



Sandalwood Management Plan



fpc Forest Products
Commission

Acknowledgement

The Forest Products Commission (FPC) acknowledges the Wongatha and Yamatji Peoples that are the Traditional Owners of the arid sandalwood lands and Western Deserts. We respect the Elders past, present and emerging.

Further detail of the FPC's commitment to first Australians is available in the FPC's Reconciliation Action Plan (FPC, 2021-22).

Feedback Feedback and comments on this document can be directed to:

Forest Products Commission

Phone: +61 8 9363 4600

Fax: +61 8 9363 4601

Email: certification@fpc.wa.gov.au



Contents

Introduction	4
Legal and other requirements	8
Scope	10
Biodiversity	12
Ecosystem health and vitality	15
Soil and water	17
Carbon cycles and climate change.....	18
Productive capacity	19
Socio-economic benefits and impacts	28
Heritage	33
Plan implementation and management.....	34
References	35
Appendix 1. Legal requirements.....	38

Executive Summary

The scope of the Forest Products Commission's (FPC) Sandalwood Management Plan (SMP) covers the management of wild sandalwood on Crown lands in Western Australia, to which the FPC has access to, and also covers aspects of management of the FPC's plantation sandalwood estate.

Biodiversity

The SMP outlines the conservation of biodiversity in accordance with legislation and other requirements. Measures include thorough pre-harvest planning incorporating management recommendations from the Department of Biodiversity, Conservation and Attractions (DBCA).

Ecosystem health and vitality

Factors such as fire, weeds and pests may impact on ecosystem health, resulting in economic and environmental loss. In collaboration with the DBCA the SMP outlines the measures taken to control significant threats.

Soil and water

Soil and water quality impacts on rangeland ecosystem health and productivity. To protect soil and water resources, the SMP outlines the relevant requirements.

Climate change and carbon cycles

The SMP outlines the potential impact of climate change and the estimated carbon stores of ecosystems and plantations.

Productive capacity

The SMP outlines measures to ensure a sustainable rate of harvesting to maintain the productive capacity of the wild sandalwood resource. The FPC seeks to promote improved resource utilisation, to help manage the impact of disturbances, and to conduct regeneration activities. An outline of sandalwood plantation management is provided.

Socio-economic benefits and impacts

The effective maintenance of the sandalwood resource delivers social and economic benefits to society, particularly to regional and Aboriginal communities. The FPC proposes to engage effectively with a range of stakeholders to sustain and enhance the socio-economic benefits of the sandalwood industry. Threats to the industry include the illegal harvesting of sandalwood.

Heritage

The FPC has a responsibility to ensure its activities do not negatively impact Aboriginal and non-Aboriginal heritage. Prior to disturbance, checks are completed for heritage sites and appropriate management actions taken. The FPC contracts heritage service providers to advise the FPC on Aboriginal heritage and culture and where appropriate, engages Aboriginal People on behalf of the FPC.

Plan implementation and management

The FPC seeks to ensure its management practices are continually improved to ensure best practice. This is achieved through training and the transfer of knowledge, adaptive management, stakeholder engagement, and internal as well as external auditing.

Introduction

The FPC's vision is to build and maintain a sustainable and commercially viable forest products industry that provides economic (*Figure 1*) and social benefits to the people of Western Australia (WA). This vision is supported by the FPC's [Policy 9 Forest Management](#) (FPC, 2021).

The FPC's wild sandalwood operations are certified to the [Australian Standard for Sustainable Forest Management \(AS4708:2013\)](#), the PEFC Standard for Chain of Custody for Forest and Tree Based Products 2002:2013 and to ISO 14001 Environmental Management System (EMS).

In outlining the way in which the wild sandalwood resource is managed, this Sandalwood Management Plan (SMP) references the FPC's role in the industry, as well as the role of the Department of Biodiversity Conservation and Attractions (DBCA), who have overall responsibility for the sustainable management of the wild sandalwood resource. Further, this SMP provides a summary of the FPC's management of the plantation sandalwood resource.

In May 2014, the sandalwood industry was the subject of the Legislative Council's Standing Committee on Environment and Public Affairs [Report 35: Inquiry into the Sandalwood Industry in Western Australia](#) (Environment and Public Affairs Committee, 2014). This review made several recommendations to improve the future regulation and sustainability of the industry - review of the Sandalwood Order 1996 (harvest limits), regeneration, licensing, illegal harvesting and reassessment of the current industry structure. The FPC continues to work collaboratively with the DBCA and stakeholders across the State towards addressing these recommendations.

Following extensive consultation with stakeholders, the FPC has developed a new industry structure that aims to provide:

- market stability;
- opportunities for new entrants in the industry;
- employment and investment opportunities in regional Western Australia;
- greater Aboriginal involvement in the industry; and
- a smooth transition to a mixed wild and plantation-based industry into the future.

The [new industry structure](#) for the sandalwood market arrangements has taken into account the views of community and industry stakeholders, and broad government objectives to position the industry for a long, viable future. This has included the Sandalwood Taskforce Report to promote the advancement of Aboriginal economic development.

The FPC has also developed the [Native sandalwood industry strategy for Western Australia](#) (FPC, 2017). It is our objective to maintain a vibrant native sandalwood industry that will add significant value to economic, environmental and social outcomes, particularly for regional communities within the areas of natural sandalwood distribution.

Sandalwood management plan

The Strategy outlines six steps to revitalise the sandalwood industry to create better outcomes for regional communities, namely:

1. Investment for industry participation in regional and Aboriginal communities.
2. Enhance value through best practice certification.
3. Protect the industry from illegal harvesting.
4. Ensure the sustainability of wild Western Australian sandalwood now and for the future.
5. Promote the value of Western Australian sandalwood in the community.
6. Encourage industry innovation.



Figure 1 – Sandalwood oil is a valuable commodity

Legal and other requirements

Licensing for the harvesting of sandalwood is managed by the DBCA under the *Biodiversity Conservation Act 2016*. This legislation replaces the Wildlife Conservation Act 1950 and the Sandalwood Act 1929. The new legislation enforces tougher penalties for illegal activities (including unlicensed harvesting) as well as improving trading and processing accountability.

The commercial harvesting of sandalwood (Figure 2) on Crown land is controlled under the *Forest Products Act 2000* and the *Biodiversity Conservation Act 2016*. The FPC is responsible for the commercial harvesting, regeneration, marketing and sale of wild WA sandalwood from Crown land (including land subject to pastoral leases).

The sandalwood harvest limit is prescribed in the Sandalwood (Limitation of Removal of Sandalwood) Order 2015 (Sandalwood Order) and is set on advice from the Minister for the Environment and approved by the Governor in Executive Council. The Sandalwood Order took effect on 1 July 2016.

The FPC is governed by the *Forest Products Act 2000* and sections of the *Forest Management Regulations 1993*. Section 12 of this Act requires the FPC in undertaking its activities to ensure:

- i. the long-term viability of the forest products industry; and
- ii. the principles of ecologically sustainable forest management are applied in the management of indigenous forest products located on public land.

Export licences for WA sandalwood are issued in accordance with the Commonwealth *Export Control Act 1982* and any associated conditions.

Under the *Native Title Act 1993*, Crown land is subject to native title rights. This Act recognises that Aboriginal people were the original inhabitants of the land before European settlement. In Crown land locations where a pastoral lease is in place, native title is deemed to co-exist with other land use rights. In these locations, land use decisions must be negotiated with traditional owners.

The FPC aligns its management of the wild sandalwood resource to the [Western Australian sandalwood industry development plan 2008-2020](#) (FPC and ASN, 2008) as well as the Industry Strategy for the Wild Sandalwood resource 2016-2026, which covers in its scope both development of the wild sandalwood industry and plantation resource.

The FPC structures its operations in line with the Safety health code for native forest hardwood logging and plantation logging (FIFWA, 2016), as well as the Code of practice for timber plantations in Western Australia (FIFWA, 2014).



