak:** the holly oak (*Quercus ilex* subsp. *rotundifolia*) is the adaptation of the holm oak to the continental Mediterranean climate. In these areas of inland Catalonia, the weather conditions (cold winters and hot, dry summers) are more extreme than on the coast, where the holm oak proliferates (*Quercus ilex* subsp. *ilex*).

2.6 The problems affecting black pine forests



Climate change and vulnerability to fires

- ▶ *Pinus nigra* forests have undergone a major reduction in terms of their area of distribution over the last 3 decades, mainly due to forest fires.
- ▶ **Sixty-six percent (66%) of forests** have a very high fire risk.
- ▶ **An increase in vulnerability and risk of forest fire in the near future is predicted** due to the foreseeable increase in dry periods and high temperatures in summer, compounded by the accumulation of fuel.
- ▶ **The effect of climate change** could lead to an even greater reduction in the forests' area of distribution. In areas that have been heavily affected by fires, the black pine is undergoing a lack of reforestation and has to contend with stiff competition from other species, such as the white pine and sub-Mediterranean oak trees, which has severely impaired the specie's evolution.

Dry black pines due to a lack of rain.

Photo: AGS-CTFC





Deficient habitat structure

- ▶ In some cases, traditional management has led to somewhat immature forests, with little vitality and biodiversity, a poor regeneration capacity and highly prone to forest fires.
- ▶ At the same time, the emergence of highly dense forest masses of woody vegetation is frequently caused by the abrupt cessation of forestry management, particularly in areas with suboptimal ecological conditions that limit the growth of black pines. This situation will be accentuated by climate change.
- ▶ These conditions **heighten the risk of plagues** (such as pine processionary) **and fires** and thwart the regeneration of black pines and their accompanying species, as well as other characteristic flora.



Few mature forests

- ▶ **Current black pine forests** are well below their natural longevity and **dynamic***.

Adaptive management is essential in view of the foreseeable changes. In Europe, forests have been managed intensively for centuries, and therefore a variety of management options and an entire science, namely **silviculture****, are available to adapt them to global changes.

Despite this, all the stakeholders involved in **forestry management** must understand and accept future uncertainty, since we are now headed for a period for which few analogies exist, and which will inevitably bring surprises.

* **Natural dynamic**: a succession of episodes of a forest free of intervention by mankind that substantially modify its structure and ecological processes.

** **Silviculture**: the science, technique and art of managing forest masses, helping forests to evolve by leveraging ecological factors and natural potential.

2.7 The uses of black pine forests: functions and products

Functions

Black pine forests in Catalonia are **multifunctional**, in other words, they render different functions (goods and services) to society simultaneously. These functions may be classified into **three categories**:

1. **Productive function**
2. **Social function**
3. **Environmental function**

In a forest, any of these functions can be prioritised without relinquishing the rest of them.

1. Productive function

Goods are obtained with a market price.

At this moment in time, the output of black pine forests consists mainly of timber production, although there are other products, such as grazing land, mushrooms or game.



Photo: AGS-CTFC

2. Social function

Assets that generate well-being are yielded.

In the case of the black pine, these assets are basically scenery and a recreational environment. Furthermore, employment can be created in the territory, such as forest managers, nature guides employed in public parks, teams of woodcutters, timber companies, restaurateurs or rural accommodation for country-goers out to pick mushrooms or to enjoy other nature-based activities.

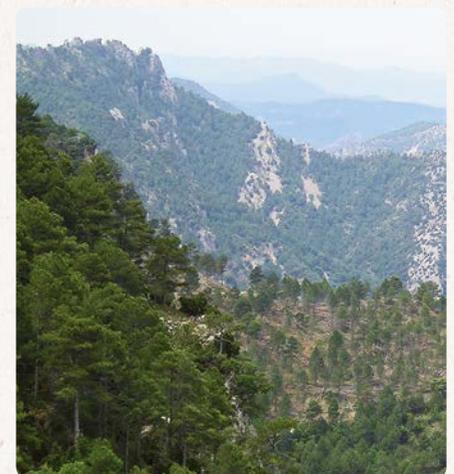


Photo: Archive of the Fundació Catalunya-La Pedrera

3. Environmental function

Indirect or non-consumer-based public assets are yielded.

Unlike the productive and social functions, environmental functions do not need a demand to exist. The main environmental functions of black pine forests are:

- water regulation
- the mitigation of erosion
- capturing atmospheric CO₂
- the conservation of biodiversity and scenic value



Photo: AGS-CTFC

Black pine forests, be they pure or mixed, **are an important reservoir of biodiversity**, both on account of the **phytogeographical** * significance of black pine forests in Catalonia and because they provide a habitat for other plant and animal species, some of which are of special interest because they are restricted, rare or endangered.