Figure 2 – Harvested sandalwood prepared for transport

Scope

WA sandalwood occurs naturally in the southern two thirds of WA and into South Australia. The total geographic range of the wild WA sandalwood resource is shown in Figure 3 . Of this area, the FPC has access to approximately 14 million hectares in the goldfields and southern rangelands. Further, the FPC has approximately 6,000 hectares of WA sandalwood plantations extending from Geraldton in the north to Esperance in the south-east.

This SMP covers the management of wild sandalwood on Crown lands in Western Australia, to which the FPC has access via licences to harvest within specified annual limits under the Sandalwood (Limitation of Removal of Sandalwood) Order 2015, and also covers aspects of the FPC's plantation sandalwood (*Santalum spicatum*).

Management of the wild sandalwood resource is considered as a whole. At the landscape level this is managed in accordance with Ecologically Sustainable Forest Management (ESFM) principles, as based on the Montreal Process framework.

The FPC's Defined Forest Area (DFA) for the management of sandalwood resources is in line with the for Chain of Custody of Forest and Tree Based Products PEFC ST 2002:2013. It includes:

- Wild Sandalwood areas listed on the annual Flora Supplying (Sandalwood) Licence.
- Plantation sandalwood operations

WA sandalwood trees located in areas approved for clearing as permitted under the *Environmental Protection Act* 1986 (usually for the purpose of mining or road construction) will be salvaged and included within the FPC's harvest quota. Typically, the FPC obtains 1 to 2 percent of its annual harvest quota from approved salvage operations.

DFA maps for the sandalwood resource are available on the FPC's website. These are updated annually or following significant change.

The FPC's internal procedure outlining certification scope is [Procedure 55 – Defined Forest Area](#).

..

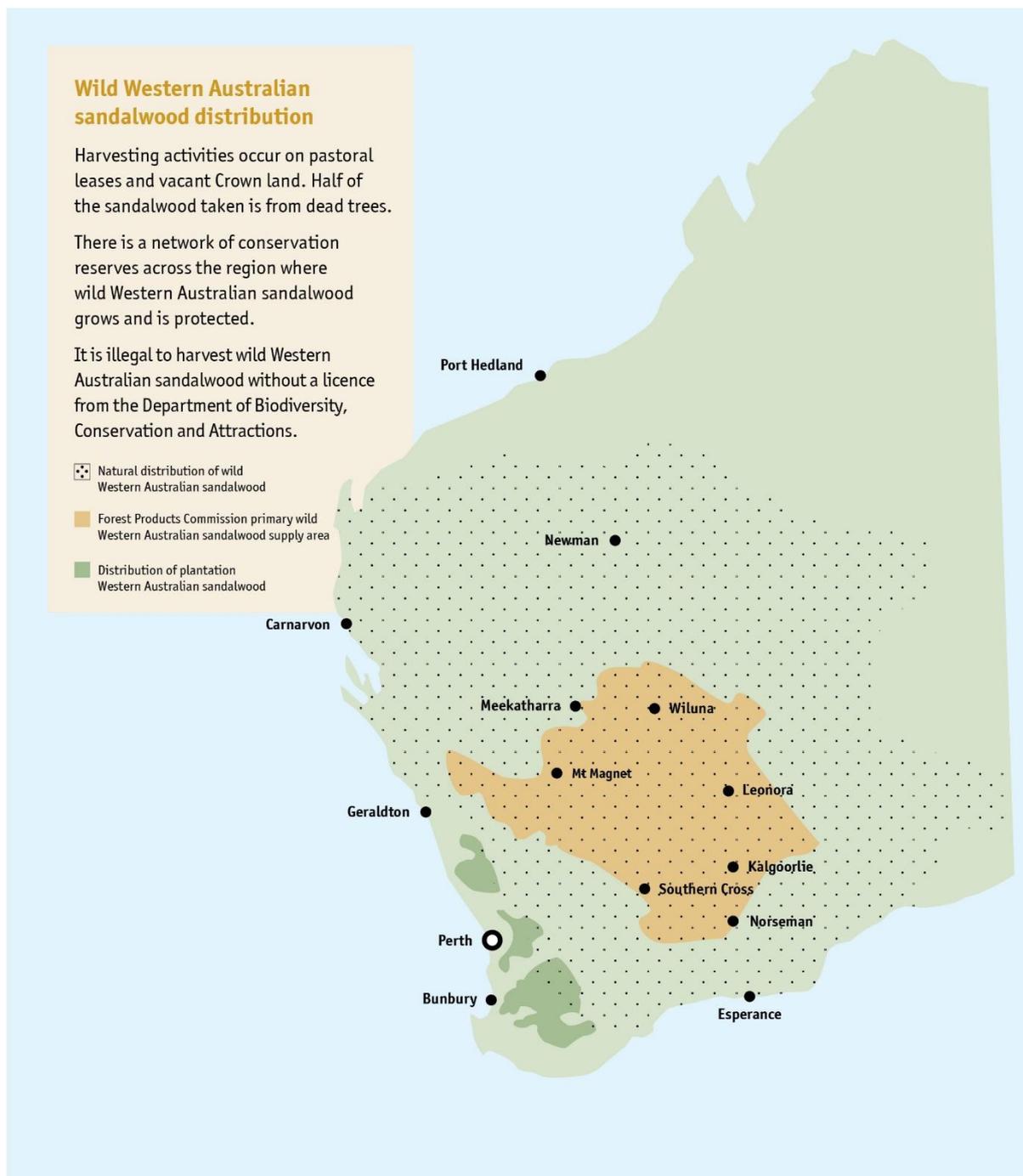


Figure 33. Geographic range of the wild and plantation sandalwood resource

Biodiversity

Biodiversity ‘...refers to the variability in structure and function of living organisms and the ecosystems in which they are a part’ (Conservation Commission, 2013, p.29). WA sandalwood occurs across a number of bioregions and sub-regions (as identified in the Interim Biogeographical Regionalisation of Australia, IBRA). The total area accessed in the FPC’s operations each year represents about 0.3% of the related bioregions.

Wild sandalwood is protected through conservation reserves, comprised of approximately 21 million hectares managed by the DBCA. This area occurs within sandalwood’s natural distribution. Conservation reserves, with the exception of one location (Credo station), are unavailable for commercial harvest.

A comprehensive review of the condition and representation of vegetation systems within the southern rangelands provided the basis for defining a Comprehensive, Adequate and Representative (CAR) reserve system (Brandis, 2008).

Some of the reserve area has been harvested and impacted by grazing and fire events, whereas others have minimal impact from these pressures. The DBCA is responsible for maintaining and improving the reserve system. The FPC has expanded its regeneration program to include agreed areas within existing and proposed conservation reserves that are suffering depletion of sandalwood.

Genetic variation has been recorded between populations of sandalwood growing in the northern areas (150 to 250 mm mean annual rainfall) and southern areas (250 to 650 mm mean annual rainfall) (Byrne *et al*, 2003). The reserve system has been selected to include representation of genetic diversity

Forest types

WA sandalwood (*Santalum spicatum*) is a slow-growing hemi-parasitic, long-living small tree that occurs naturally in the southern half of the State. It typically grows to four metres in height with a stem diameter of 200 millimetres at 150 millimetres above the ground (*Figure 4*). Exceptional examples may grow to ten metres with a stem diameter exceeding 400 millimetres.

WA sandalwood is a root hemi-parasite requiring suitable host plants from the seeding stage through to maturity. Sandalwood roots connect to host roots through structures called haustoria. Each haustorium can be up to two centimetres in length and individual sandalwood can have hundreds of connections. The haustoria help the sandalwood tree gain water and nutrients from the host. WA sandalwood generally prefers nitrogen-fixing host plants, particularly from the genus *Acacia*.

Sandalwood management plan

Within the rangelands, sandalwood grows on a range of soil types and with a variety of plant species, and the best stands are often found where there is mix of vegetation types (Loneragan, 1990; Kealley 1991).



Figure 4. Western Australian sandalwood (*Santalum spicatum*) tree in the wild

Protection of flora, fauna and ecological communities

In Western Australia, the *Biodiversity Conservation Act 2016* provides for the conservation and protection of native plants (flora) and animals (fauna). The Act allows the Minister for Environment to declare a higher level of protection to flora, fauna and ecological communities that are likely to become extinct, are rare, or otherwise in need of special protection. These listings are reviewed annually. The *Environmental Protection and Biodiversity Conservation Act 1999* also contains provisions relating to the protection of nationally listed threatened flora, fauna and ecological communities.

Wild WA sandalwood (*Santalum spicatum*) is not listed as either threatened or priority flora, but under the *Biodiversity Conservation Act 2016* all native flora including any part of it, is

protected. The taking of flora, including for the sale of native flora from private property, requires a license from the DBCA.

Threatened flora and fauna are ranked according to their level of threat using the International Union for Conservation of Nature (IUCN) Red List categories and criteria. The rankings include (DBCA, 2019):

- CR: Critically Endangered – *considered to be facing an extremely high risk of extinction in the wild.*
- EN: Endangered – *considered to be facing a very high risk of extinction in the wild.*
- VU: Vulnerable – *considered to be facing a high risk of extinction in the wild.*
- CD: Conservation dependent fauna - *fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.*
- OS: Other specially protected fauna - *fauna otherwise in need of special protection to ensure their conservation.*

Species may be listed as Priority where there is insufficient information for them to be assessed as threatened. Priority listed species are ranked for evaluation of conservation status with Priority 1 (P1) being the highest, down to Priority 5 (P5). Priority categories are defined in the document titled [Conservation Codes for Western Australian Flora and Fauna](#) (DBCA, 2019).

Ecological communities are defined as ‘*a naturally occurring biological assemblage that occurs in a particular type of habitat*’ (DEC, 2013, pg. 1). As for individual species, they can also be listed as Threatened or Priority with category definitions and criteria described by the [DBCA](#).

Prior to any disturbance activities, a check for the presence of threatened and priority flora, fauna and ecological communities is undertaken using databases managed by the DBCA. If any are identified within or in proximity to the disturbance area, further action is taken under the direction of the DBCA (for example a field survey may be required). Management strategies are implemented in accordance with the DBCA’s instructions. Contractors must report sightings of threatened and priority flora, fauna and ecological communities to the FPC Authorised Officer.

Ecosystem health and vitality

Maintaining ecosystem health and vitality is essential for a range of forest values including ecosystem functions and processes, biodiversity and cultural heritage.

Sandalwood distribution is principally influenced by the presence of suitable hosts, soil moisture, mechanisms of seed dispersal and fire history. These factors are frequently masked by long-term drought and grazing impacts of domestic and feral stock.

Fire

Sandalwood is vulnerable to wildfire (Loneragan, 1990). Wildfire on Unallocated Crown Lands outside towns is managed jointly by the DBCA and local authorities. The DBCA is responsible for fire management on conservation reserves, whilst fires on private, leasehold or pastoral land falls to the responsibility of the temporary or private landholder.

FPC contractors must comply with harvest and vehicle movement ban declarations. The FPC also ensures firebreaks are maintained around camps, landings and bark heaps.

Pests

A major threat to ecosystem health and vitality is the impact of feral animals on native wildlife and regeneration efforts. The DBCA runs a successful program called Western Shield, which uses 1080 poison baits to control foxes to help protect native wildlife. These baits are placed in both conservation reserves and areas available for harvest. Native wildlife is not harmed by the baits. Domestic animals are strictly prohibited from accessing conservation reserves, and the FPC does not allow domestic animals on worksites without prior written consent. Western Shield is also integrating the feral cat bait, Eradicat® (also containing 1080) with fox baiting to reduce the impact of feral cats on native fauna.

Crown reserves and Unallocated Crown Land are free from grazing by domestic stock, but are exposed to feral goats, especially where natural water is present. Goat numbers are often higher in the north-west region.

Feral goats have a considerable impact on vegetation composition, cover and health which in turn can lead to increased erosion and habitat destruction. Goats have been shown to damage sandalwood by severely browsing leaves and breaking branches up to 1.8 metres above ground level. Control measures for feral goats include fencing, shooting and the management of water points.

Fencing from grazing has shown to increase both survival and development of sandalwood seedlings (Loneragan 1990; Brand 2000). Data from a long-term sandalwood trial at Ninghan station (near Paynes Find) showed that seedling survival within plots fenced to exclude grazing by feral and domestic herbivores (including sheep and goats) was more than twice that of unfenced plots, after 17 years (Brand *et al.* 2014).

Weeds

Weeds within areas outside of pastoral leases where wild WA sandalwood occurs are managed through the DBCA (refer to the [DBCA's website](#)). Advice is sought from the Department of Primary Industries and Regional Development (DPIRD) with regards to declared weeds.

Heavily disturbed sites are hotspot areas for weeds. As FPC contractors can potentially spread weeds through machinery, they must follow hygiene practices to minimise the risk of spread. Some conservation areas require vehicles to be clean on entry (free of weed bearing material) prior to entering as a precaution.

The FPC is responsible for weed control within its plantations. It is vital that weeds are strictly controlled in the first few years of plantation establishment, then monitored as part of regular plantation inspections and any necessary control measures implemented.

Disease

Dieback caused by the pathogen *Phytophthora cinnamomi*, in the higher rainfall areas of south-west WA is not regarded as an issue in the semi-arid regions. No other diseases are known to impact WA sandalwood.

Soil and water

The FPC manages risks to soil and water values through its independently certified Integrated Forest Management System. This system includes ensuring strict controls and monitoring for the risks of oil or fuel spill, soil disturbance, compaction and erosion, waste and equipment.

Specific measures for the protection of water courses are prescribed within operational procedures. For example, refuelling of equipment or road construction is prohibited near water values.

Before a sandalwood operation commences, harvest exclusion areas are clearly identified. This includes fragile landscapes, rock outcrops and soil and water values such as lakes, swamps and other forms of wetlands. Buffer zones are also implemented where required.

Road construction and maintenance forms the majority of the FPC's infrastructure in the sandalwood Defined Forest Area. This includes roads, temporary access tracks and bush movement tracks. Preference is given to using existing tracks, such as pastoral access tracks, fence lines and mineral exploration tracks. Where new tracks are constructed, they must not interrupt natural water movement patterns and use natural openings in the sandalwood landscape. Bush movement tracks must be blade up to minimise vegetation impact, and contractors are required to avoid multiple passes over the same area where there is a likelihood of causing compaction and/or rutting.

Roads and tracks are demarcated and mapped, and their condition is recorded prior to any work commencing. This information is provided to the contractor during the pre-operation briefing.

To manage erosion, adequate control measures are put in place on access tracks, where there is a need due to gradient. During harvesting, if heavy rainfall (>25 millimetre) is imminent, erosion control work must be completed. Any damage to roads is repaired by contractors, and deteriorated roads are not to be used until the road is repaired.

Soil disturbance during harvesting operations is mainly caused by the operation of heavy machinery. The FPC monitors the extent of soil disturbance and an incident report is raised if the disturbance exceeds defined thresholds.

Carbon cycles and climate change

Future climate projections to the year 2090 indicate a trend toward decreasing winter rainfall and elevated summer temperatures across the majority of the FPC supply areas (CSIRO and Bureau of Meteorology, 2015).

Lack of winter rainfall is a significant impediment to both natural and planted sandalwood regeneration. Rainfall associated with wild sandalwood in the semi-arid regions of central WA, varies from about 100 to 400 millimetres per annum with a great variation in both location and timing. Rainfall affects seed production, germination and survival.

There is limited information of the effect of drought on the survival of mature sandalwood populations. Population mortality of greater than one percent per annum in large trees in some regions has been recorded (Brand *et al.*, 2014).

The FPC has a regeneration key performance indicator which is to be reported at the end of the 2016 to 2025 period. The review of regeneration performance after 10 years is appropriate because of the fluctuating likelihood that any given year will receive the minimum rainfall for establishment. Reporting any year in isolation does not account for annual climate fluctuations impacted by three to seven year *El Nino* and *El Nina* cycles (BOM, 2015).

In the semi-arid regions, an estimated 10 to 20 tonnes of carbon per hectare is stored in the trees, roots, wood debris, branches and shrubs of all plant species (Berry *et al.*, 2010). This means, there is approximately 164 million tonnes of carbon stored in the native vegetation across the wild WA sandalwood estate that is harvested.