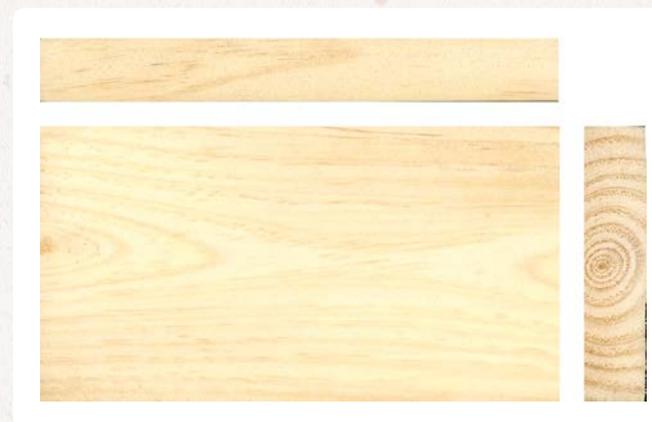
The products

The productive function of black pine forests is based mainly on **wood production**, although it also includes **grazing land, mushrooms and game**. Moreover, the use of **biomass for energy purposes** also constitutes a major market opportunity.

Black pine wood

- ▶ Historically, wood has been, and still is, **the main product yielded by black pine forests**. It is highly stable wood, with little resin, very dense but semi-heavy, with high natural durability and excellent priming and machining properties. This is why it is a very commercial wood with a great deal of potential in Catalonia.
- ▶ Most of the wood that is extracted from black pine forests in Catalonia at this moment in time is **small-diameter and of average-to-low quality** and is intended mainly for industrial packing (pallets and reels).

* **Phytogeography**: the study of the geographic distribution of plant species on the Earth and the environmental characteristics that condition them.



Radial, tangential and cross-sectional planes of black pine wood.

Photo: Mario Beltrán



Examples of the use of black pine wood in outdoor furniture and fixtures.

Photos: AGS-CTFC

Mushrooms

- ▶ **Mushroom-gathering in black pine forests** in Catalonia is a major economic activity, although it does not normally benefit the ownership, i.e., the owner of the forest receives no economic remuneration. Nevertheless, it is an increasingly more popular recreational activity that also has a major impact on other sectors, such as tourism.



Mushrooms. Photo: Wikimedia Commons, public domain



Photo: Jordi Camprodon

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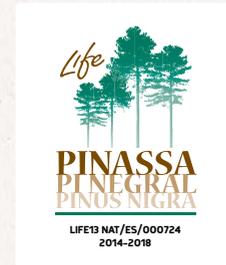
**What we can do to
conserve and help
black pine forests**

3.1 The Life+PINASSA project



LIFE is a European Union programme that co-funds projects intended to protect the environment and promote sustainable development.

The Natura 2000 network protects the European Union's most important natural spaces containing habitats and plant and animal species of community interest.



Life+PINASSA is a project of the European Union's LIFE programme that has worked to contribute to the **conservation of black pine forests** in Catalonia for 5 years.

The project has pursued the following specific objectives:

- ▶ **To identify and protect** a representative sample of the best masses with exceptional cultural and biological characteristics present in the black pine's distribution area, improve the stability, reforestation and biodiversity of the habitat and reduce its vulnerability to fires.
- ▶ **To significantly improve** the biodiversity of young, dense, single-structure black pine forests and regenerate those that have been over-exploited or affected by big fires.
- ▶ **To increase the resistance and resilience*** of black pine forests in the face of big fires and climate change.
- ▶ **To generate and transfer** management plans and tools to forestry owners and to government bodies in order to make black pine forest conservation compatible with productive and recreational functions.
- ▶ **To contribute** to solving the conflicts between the different functions of black pine forests: productive, environmental and social.
- ▶ **To disseminate** information about the Natura 2000 network, environmental values and the sustainable management of forests in schools and to the general public.

* **Resilience:** an ecosystem's capacity for self-defence and recovery.

3.2 Actions that need to be taken to preserve and restore dwindling singular forest stands

The **conservation and restoration of singular stands** of black pine is very important for two main reasons.

Firstly, because they are in very short supply in our landscape, where they offer **outstanding value** as compared to most other forests in terms of maturity of trees, the number and abundance of species associated with the forests (biodiversity), natural heritage value (large trees, often different shapes, with the look of an “enchanted forest”).