The FPC sandalwood plantation estate, established on previously cleared farmland, is approximately 6000 hectares and will contain approximately 40 tonnes of carbon/hectare at age 25 years (source Wheatbelt Natural Resource Management, WA), which equates to approximately 236,000 tonnes of carbon.

Productive capacity

Wild sandalwood

The FPC wild sandalwood supply area is divided into three geographic regions, namely north-east, north-west and south (*Figure 5*). These regions were defined by cross referencing CSIRO's IBRA bioregions with observed grazing impacts and controls (hence the status of regeneration and future growth).

These regions have been subject to extensive inventory that has provided important data to help define the correlation of geology, soil and vegetation with occurrence of sandalwood, distribution of tree size and condition of the standing resource within these regions. In addition, this inventory data has supported an understanding of regeneration and recruitment processes within the sandalwood population. These are fundamental to being able to regulate the harvest and pursue objectives related to sustainable management of the resource.

Modelling of the WA sandalwood resource has been undertaken using data collected from over 1,300 inventory plots within these regions established between 2001 and 2011. *Figure 5* shows the regions used for inventory analysis and the likely occurrence of sandalwood based on plot analysis. Datasets from these zones provide the basis for estimating and regulating the yield of wild WA sandalwood.



Figure 5: Concentration of sandalwood in the FPC supply areas

Standing resource (growing stock)

Table 1 provides the inventory estimate of the total sandalwood resource on available land tenures. It does not include resource estimates for those land tenures where harvesting will not occur (e.g. the existing and proposed conservation estate), or for sandalwood outside the FPC's three sandalwood regions.

Table 11: Inventory estimate of the total sandalwood resource on available land tenures

	Available Resource at 1/1/2016			Tonnes harvested 1/1/2016 to 30/06/202130/06/2021	
	Hectares	Green	Dead	Green	Dead
Total	14 222 000	164 000	90 000	4875	4287

The Available Resource figures are the available sandalwood area and volume estimates provided for the 2015 review of the Sandalwood Order on available land tenures. These estimates were based on extrapolated samples of measured trees with a circumference of greater than 400 millimetres (over bark) measured at approximately 150 millimetres above ground, and sample measurements of tree weight. The tonnes harvested are the totals removed to 30 June 2021 under the current Sandalwood Order.

Population structure

The minimum size for living wild sandalwood trees to be harvested is 127mm diameter or 400 millimetres circumference (over bark) measured at approximately 150 millimetres above ground. The frequency distribution of tree sizes across the areas available for harvesting is a key determinant of the potential total quantity of green wood that can be harvested (Herford *et al*, 2015).

Within natural populations of sandalwood in semi-arid regions of WA, regeneration levels are currently low or absent in a range of locations (Kealley, 1991, Brand *et al.*, 2014). Poor recruitment has been identified as a serious issue for the future resource management for some time (Kealley, 1991).

The FPC (as well as its predecessor, the Department of Conservation and Land Management) has engaged in long term research to understand the causes of this decline and the measures that might be implemented to provide for sustainable management.

The primary causes for regeneration failure are considered to be:

- Absence of small native marsupials, particularly the woylie (*Bettongia penicillata*) and boodie (*Bettongia lesueur*), which have been predated by feral cats and foxes (Burbidge *et al.*, 1988), that formally dispersed and buried seed (Murphy, 2005, Chapman, 2015).
- Severe impact from browsing and grazing by pastoral livestock and feral animals for more than 100 years, especially goats, sheep and rabbits (Loneragan 1990, Brand, 2000).
- Increased occurrence of drought, related to climate change.

FPC studies show that manually planting sandalwood near suitable host species and land systems, and in the absence of grazing, is critical to help sandalwood regenerate in much of its natural range in semi-arid WA (Brand *et al*, 2014).

The FPC actively plants sandalwood seeds back into rangeland areas (see *Regeneration – Operation Woylie*). Since 2011, the FPC has used mechanical seeding (Sawyer, 2013) to sow approximately 8-20 tonnes of sandalwood seeds per year into suitable areas in semi-arid WA. FPC's aim is to restore a regeneration cohort and maintain a representation of mature trees to assist in the recovery and persistence of WA sandalwood populations, including in areas harvested.

Sustained yield

The main purpose of the 2015 review of the Sandalwood Order was to determine an acceptable level of harvest for wild sandalwood from available areas. The review recommended that the annual quota be reduced from 3,000 tonnes to 2,500 tonnes of wood, representing a 16.7 percent reduction from the previous quota (Herford *et al*, 2015).

Over the ten year period of the Sandalwood Order, the FPC will harvest up to approximately 8 percent (11,250 tonnes) of the standing resource within the supply zones scheduled for harvest during this period (Herford *et al*, 2015).

The rationale for the levels of harvest are documented in Herford *et al*. (2015) and is based on robust inventory data for standing resource, which accounts for factors such as rates of growth, natural mortality and impacts from grazing (some areas have been excluded due to excessive feral animal activity). The Sandalwood Order is due to be reviewed by the end of 2024 with consideration given to the available plantation resource and any additional research findings and inventory results.

The FPC has a formal environmental performance indicator to monitor the harvest of green sandalwood and ensure harvest does not exceed the allowable cut detailed in the 2016 Order in Council (FPC, 2017). Further, the FPC undertakes remediation work as necessary to promote productive capacity, which includes re-seeding (if required) following unsuccessful regeneration.

The FPC conducts yield calculations and population modelling to ensure appropriate application of silviculture to sustain productive capacity. These calculations are refined over time to ensure quality datasets. The FPC records information from inventory plots and maintains records of harvest data. Inventory plots measure green (living) sandalwood including mature plants of potential harvest size, and dead sandalwood of a minimum dimension. Observations can also be made regarding factors such as vegetation type and condition, grazing pressure and weeds.

Sandalwood management plan

The FPC is investigating new technology to undertake further inventory work to continue to quantify the sandalwood resource in these regions and in those areas not previously assessed.

Harvesting

The FPC's silvicultural objective for harvesting is to maintain the regenerative capacity of existing wild WA sandalwood stands whilst protecting all other forest values.

Following pre-disturbance planning and approvals, exclusion zones (e.g. cultural heritage sites, rare flora or fauna) and operational boundaries are clearly identified.

The harvesting operation in an area may occur over several years. An operational camp is established where harvested sandalwood is stored and processed to accommodate the contractors and their employees.

The harvesting operation includes tree selection, removal of trees and roots, extraction of harvested material and the ripping and seeding of stump-holes.

Selected trees must be a minimum 127mm diameter (400mm circumference) at 150mm height.

Harvesting involves vertical whole tree extraction by a machine. This method allows the root material to be utilised, which provides a valuable sandalwood oil resource. Locations of each tree harvested are recorded with GPS. Harvested product is prepared and packed into racks or bins for transport (*Figure 6*).

After a tree is removed, three seeds are sown in each stump-hole.

The FPC Authorised Officer monitors operations and ensures that harvesting occurs systematically throughout the approved areas for harvest. Contractors are required to log the movements of their machinery throughout the harvest area using GPS. This is an important management tool to ensure operational compliance and to plan for regeneration.



Figure 6 – Harvested sandalwood prepared for transport

Since 2000, both improvements in harvesting and the development of new markets for a wider range of products have enabled significantly better utilisation. The improvements include vertical tree extraction, resulting in an estimated three-fold increase in root material harvested, and market acceptance of smaller branch material. Recovery of root material, which contains a high oil content increases the value of the overall product and reduces the number of trees harvested (FPC, 2017).

Regeneration (Operation Woylie)

The FPC's objective for sandalwood regeneration is to establish a cohort of young trees in areas in currently subject to harvesting operations, and additional areas that were previously subject to harvesting or where sandalwood is in decline (see also *Population structure*). At a minimum, each year 100 seeds are planted for each sandalwood tree harvested. In 2019 and 2020, this figure rose to over 200 seeds per tree harvested.