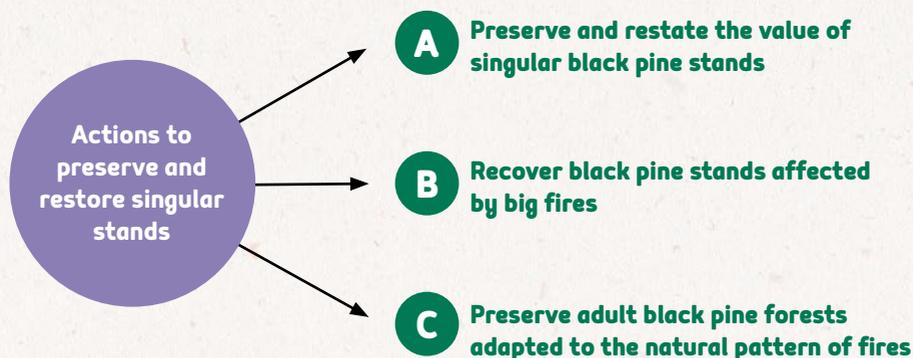
Then there is the possibility of conducting **scientific research** (to study the forest’s natural dynamic: how trees compete with each other, how they grow old and how new trees are born in the forest, the biodiversity associated with old trees and dead wood, etc.) and recreational activities in them.



Example of a singular black pine stand in the Cardó mountain range.

Photo: Jordi Camprodón

The conservation and restoration of the few remaining singular stands in the black pine’s area of distribution include the **following actions**:



A **Preserve and restate the value of singular black pine stands**

The black pine is a species that enjoys great longevity and grows in climate conditions with different stress-inducing factors (drought in summer, very cold winters and frequent late frosts). Although large specimens can still be found, sometimes even more than 200 and 300 years old, they are still far from the specie’s longevity limit. The organisms associated with dead wood, birds that breed in tree cavities and tree-inhabiting bats, have been located more in the singular stands than in other less-mature black pine forests.

This action consists of:

- ▶ By means of agreements with the owners, providing greater protection to a network of 12 singular stands that amount to 174 ha. The objective of this management is to allow them to evolve naturally, without precluding the application of improvement treatments in certain cases, if technically advisable (lack of heterogeneity, problems with competition or poor regeneration). In publicly owned forest stands, partnership agreements have been signed, while in private forest stands, 3 leasing contracts for a term of 25 years have been entered into pursuant to which the owners undertake to preserve the forest.
- ▶ A plan has also been drawn up to regulate public use and to decide in which forest stands guided tours can take place.

B **Recovering black pine forest stands in areas hit by big fires**

Black pine forests affected by large-scale forest fires, such as on the mountain of Montserrat, have been reduced to small groups of adult trees. In such conditions, the regeneration of the black pine is extremely difficult on account of the stiff competition from the other woody undergrowth species.

This action is intended to improve the regeneration of *Pinus nigra* in areas where there have been large-scale forest fires that have substantially altered the habitat and where the continuity of the species is clearly at risk.

This action consists of:

- ▶ The sowing of black pine seeds and planting of saplings.
- ▶ Clearing away the thick vegetation that competes with the black pine (young holm oaks, white pines and bushes), respecting any protected plant species (oak trees, maples, fleshy fruit-producing bushes and other plants that are generally scarce in the area). The aim is to reduce competition in order to promote the black pine's natural regeneration.



Different pictures of the sowing of seeds and planting of black pine saplings.

Photos: Jordi Bas (top photos) and Jordi Camprodon (bottom)

C Preserve adult black pine forests adapted to the natural pattern of fires

The frequency of fires and their effect on adult black pines in the form of wounds caused by the heat, demonstrate how this species has adapted to **a natural pattern of fire** generated by **lightning bolts** that cause the undergrowth to burn but do not affect the tops of the trees.

This action guarantees the conservation of the black pine's habitat, maintaining structures with a low fire load in the bottom strata and an arboreal stratum of mature trees.

This action consists of:

- ▶ **Emulating the natural dynamic** of low-intensity fire by means of **prescribed burns*** in areas that show signs of maturity and of the effects of natural fires and which, however, currently present a fire load in the bottom strata that could pose a threat to the black-pine's survival in the event of a natural or human-induced fire.



Fire prescribed by the GRAF units (Forestry Action Reinforcement Group) of the Fire Department of the Government of Catalonia.

Photos: Jordi Bas



*** Prescribed burn:** A prescribed burn is the controlled application of fire to a species in specific weather, fire load and topographic conditions, with the aim of achieving a specific objective, such as forest fire prevention management, facilitating the regeneration of a plant species or for grazing.

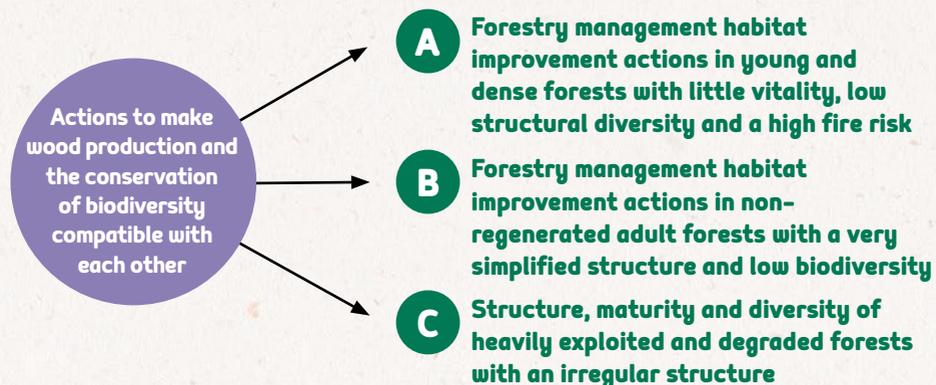
3.3 The actions required to make wood production and the conservation of biodiversity compatible with each other

Productive, social and environmental functions must be developed in such a way as to be compatible with the conservation of viable populations of the plant and animal species that are characteristic of our forests.



Photo: Jordi Bas

The forestry-improvement actions that have been implemented with regard to making the production of wood compatible with the conservation of biodiversity are as follows::



A Forestry management habitat improvement actions in young, dense forests with little vitality, low structural diversity and a high fire risk

Many *Pinus nigra* forests are populated by young trees which are a result of the species' natural regeneration in what used to be pastures or farmland. These forests are:

- ▶ very dense structures
- ▶ fragile and somewhat unstable forests with little biodiversity
- ▶ highly vulnerable to droughts and forest fires

Without any **forestry enhancement interventions** these forest stands are unlikely to progress to more mature and heterogeneous stages that are conducive to biodiversity and the heterogeneity of plant life and microhabitats (dead wood, cavities) and resilience in the face of disease, plagues and adaptation to global change.

These actions consists of:

- ▶ Tree-clearing in order to improve tree vitality, regeneration capacity, stability, fire-resistance and quality of habitat. Moreover, they are a key part of adaptive management in the face of climate change for the management of natural **conifer*** forests



Tree-clearing work in young, dense black pine masses.

Photo: Jordi Bas

* **Conifer:** plant species that disperses its seeds through pine cones.

B Forestry management actions to improve the habitat of adult forests that have not regenerated and have a very simplified structure and low biodiversity

If we are to guarantee the conservation of pine groves or forests, it is imperative that we also guarantee sufficient **natural regeneration** of the black pine as a dominant species, since this largely conditions the habitat's structure.

The natural regeneration of the species in many areas of its habitat is **non-existent or very limited** due to historical processes.



Photo: Jordi Bas

In the face of this **lack of regeneration** we may choose to either wait until it occurs naturally in the future, when the environmental conditions so permit (when dead trees open up clearings, a low-intensity fire that merely burns the undergrowth occurs, etc.), or we can bring it about ourselves by means of **different interventions**.

Habitat improvement forestry management actions consist of:

- ▶ Clearing trees in order to promote the growth of trees in the future and biodiversity, leaving some of the felled trees on the ground to be decomposed by fungi and invertebrates.
- ▶ Tree girdling, which consists of the removal of a full strip of bark of about 10 centimetres and the outer wood of the tree with a saw or an axe. This will cause the tree to weaken and die within a few years. The purpose of girdling is to reduce competition without actually removing the tree (for example, in situations where access is difficult, where there is a great deal of ongoing regeneration, etc.) and to promote diversity.

The girdled tree will gradually decay over the years and may be colonised by fungi, moss, lichen and **saproxyllic*** invertebrates. It will be a magnificent place for woodpeckers to nest. Old woodpecker nests can be reused by other birds, bats and other animals. Moreover, the bark will gradually become detached, providing shelter for bats.

* **Saproxyllic:** saproxyllic organisms are those that depend on dead wood for part of their life cycle.