The FPC sources seed from plantations and wild sources. Seed is sorted and stored at the FPC's nursery and seed centre in Manjimup. Seed must be mature, de-husked, good quality and no more than two years old when it is sown. The FPC has reviewed the genetic diversity of sandalwood seed from the wheatbelt plantation genetics and the southern rangelands where most of the harvesting and seeding occurs. Byrne *et al* (2003b) reported that *Santalum spicatum* is thought to contain two main genetic groups: Northern region (Arid) and

Sandalwood management plan

Southern region (Semi-arid). For a relatively wide-spread species, it shows only moderate levels of genetic diversity compared to other Australian tree species.

The FPC aims to include wild collected seed in planting mixes to enhance genetic diversity. However this is not always possible due to trees not producing seed as a result of poor seasonal conditions. In recent times, drought conditions have meant that very little wild seed has been available. Irrespective of seasonal conditions the inefficiency of wild seed collection (widely dispersed trees with unreliable seed production) makes collection of the full annual requirement from this source impractical.

The quality/viability of seed from plantations is also generally greater than wild seed providing the best chance of achieving good germination and survival.

The FPC has also committed to seeding on conservation estate where harvesting does not occur. The FPC has recently undertaken seeding on Burnerbinmah DBCA conservation estate. As part of this seeding operation, we have collected all wild seed available from the conservation area and planted it, with the plantation seed, back into the area.

Regeneration operations are generally planned for areas where regeneration is likely to be successful – for example in areas not subject to extensive grazing pressure - to ensure the best results. Due to sandalwood's general low tolerance to fire, regeneration is targeted in areas where fire risk is low.

At present, the FPC has a sandalwood regeneration key performance indicator of establishing 50,000 seedlings annually, on average, as reported in the FPC's Annual Reports. The aim is to achieve sandalwood germination and survival that is greater than the number of trees harvested annually. The area receiving regeneration treatments will be approximately twice the area harvested over the same period. In 2018-19 and 2019-20 the FPC expanded its seeding program significantly and sowed over 20 tonnes of sandalwood seed each year.

Management for regeneration is based on the following key elements:

- The sowing of seed in freshly disturbed soil adjacent to host plants to imitate the behaviour of seed-caching marsupials.
- All seed is mature, de-husked, good quality and no more than two years old at the time of sowing.
- Ensuring the seeds are sown in soils and vegetation types that are suitable for sandalwood establishment and growth, and in areas where there is limited grazing pressure from domestic and feral herbivores.

A regeneration plan is developed and provided to contractors who undertake the work. The plan outlines the boundaries of the regeneration, exclusion zones, access tracks and GPS reference points for seeding runs. The FPC has designed and built its own seeding machine ('Woylie machine') that integrates ripping and seeding. Ripping the soil to 300 millimetres

depth will produce a significantly larger number of germinates compared to no ripping (Sawyer, 2013). Regeneration operations occur around January to April each year in preparation for the autumn rainfall. If necessary, fencing or other measures to control grazing are used to protect regeneration areas.

The seeding riplines are placed within the driplines of host plants. The seed is sown at a depth between 10 to 50 millimetres. Priority host trees are *Acacia* species including *A. accuminata* (jam), *A. anuera* (mulga) and *A. tetragonophylla* (curara).

During regeneration operations, regular inspections are conducted to ensure adequate host selection, ripping depth, and seed burial and placement are in accordance with the FPC procedures.

It is recommended to plant sandalwood seeds early in the year (February-March) to allow the seeds the maximum amount of time to germinate and establish during mid-autumn and winter (Brand and Sawyer 2016). Studies have shown that sandalwood germination is related to good rainfall events during April-August (Brand and Sawyer 2016, Brand 2017). Seeds can remain viable for up to three years after sowing. After good autumn/winter rains, sandalwood seeds normally require about 4-8 weeks to germinate and then another four weeks to emerge.

Seedling survival is monitored in the first summer after germination. If the survival target is not met, the number of seedlings is monitored annually for up to 5 years and re-seeding will occur if the target is not met by this time.

The annual program covers approximately 20,000 hectares spread over 5 to 10 separate locations. To date, approximately 1% of seed sown through this regeneration program result in established seedlings, but numbers are variable and good germination rates are dependent on good autumn/winter rainfall events.

Plantation sandalwood

The FPC in collaboration with the Australian Sandalwood Network has developed the [Sandalwood \(*Santalum spicatum*\) establishment guide](#) (FPC and ASN, 2018). This guide is based on 30 years of plantation research and experience and provides advice on how to grow plantation sandalwood in WA. The sandalwood guideline considers factors such as site selection, suitable host species, establishment, thinning, host-to-sandalwood ratio, grazing, pre and post plant weed control, fire management, seed production and rotation length.

In addition, the plantations are managed for forest health, including monitoring and treating pests and diseases.

Harvesting

At this stage the FPC has not commenced commercial harvesting of sandalwood plantations due to their age. Valuable aromatic heartwood and oils are produced within sandalwood trees from about age 10 to 15 years, but research indicates that it is better to wait until the

trees are aged approximately 25 years to obtain a greater proportion of heartwood and high quality oil (Brand *et al.*, 2007, Brand and Norris, 2017). The FPC plans to commence harvesting around year 2026, when the oldest plantations are at least 25 years of age.

Establishment

Establishing sandalwood in plantations is more complex than most tree species, as sandalwood is a root hemi-parasite. Sandalwood trees must be planted near suitable host trees, and extensive trials have shown that the best hosts are the nitrogen-fixing species, especially jam wattle (*Acacia acuminata*). Planting native sandalwood and hosts trees also has the added benefit of increasing the biodiversity levels on ex-farmland, with a variety of native fauna making use of these plantings for food and habitat.

Host species are selected based on site climatic conditions and soil type. *Acacia acuminata* is an excellent host, because it will grow on a range of soil types and is also relatively long-lived (15-30 years), so the majority of trees will support the sandalwood throughout the rotation.

Within the *A. acuminata* group, there are also different variants (including typical variant and narrow-phyllode variant). Using the *A. acuminata* variant that grows locally is normally the best option. Many other species can also be used as hosts, including mulga (*Acacia aneura*) and wodjil (*Acacia resinimarginea*). However, in general, it is recommended to have at least 50 per cent *A. acuminata* planted on the site.

As part of plantation establishment, site preparation may include ripping in rows, but this depends on the soil type, where mounding or scalping may be more suitable. Six-month-old host plants are planted at a density of approximately 1,000 stems per hectare. Generally, it is not until the host trees are about one to two years of age (or at least 1 metre in height) that the direct seeding of sandalwood near the host tree occurs.

Weeds need to be controlled within the early stages of the plantation. This is critical as competition from weeds can dramatically reduce sandalwood survival and growth. The plantations also need to be protected from grazing herbivores (such as cattle, sheep, goats, rabbits and kangaroos) for at least the first five years. Pests such as various insects and the red legged earth mite may also need to be managed.

The ratio of host-to-sandalwood should be managed to ensure the parasitic demands of the sandalwood can be accommodated throughout the life of the plantation. To achieve a good host-to-sandalwood balance, selective thinning of the sandalwood may be beneficial.

Socio-economic benefits and impacts

The FPC's contracts for sandalwood harvesting, regeneration and haulage; and sale for high-value oil production is estimated to be worth around \$245 million (over ten years) to regional economies.

Bringing value to wild sandalwood regions

Dutjahn custodians are an Aboriginal group that holds a 50 per cent share in Dutjahn Sandalwood Oils (DSO). DSO have a contract with the FPC to purchase oil grade wild sandalwood. The sandalwood oil distilled at Dutjahn's Kalgoorlie facility supplies local and international essential oil, perfume, cosmetic and pharmaceutical manufacturers.

In 2016, wild sandalwood industry contracts were restructured to expand regional development and create new opportunities for Aboriginal communities. However, the process demonstrated that fully communicating upcoming tenders and opportunities will not significantly increase the participation of Aboriginal businesses and communities in the industry. This is due to the current lack of business capacity of many living-on-country Aboriginal people to respond to tenders and demonstrate the infrastructure required to run a harvesting or haulage business.

Learning from the 2016 experience, in 2017, the FPC commenced a pilot program to address this issue by awarding a private treaty contract to the Goldfields Land and Sea Council to employ local Aboriginal rangers to harvest sandalwood and collect and sow sandalwood seed. This pilot has provided important information about building capacity such as the FPC's requirement to work with Aboriginal businesses to implement an appropriate safety management plan.

The FPC is now developing a Rangeland Aboriginal Engagement Strategy (Sandalwood Dreaming) that will expand the pilot program to more Native Title claimants and traditional owners. It is hoped that through negotiating Future Act Agreements this will provide opportunity for business start-ups that lead to the establishment of sustainable forestry enterprises for traditional owners on-country. Critical to this is the FPC's intention to work with traditional owners to replenish sandalwood stocks that have been degraded by incompatible land use.

Each year up to 200 tonnes of WA sandalwood will be released for tender to encourage innovation and investment in manufacture of sandalwood products in regional and Aboriginal communities. Beyond the uses of oil, sandalwood has highly desired properties for use in ceremonial items, incense, mosquito repellents, arts and crafts. Sandalwood is a keystone timber that may also drive the sustainable commercial production of other arid timber species.

Sandalwood management plan

Sandalwood nuts/fruit (*Figure 7*) are sourced from both wild and plantation sandalwood and foremostly supply rangeland wild seeding operations (Operation Woylie). The kernels within the nuts can also be used in a range of products including skin creams and hand washes. It is hoped that sandalwood nuts will become an important new part of the industry in the future, particularly as a crop able to provide an income from plantations prior to harvesting for wood.



Figure 7. Sandalwood fruit prior to reaching maturity

To enhance socio-economic benefits, the FPC will continue to:

- Pursue value adding opportunities, such as adopting and promoting new technologies.
- Focus effort on maintaining and improving the FPC's sandalwood regeneration program.
- Ensure effective stakeholder engagement remains a vital component of our business.

Threats

Potential negative social impacts of the FPC's activities include dust and noise impacting neighbours, pastoralists, and/or road users. These are managed through the operational planning process and monitored through operational supervision.

Apiary sites

Bee keeping is a land-use that co-exists with some sandalwood operations. The FPC prescribes no interference with beehives including no disturbance of vegetation within 100 metres of an active apiary site.

Illegal harvesting

Sandalwood management plan

Illegal harvesting of sandalwood has been an issue in past years due to the high value of the wood, lack of adequate deterrent penalties and the low probability of prosecution. This activity has in the past caused significant disruption to the sandalwood market. However, since the new Sandalwood Order took effect on 1 July 2016, which set the annual quota at 2,500 tonnes per annum, introduced significant fines for illegal harvesting as well as increased surveillance and prosecutions, the impact of illegal harvesting has been significantly reduced.

Illegal harvesting impacts the sustainability of the resource, as harvest levels may be higher than licenced, and unregulated practices will not ensure successful regeneration post-harvest. Unregulated harvesting activities may also negatively impact environmental values such as threatened flora and fauna, soil and water values and heritage values.

The penalties for the illegal harvesting of sandalwood have increased substantially under the *Biodiversity Conservation Act 2016*. The new maximum penalties are now \$200,000 for individuals and \$1 million for corporations. In addition, the Act also enables a court to impose an additional penalty of up to \$20,000 per tonne for the unlawful taking of sandalwood.

Seized sandalwood was previously auctioned by the DBCA which could cause instability in supply levels. To combat this problem the FPC now assists with the sale of any apprehended illegal sandalwood on behalf of the State.

The FPC is working with the DBCA and the Commonwealth Department of Agriculture and Water Resources, who have regulatory responsibility under the *Illegal Logging Prohibition Act 2012*, to implement an assurance system which will assist to demonstrate legality and compliance with relevant legislation.

To assist in the control of illegal activity the FPC:

- Developed a legality verification framework for use by the industry and the regulators. This system can ensure that all legal wood will be traceable, giving confidence to buyers as to the source. In industry consultation on this system, the FPC received strong support for its implementation from both plantation growers and wood processors.
- Requires that all its operations adopt a legal verification system. This will ensure that there is a system in place for at least 90% of the legally-produced wild sandalwood from WA.
- Provides funding to the DBCA to improve its enforcement capability.
- Is committed to maintaining Chain of Custody certification of Forest and Tree Based Products (PEFC ST 2002:2013) for wild sandalwood as a mechanism to assist in demonstrating that wood is identified and traceable, providing confidence to buyers and consumers that the product has been legally harvested.
- Is investigating remote sensing technology to monitor sandalwood populations.

As a result of these legislative changes, over the last 5 years there has been a significant drop in illegal sandalwood harvesting. Table 2 below indicates the quantities of illegally harvested sandalwood seized between 2011 and 2020 (DBCA Compliance data).

Table 22: Quantities of illegally harvested sandalwood seized

Year	Number of seizures	Tonnes seized	Avg Tonnes per seizure	Percentage of allowable cut
2011	4	11.1	2.775	0.44
2012	20	184	9.2	7.40
2013	1	17.3	17.3	0.69
2014	2	309	154.5	12.4
2015	2	2.8	1.4	0.11
2016	4	22.5	5.625	0.90
2017	4	7.5	1.875	0.30
2018-20	17	22.5	1.32	0.90

Prior to 2016, monitoring of illegal harvesting was limited. Since 2017, the FPC has been funding a full-time sandalwood compliance enforcement officer with the DBCA resulting in a significant increase in compliance monitoring activities (491 separate inspections since 1 Jan 2018). This has resulted in significantly more seizures of smaller quantities of wild sandalwood. In 2019/20 the average quantity of each seizure was the lowest recorded over the last 10 years, being 1.3 tonnes (*Figure 8*).

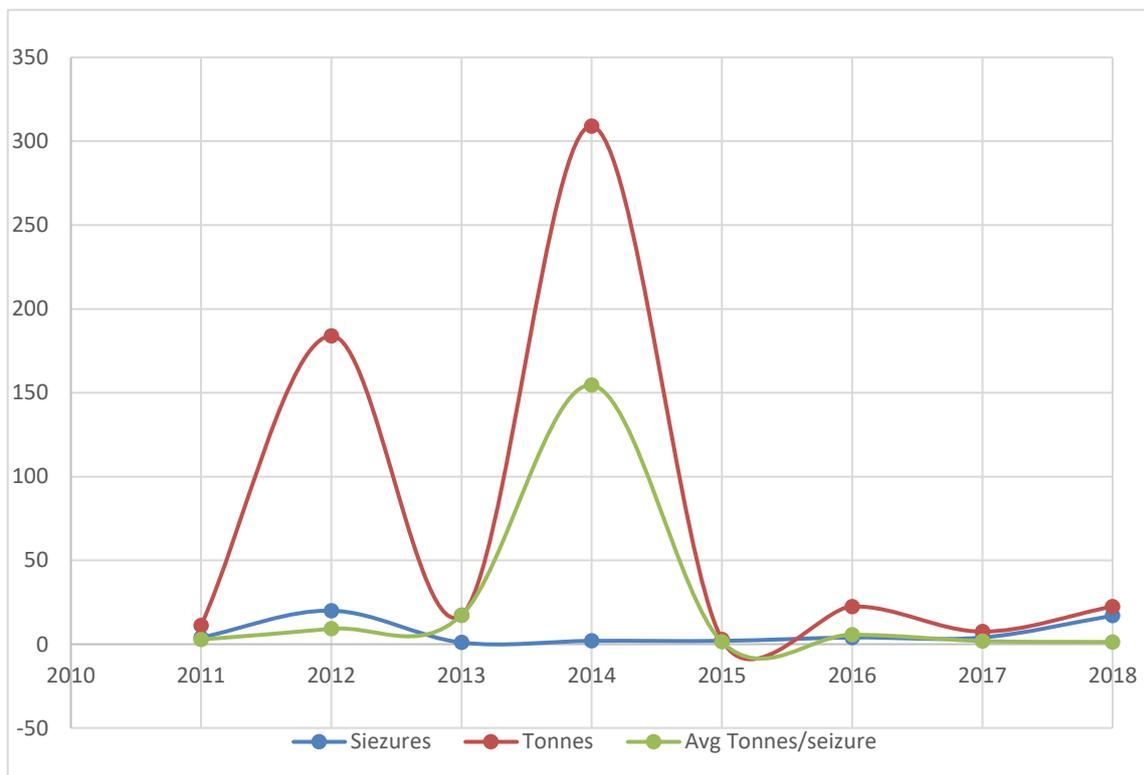


Figure 8. Trend - Number of illegal sandalwood seizures and average tonnes per seizure 2011 to 2018. Note: 2018 data includes seizures up to Oct 2020) Source DBCA.