The process of girdling a black pine to regulate competition between trees and promote biodiversity. Photo: Jordi Camprodon

C Improving the structure, maturity and diversity of heavily exploited and degraded forests with an irregular structure

The black pine, being a species that lives in semi-shade, is the species of pine tree with the greatest ease of regeneration of all high pine trees under the cover of high trees. This facet, linked to the type of management that has traditionally been implemented in Catalonia, has led black pine forests to be structurally irregular.

In order to improve the structure of this type of over-exploited and degraded woodland, several types of **action** are called for.



Photo: Jordi Bas

Habitat improvement forestry management actions consist of:

- ▶ Generating dead wood, both standing and lying on the ground, in order to improve the forest's ecological complexity and biodiversity.
- ▶ Mixed clearing and targeted felling in small forests to condition the growth of the forest and channel it towards long-and medium-term structural maturity stages, while also achieving greater overall stability of the arboreal stratum.
- ▶ Reducing the danger of forest fires by means of selectively felling ladder fuel and by increasing resilience to climate change.



Forestry improvement work.

Photo: Jordi Bas

3.4 Action that needs to be taken to prevent big forest fires

The improved analysis and study of the **behaviour patterns of big fires** has made it possible to establish a methodology to determine the key locations that condition the movement and the ultimate extent of these fires. These locations, known as **strategic management points (SMP)** make fire-fighting easier by concentrating resources in places where safer and more effective control operations can be implemented.

The main objective is to reduce the risk of **big forest fires (BFF)** in black pine habitats by means of interventions at the strategic management points (SMP). Once the treatment has been completed in the SMP, the resulting black pine forest structures will guarantee a fire behaviour that should be easier to control with extinguishing devices and will help to reduce devastating high-intensity fires that spread through treetops.

The prevention work will consist of the implementation of SMP zones for:

- ▶ Forestry treatment: low-level tree clearing, pruning of leafy trees to a height of 2 m, selective felling of **ladder fuel***. Part of the trees cleared are girdled or are left there to generate dead wood.
- ▶ Prescribed burns implemented to reduce the accumulation of forest fuel.

The **objective** of these actions is to generate black pine forest structures that are resistant and resilient to BFF and above all help to reduce the intensity of fires that may break out in the area.



Burns prescribed by the GRAF units (Forestry Action Reinforcement Group) of the Fire Department of the Government of Catalonia. Photos: Jordi Bas

* **Ladder fuel:** Woody undergrowth species that climb up to the tree tops and allow the fire to spread to the arboreal stratum.

3.5 How to perform ecological follow-up of conservation actions

Ecological follow-up consists of making plant and animal life forestry inventories. The purpose of these inventories is to **evaluate the impact of the actions** that we have previously described on the structure of the habitat, biodiversity, vitality and vulnerability to big forest fires. In other words, follow-up is necessary in order to know **to what extent the actions have been effective** and how the different organisms have responded to the changes in the habitats (felling, prescribed burns, dead wood left lying, etc.).

The following actions are required to carry out this assessment:

- ▶ **E**Make inventories over time: before the forestry improvement work and the prescribed burns and then after a certain time (1 or 2 years).
- ▶ **M**ake inventories in nearby areas where no work has been conducted to verify whether there have been any changes compared to areas where work has been done.

The areas where actions are performed are known as **experimental zones or plots**, and **control or reference zones or plots** if no work is performed.

Forestry ecosystems respond slowly to changes, following the rate of growth of the vegetation. Therefore, follow-up must be regarded as long-term, and be evaluated every 2, 5 or 10 years.



Example of a logical follow-up actions: measuring the diameter of tree trunks and of dead wood. Photos: Jordi Bas and Jordi Camprodon

Besides **follow-up over time**, ecological or biodiversity inventories also help to compare differences between habitats. Differences may be found in:

- **the structure of the forest:** species of trees, abundance depending on size, soil cover by grass, bushes, trees, the presence of saplings, etc.
- **plant species of special interest:** rare or endangered.
- **animal groups:** such as birds, bats, butterflies, invertebrates that inhabit the dead wood and soil.

All this information is highly valuable for ascertaining biodiversity in the forest and to see how it responds to changes in habitat.



Installation of roosting boxes for bats in order to monitor populations of these animals, and as a conservation measure.

Photo: Jordi Bas



Observation of animals to detect and assess populations of endangered species, such as the booted eagle.

Photo: Jordi Bas



APPENDIX. Actions to be taken into account in order to protect and improve biodiversity in forestry work

Photo: Jordi Camprodon

Actions on trees

- ▶ Preserve trees with **woodpecker nests**, particularly those that contain multiple cavities, regardless of whether the trees are dead or alive. Woodpeckers are the only birds that can dig a nest inside trees. Once they abandon them, they can be used by other birds, such as tits and wood nuthatches, and other animals such as bats, dormice, genets and numerous species of invertebrates.
- ▶ Preserve all trees with **platform nests*** of interest for birds of prey, such as the sparrow hawk, goshawk or booted eagle, as well as the circle of trees around the nest. Avoid opening up new paths and trails near the nests.
- ▶ Preserve adult trees whose **main trunk forks upwards**. These branches, somewhat uncommon, are of great interest for bats in order to form cavities, used, for example, for long-eared bat breeding colonies. Without this forked trunk it is difficult to form shelters, since it is difficult to make natural cavities among conifers that are suitable for animals other than the woodpecker.
- ▶ Maintain **at least 10 trees/ha** that evolve naturally in the black pine forest. Preferably thick reserve trees should be maintained to promote biodiversity. They may include trees with cavities which are decrepit or have dead branches, forked trees, trees with malformations or with bird of prey platform nests.
- ▶ Provide **roosting boxes for bats**, particularly if there are rare or endangered species or for the biological fight against pine processionary.
- ▶ Maintain a **proportion of oaks, maples** and other deciduous trees and all the old and large oaks (or other leafy trees) scattered throughout the forest.



Bechstein's bat, typical of mature forests with tree holes.

Photo: Jordi Bas

* **Platform nests:** large constructions of thin branches that are reused every year as nests by birds of prey and crows.

Actions on dead wood

- ▶ Maintain a sufficient proportion of **dead wood, either standing or lying on the ground**, of all types and stages. The amount to be left will be adapted in each case to the characteristics of the forest stand and depending on the inventory data available for reference stands of a similar structure.
- ▶ If there is seen to be little dead wood, **some of the trees can be girdled**, selected from the ones that have to be felled during clearing work. One alternative is to **fell them and leave them lying on the ground**, for example, near the trails. Similarly, some high stumps (about 50 cm) can be left in the stand. Birds, rats, fungi, moss, lichen, beetles and other invertebrates may occupy the dead wood throughout the decomposition process. These dead trees may eventually contain more life than when they were alive.



Old stump covered with moss.

Photo: Jordi Camprodon



The girdling process in a black pine.

Photo: Jordi Bas



Fungal growth on dead wood.

Photo: Jordi Camprodon



Black pine trunk felled with high stump and left lying down.

Photo: Jordi Camprodon

Actions on endangered plant life

- ▶ Do nothing in stands where plant populations threatened with extinction have been detected.
- ▶ Avoid the extraction of wood above rocky substrates, the habitat of **endemic*** or endangered plants. For example, *Armeria fontqueri*, *Biscutella laevigata* subsp. *fontqueri* or *Paeonia officinalis* subsp. *microcarpa*.

Actions on the undergrowth

- ▶ When the undergrowth is cleared to prevent fires, a **maximum cover of 25%** must be maintained, as well as bushes over 1.3 m high and which include:
 1. **Species of biogeographical interest** (e.g. *Rosa pimpinellifolia*, *Prunus mahaleb* and *Rhamnus alpina*).
 2. **Woods species that yield fleshy fruits** (*Crataegus*, *Rubus*, *Rhamnus*, *Sorbus*, *Prunus*, etc.).
 3. **Trunk-climbing ivy**. These climbing plants are very important for pollinating insects, as food in winter for animals (fruit) and as shelter for birds, mammals and invertebrates.
 4. **High and dense shrubs distributed over the cleared surface area**. These shrubs should be maintained as they provide shelter for birds that breed in thickets as well as for mammals and nidifugous chicks.
- ▶ Protected wood species (e.g. *Taxus baccata* and *Ilex aquifolium*) should never be felled.

Periods for carrying out work

- ▶ Forestry work should preferably be done **outside the breeding season for protected species**.

* **Endemisms**: organisms that live in relatively small geographic areas. For example, we talk about the endemisms of Els Ports, Pyrenean or Iberian endemisms, etc.).



Black pine forest in the mist.

Photo: Jordi Bas



Black pine wood undergrowth with leafy growth.

Photo: Jordi Bas

For further reference...

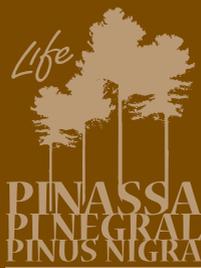
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