Stakeholder engagement

Stakeholder engagement is an integral element of the FPC's strategic goal to facilitate a vibrant forest industry to deliver social and economic benefits, particularly in regional WA . Stakeholders are people or groups of people with vested interest in; influence on; or impacted by the FPC's activities.

[Policy 54 Stakeholder engagement \(FPC, 2019\)](#) commits the FPC to meaningful and constructive stakeholder engagement with goals of trust, inclusivity and value.

Through strategies such as the [Native Sandalwood Industry Strategy \(FPC, 2017\)](#), developed in consultation with community, industry and State Government agencies, the FPC promotes stakeholder engagement through:

- investing in industry participation and Aboriginal communities;
- promoting the values of Western Australian sandalwood in communities;
- encouraging industry participation;
- dedicated engagement staff;
- neighbour notifications;
- the FPC website;
- meetings, information tours, site visits and presentations; and
- FPC staff living and being involved in Kalgoorlie and Carnarvon's regional communities.

The FPC recognises and promotes the rights of the community to be heard. Further information about the FPC's stakeholder engagement is available on the [FPC's website](#) which provides an enquiries and comment email link with supporting information that includes the FPC's complaint handling process.

Aboriginal engagement

The FPC is on a reconciliation journey that recognises that Aboriginal and Torres Strait Islander cultures are enduring, have persisted for thousands of years, and are profoundly connected to the lands and environments where the FPC operates. The FPC welcomes Aboriginal and Torres Strait Islander People's contribution to our policies and practices; and strives to deliver forestry opportunities for Traditional Owner's benefit while respecting native title rights and protecting cultural heritage.

[Policy 92](#) defines the FPC's Aboriginal engagement vision as to walk together for healthy forests and communities through collaborative First Nations relationships. The policy

Sandalwood management plan

commits the FPC to respect Aboriginal natural resource lore; and protect Aboriginal culture and heritage.

The FPC's *Sandalwood Dreaming* initiative aims to increase Aboriginal economic participation in the Sandalwood industry, firstly by increasing Aboriginal business and safety management capacity in sandalwood harvesting and regeneration; and secondly, by identifying opportunities for sandalwood raw material to generate new value-adding industries for Traditional Owners.

The FPC participated in; and supports the 2020 WA Sandalwood Taskforce Report that engaged Traditional Owners and provided eight recommendations to use the wild sandalwood resource to drive economic development opportunities for Aboriginal communities and to grow Aboriginal businesses.

Additional initiatives for Aboriginal engagement across all the FPC's operations have been identified in the FPC's Reconciliation Action Plan.

Heritage

The FPC complies with the *Aboriginal Heritage Act 1972* and ensures its activities do not negatively impact Aboriginal cultural heritage. Procedure 44 prescribes the FPC's process for pre-operation checks, Traditional Owner consultation and survey where required.

The FPC contracts heritage service providers (i.e. qualified archaeologists and anthropologists with long established and trusting relationships with Aboriginal spokespeople) to advise the FPC on Aboriginal heritage and culture and where appropriate, engages Aboriginal People on behalf of the FPC.

Information and management actions generated by the Procedure 44 process is communicated to contractors during the pre-operation briefing and is recorded on the operations plan. It is acknowledged that there are likely to be unknown unregistered heritage sites within the sandalwood operations areas. The FPC has an employee cultural awareness strategy to provide staff an understanding of cultural heritage and working with contractors, are vigilant in monitoring for heritage indicators and reporting suspected sites or artefacts.

The FPC also complies with the and the *Heritage of Western Australia Act 1990*. Non-Aboriginal heritage is managed through pre-operation checks and communication of locations and management actions to contractors.

Plan implementation and management

Management under this plan is monitored and continually improved under the FPC's Integrated Forest Management System (IFMS) and Procedure 160 - Wild Sandalwood Chain of Custody and due diligence system. These processes enable all legal and other compliance obligations to be identified and regularly reviewed. The due diligence system provides the basis for ongoing development of procedures and work instructions, measurement of performance, and review ensuring continuous improvement.

The FPC's commitment to implementing forest management practices that are environmentally sound, socially acceptable and economically viable is documented through its Forest Management Policy, through maintaining an independently certified environmental management system, and ensuring our management systems are closely aligned to the principles of sustainable forest management. A copy of [Policy 9 Forest Management](#) is available on the FPC website.

Planning

Prior to the commencement of any disturbance activities, the FPC undertakes an operational planning process to identify forest values such as cultural heritage (Aboriginal and European), social and economic values, soil and water values and flora and fauna values to be managed.

The FPC identifies the aspects of our activities that can have an impact on a range of forest values. Impacts are rated in terms of their significance. Activities or operations that have the highest potential negative impact/s are managed by ensuring objectives and targets are set to mitigate or reduce the potential for these negative impacts to occur. These objectives and targets are monitored regularly, and periodic performance evaluations are completed. Objectives and targets can also be set to pursue opportunities for positive impacts.

Incident management

Incident management is an important part of the FPC's IFMS, and the FPC has robust incident management procedures and practices in place. The FPC's procedures provide guidance for reporting incidents and managing the process through to closure. The FPC has in place a process for determining the root cause of incidents and implementing appropriate corrective actions and system improvements.

Incident data is periodically analysed for trends, incident recurrence and to determine the effectiveness of prescribed actions.

Performance monitoring and auditing

Performance monitoring and auditing are an integral part of the IFMS. All FPC operations are routinely internally and externally audited. The FPC routinely reports on its operational

performance. The following key performance indicators for wild sandalwood are currently reported in the FPC's Annual Reports:

- a) Harvest of sandalwood does not exceed license limits
- b) Effectiveness of sandalwood regeneration: target is average 50,000 seedlings established annually. The current average seedling survival over ten years is 39,000 per annum. In response, the seeding program for future years has been increased from 144 tonnes to 20 tonnes of seed planted.

Population monitoring will continue, both within the FPC's sandalwood regions and elsewhere to continue to build an understanding of the species response to different environments. The scope of ongoing inventory and monitoring activities will be developed in consultation with the DBCA.

The FPC's IFMS is reviewed regularly at both operational and Executive level to assess and continuously improve the effectiveness of the system.

Research

The FPC continues to refine techniques for the successful establishment of sandalwood regeneration, with ongoing monitoring of survival under a range of conditions at trial locations in the rangelands. Trials have also been established to determine if moisture retention treatments can aid germination and establishment.

The FPC has supported trials investigating the use of mechanised nut harvesters in its sandalwood plantations. A cost-effective system to collect large volumes of sandalwood nuts is potentially important to help develop large-scale processing of sandalwood seeds in WA.

The FPC continues to further refine techniques used to mechanically seed sandalwood back into the semi-arid regions of WA, under the project name "Operation Woylie".

References

- 2016. 'Safety health code for native forest hardwood logging and plantation logging', Forest Industries Federation of Western Australia, Perth, Australia.
- 2017. 'Native sandalwood industry strategy for western australia', Forest Products Commission, Perth, Australia.
- 2018. 'Policy 9 Forest management', Forest Products Commission, Perth, Australia.
- 2018. 'Sandalwood (*Santalum spicatum*) establishment guide', Forest Products Commission and Australian Sandalwood Network, Perth, Australia.
- 2018. 'Annual Report 2017-2018', Forest Products Commission, Perth, Australia.

- (BOM) Australian Bureau of Meteorology 2015. *Risk Management and El Niño and La Niña* [Online]. Available: www.bom.gov.au/watl/about-weather-and-climate/risk/risk-enso.shtml [Accessed 15 January 2015].
- (Conservation Commission) Conservation Commission of Western Australia 2013. 'Forest Management Plan 2014-2023', Perth, Australia.
- (DBCAs) Department of Biodiversity Conservation and Attractions 2019. 'Conservation Codes for Western Australian Flora and Fauna', Department of Biodiversity, Conservation and Attractions, Perth, Australia.
- (DEC) Department of Environment and Conservation 2013. 'Definitions, categories and criteria for threatened and priority ecological communities', Perth, Australia.
- (FIFWA) Forest Industries Federation of Western Australia 2014. 'Code of practice for timber plantations in Western Australia', Forest Industries Federation of Western Australia, Perth, Australia.
- (FPC and ASN) Forest Products Commission and (ASN) Australian Sandalwood Network 2008. 'WA Sandalwood industry development plan 2008-2020', Forest Products Commission and Australian Sandalwood Network, Perth, Australia.
- (FPC) Forest Products Commission 2016. 'Policy 54 Stakeholder engagement', Forest Products Commission, Perth, Australia.
- Berry, S, Keith, H, Mackey, B, Brookhouse, M and Jonson, J 2010. Green Carbon. The role of natural forests in carbon storage. In: Part 2. Biomass carbon stocks in the Great Western Woodlands. Australian National University, Canberra, Australia.
- Brand, J. 2000. The effects of management regime and host species on Sandalwood (*Santalum spicatum*) recruitment near Paynes Find Western Australia. *The Rangeland Journal*, Vol. 22, no. 2, pp. 243-255.
- Brand, J. (2017). Report on sandalwood seeding trials on Lorna Glen station, in the arid northern Goldfields, 2013-16. Internal Report, Forest Productions Commission, WA.
- Brand, J. and Sawyer, B. (2016). Seed pre-treatment and time of sowing effects on sandalwood (*Santalum spicatum*) regeneration in semi-arid regions, near Kalgoorlie, Western Australia. Internal Report, Forest Productions Commission, WA.
- Brand, J.E., Fox, J.E.D., Pronk, G. and Cornwell, C. (2007). Comparison of oil concentration and oil quality from 8 to 25-year-old *Santalum spicatum* and *Santalum album* plantations with those from mature *S. spicatum* natural stands. *Australian Forestry* **70** (4): 235-241.
- Brand, JE and Norris, LJ 2017. Variation in oil content and tree size between six geographically separate *Santalum spicatum* families, established near Narrogin, Western Australia. *Australian Forestry* **80** (5): 294-298.
- Brand, JE, Sawyer, B & Evans, DR 2014. The benefits of seed enrichment on sandalwood (*Santalum spicatum*) populations, after 17 years, in semi-arid Western Australia. *The Rangeland Journal*, Vol. 36, no. 5, pp. 475-482.
- Brandis, AJ, 2008. 'Rescuing the rangelands: management strategies for restoration and conservation of the natural heritage of the Western Australian rangelands after 150 years of pastoralism'. WA Department of Environment and Conservation, Perth, 246 pp.
- Burbidge, AA, Johnson, KA, Fuller, PJ & Southgate, RI 1988. 'Aboriginal knowledge of the mammals of the central deserts of Australia'. *Wildlife Research*, Vol. 15, no. 1, pp. 9-39.
- Byrne, M, Macdonald, B, Broadhurst, L and Brand, J 20032003b. 'Regional genetic differentiation in Western Australian Sandalwood (*Santalum spicatum*) as revealed by nuclear RFLP analysis'. *Theoretical Applied Genetics* **107**: 1208-1214.

- Chapman, T.F. (2015). Reintroduced burrowing bettongs (*Bettongia lesueur*) scatter hoard sandalwood (*Santalum spicatum*) seed. *Australian Journal of Zoology* **63** (1): 76-79.
- CSIRO and Bureau of Meteorology 2015. Climate Change in Australia Information for Australia's Natural Resource Management Regions. Technical Report, CSIRO and Bureau of Meteorology, Australia.
- Herford, I, Rayner, M, Kealley, I, Morrison, K & Dawson, R 2015. 'Review of the *Sandalwood (Limitation of Removal of Sandalwood) Order 1996 Report*', Department of Parks and Wildlife, Perth, Australia.
- Kealley, IG 1991. 'The Management of Sandalwood', Wildlife Management Program 8, Department of Conservation and Land Management, Western Australia.
- Loneragan, OW 1990. 'Research Bulletin - Historical review of sandalwood (*Santalum spicatum*) research in Western Australia', Department of Conservation and Land Management, Perth, Australia.
- Murphy, MT 2005. 'Seed caching by woylies *Bettongia penicillata* can increase sandalwood *Santalum spicatum* regeneration in Western Australia'. *Austral ecology*, Vol. v. 30, no. no. 7, pp. pp. 747-755-2005 v.30 no.7.
- Parliament of Western Australia, Legislative Council, Standing Committee on Environment and Public Affairs, 2014. 'Report 35 Inquiry into the Sandalwood Industry in Western Australia'.
- Sawyer, B 2013. 'Sandalwood (*Santalum spicatum*) establishment in the semi-arid and arid regions of Western Australia'. *The Rangeland Journal*, Vol. 35, no. 1, pp. 109-115.
- WA Sandalwood Taskforce (2020) 'The WA Sandalwood Taskforce: Advancement of Aboriginal Economic Development Using Wild Harvested Sandalwood.' Government of Western Australia, Perth, Australia
- Wheatbelt Natural Resource Management. 'Carbon value from sandalwood factsheet', Australia.
- Williamson, AJ 1982. 'Sandalwood survey', Forest Department of Western Australia, Perth, Australia.

Appendix 1. Legal requirements

The FPC has numerous procedures and corporate documents relevant to sandalwood management that are not listed below. There are also other requirements, such as the Code of practice for timber plantations in Western Australia, of which the FPC adheres to. The following list of legislation is relevant to the FPC's management of wild and plantation sandalwood in Western Australia.

Western Australian legislation

Aboriginal Heritage Act 1972

Aboriginal Heritage Regulations 1991

Agricultural and Veterinary Chemicals (Western Australia) Act 1995

Biodiversity Conservation Act 2016

Biodiversity Conservation Regulations 2018

Biosecurity and Agriculture Management Act 2007

Biosecurity and Agriculture Management Regulations 2013

Biological Control Act 1986

Bush Fires Act 1954

Bush Fires Regulations 1954

Conservation and Land Management Act 1984

Conservation and Land Management Regulations 2002

Contaminated Sites Act 2003

Contaminated Sites Regulations 2006

Corruption and Crime Commission Act 2003

Country Areas Water Supply Act 1947

Country Areas Water Supply By-laws 1957

Criminal Code 1913

Dangerous Goods Safety Act 2004

Dangerous Goods Safety (Storage and Handling of Non-Explosives) Regulations 2007

Emergency Management Act 2005

Forest Management Regulations 1993

Environmental Protection Act 1986

Environmental Protection and Biodiversity Conservation Act 1999

Sandalwood management plan

Export Control Act 1982

Equal Opportunity Act 1984

Forest Products Act 2000

Health Act 1911

Heritage of Western Australia Act 1990

Heritage of Western Australia Regulations 1991

Local Government Act 1995

Medicines and Poisons Act 2014

Metropolitan Water Supply Sewerage and Drainage Act 1909

Minimum Conditions of Employment Act 1993

Native Title Act 1993

Public Sector Management Act 2001

Poisons Act 1964

Poisons Regulations 1965

Rights in Water and Irrigation Act 1914

Soil and Land Conservation Act 1945

Town planning and Development Act 1928

Waterways Conservation Act 1976

Western Australian Industrial Relations Act 1979

Commonwealth legislation

Agricultural and Veterinary Chemicals Code Act 1994

Environment Protection and Biodiversity Conservation Act 1999

Export Control Act 1982

Illegal Logging Prohibition Act 2012

Native Title Act 1993

International and Other Legislation or requirements

Global Forest Watch Intact Forest Landscapes

Transparency International 2019 Corruption Index

International Union for Conservation of Nature Red List criteria

Sandalwood management plan

CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) database

Map of threatened ecological communities in Australian Government Department of Agriculture, Water and the Environment - Protected Matters search tool:
<http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf>