Ecological Thinning and Fire Mitigation Plan

Lot 15032 on Deposited Plan 206299,
53 Tyler Road, Boddington

wespine

1. Introduction

Wespine Industries intends to improve the health of the remnant native vegetation on its property near Boddington. This will be achieved through the application of silviculture, notably ecological thinning, and reintroduction of fire to the property. The mitigation of bushfire risk to valuable plantation assets and community protection will be a beneficial outcome.

This Ecological Thinning and Fire Mitigation Plan sets out the objectives and how they will be achieved silviculturally, as well as the measures in place to conserve the flora, fauna, and productive capacity of the site.

A key finding of the Review of Silviculture in Forests of South-west Western Australia (Burrows, Neyland, & Ruprecht, 2011) was the opportunity that silviculture provides to assist forests to adapt to climate change. In summary, the report found that "declining rainfall has significantly impacted water availability in the FMP area and predicted future climate change is likely to lead to further impacts. Further declines in streamflow and impacts on aquatic environments are likely. The impact of climate change needs to be closely monitored with adaptive management strategies."

Mitigating the effects of reduced rainfall and higher temperatures on the forest and associated communities will require adaptive action to help to align density and structure of the forest with current and future climate. Targeted action may protect susceptible ecosystems, retain water availability in some parts of the forest, improve the health of forest and associated ecosystems, reduce susceptibility to high intensity fire and allow for the persistence of ground and surface water dependent ecosystems.

A reduction in stand density reduces competition for water and has positive effects on vegetation health and vitality, increasing resilience to pest and diseases. Enough reduction in stand density increases the amount of water moving through the soil profile to groundwater and into streams. Ecological thinning aims to reduce the impact of declining rainfall on the forest and associated ecosystems.

2. General

The native remnants total 329 hectares (see attached map). The native vegetation is very degraded, from historical grazing. Past harvesting is evident. Significant grazing pressure, combined with the general absence of fire means that there has been little to support regeneration of vegetation.

The native bushland in this area is Jarrah dominant in the higher landscape. Lower slopes and gully depressions are a mix of jarrah - wandoo open forest. The landscape is dominated by undulating gravelly soils upslope. The soils grade to sandier loams towards lower slopes. There are substantial populations of she-oak.

The most significant challenge to restoring forest health over most of the property is to encourage regeneration. The regeneration pool is presently non-existent.

Some areas within the property are very heavily stocked with regrowth wandoo, and would benefit from thinning from below to allow the concentration of site resources upon the most healthy trees that will encourage the early formation of habitat features (hollows etc).

The remnant forest has been stratified into three management zones, that have different objectives (with reference to Figure 2 - Map of Management Zones);

i. Fire Mitigation Zone, marked in red.
ii. Water Management Zone, marked in blue.
iii. Regeneration Management Zone, marked in green.

Figure 1 - Reducing the likely intensity of bushfires is a priority.

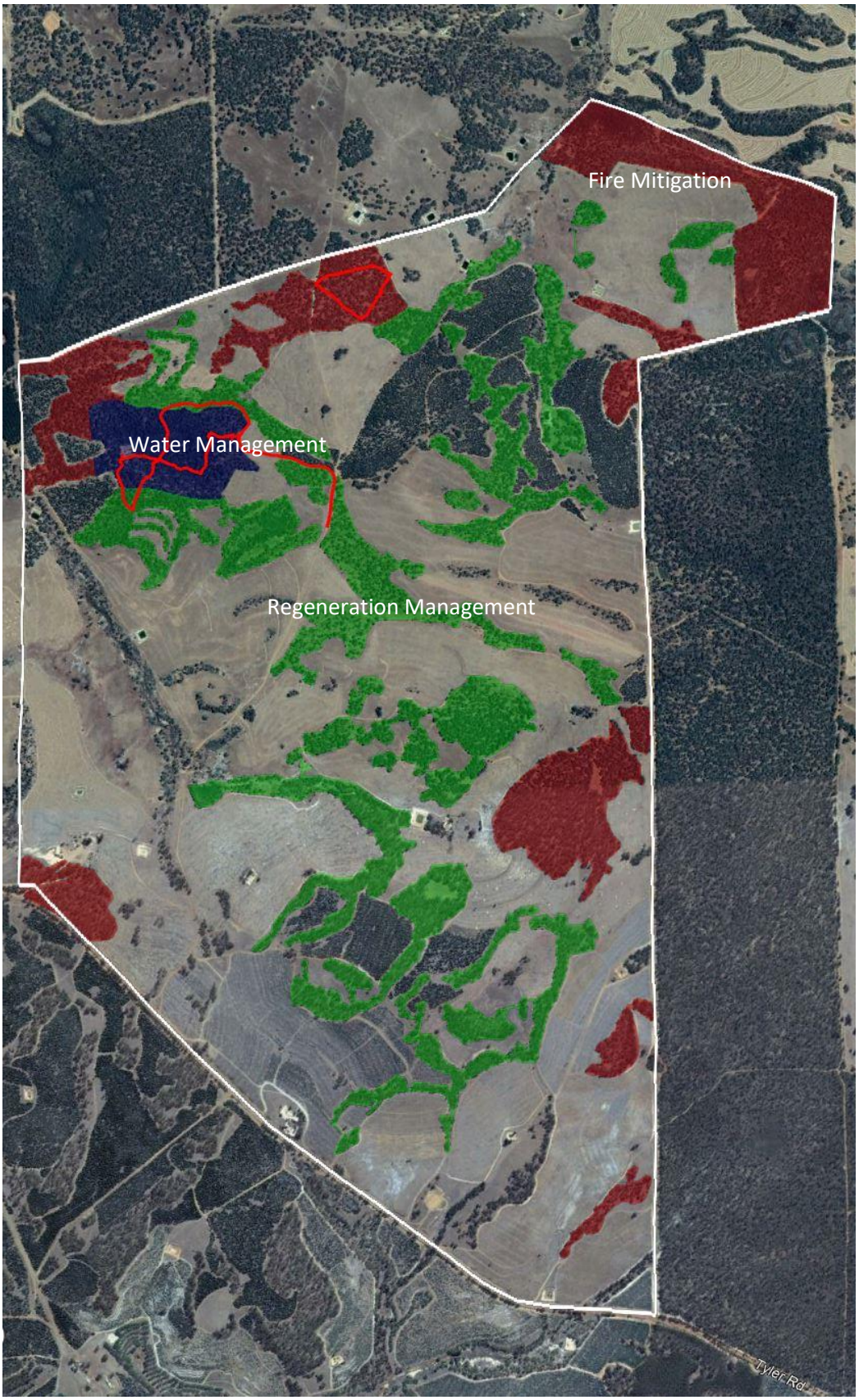

Figure 2 - Map of Management Zones

3. Objectives

The specific objectives for the forest remnants are set out below in accordance with the zones:

i. Fire Mitigation Zone

a. Thin from below to reduce crown density and remove ladder fuels that allow fire to transition from ground fire to crown fire.
b. Avoid increasing surface fuels by employing high utilisation harvesting systems.
c. Conduct prescribed burning to reduce surface fuels.
d. Treat coppice to prevent re-sprouting and rapid diminution of fire mitigation.

ii. Water Management Zone

e. Thin from below to reduce crown density and reduce foliar transpiration.
f. Treat coppice to prevent re-sprouting and rapid diminution of water yield improvements.

iii. Regeneration Management Zone

g. Thin from below to remove less vigorous and or suppressed trees (mimicking the natural thinning process).
h. Deliberately utilise less than 100% of harvested trees, to ensure that material capable of forming ash beds remains.
i. Time the reintroduction of fire to coincide with high seed production year, which will find seed beds among the fresh ashes.
j. Improve habitat for threatened species.

4. Fire Behaviour Basics

There are three basic components that are required for a fire to ignite, burn and continue to burn. These are oxygen, heat and fuel and are described in the fire triangle (Sneeuwjagt & Higgs, 1995). The fuel can be any material that can be burnt, oxygen (O_2) is an essential part of the chemical reaction needed to create fire, and heat is needed for ignition.

Fire spreads by a process called heat transfer. This is when the material immediately next to a fire is preheated to point where it gets hot enough to ignite.
Weather influences fire behaviour by creating conditions suitable for burning. Wind and temperature are the predominant drivers of fire behaviour. Hot temperatures will speed up the process of preheating and heat transfer and allow a fire to spread more quickly. Wind also speeds up the process of heat transfer by pushing flames and heat sideways to preheat unburnt areas. Wind can also change the direction of a fire and turn a fire flank (the side of a fire - lower intensity) into a fire front (the head of the fire - highest intensity).

The nature of our native forest fuels is such that fuel for each stratum is distinct (e.g. surface, near-surface, elevated) and each stratum plays a different but significant role in determining the behaviour of a fire burning through each. When a fire ignition occurs it is limited in size and heat output and thus spreads through the surface fuel layer only. As the fire builds in size and speed and intensity, it involves other strata until, if the conditions are conducive, it eventually involves the entire fuel complex−a so called crown fire (Sullivan, et al., 2014).

Figure 3 - Transition between surface and crown fire in Jarrah via ladder fuels (Sullivan, et al., 2014)

As a fire transitions into a higher fuel layer there will be a stepwise increase in rate of spread and intensity. The most dramatic changes will be observed when a surface fire transitions into a crown fire via a process known as “torching” or “laddering”. With the onset of crowning, a fire at a minimum typically doubles its spread rate in comparison to its previous state (Sullivan, et al., 2014).

This sudden jump in the fire’s rate of spread occurs as a result of:

- increased wind speeds just above the tree canopy (several times faster than understorey winds)
- increased efficiency of heat transfer into a taller and more porous fuel layer, and
- the enhanced radiant heating owing to a taller and deeper flame front.

Fire transitions can also lead to an increase in spotting density and distances (Sullivan, et al., 2014).

Figure 4 - Laddering and Fire Progression, compared to a forest after active fuel treatments

5. Fire Mitigation through active management

It is possible, through active management of forests, to create a forest structure that can resist the expression of extreme fire behaviour and create zones from which assets can be better protected from fire, or from which to build a fire suppression effort around.

In Western Australia, the application of prescribed burning has for many years helped to create forests that are defendable from destructive wild-fires. Until the late 1990's fire crews attended 300 or more fires in the forest per year, but 90% were extinguished before they reached 10 hectares in size.

Prescribed fire is very effective at reducing surface fuels, and in reducing laddering and spot fire spread through the burning off of fibrous barks (Gould, McCaw, & Cheney, 2007) (McCaw, Gould, Cheney, Ellis, & Anderson, 2012) (McCaw, 2012).

However, the area that has been treated by prescribed fire has been declining for many years and the area affected by bush-fires has been increasing. In addition, the difficulty of conducting prescribed burning around towns and other sensitive assets due to risk of escapes (like the Margaret River fire in November 2011) has increased. Smoke can be both a nuisance and economically detrimental to neighbours (e.g. grape growers). Evidence from the USA suggests that incentives for forest managers to reach specified quantum of hectares treated leads to prescribed burning efforts being allocated towards the lower cost, lower risk areas where these targets can most readily be met (USDA, 2006).

Table 1 - Principles of fire resistance for dry forests [after (Agee & Skinner, 2005)]

Principle	Effect	Advantage	Concerns
Reduce surface fuels	Reduces potential flame length. Rate of spread will be lower[1]	Control easier, less torching or laddering	May be quite disturbing of site if done mechanically rather than with prescribed fire
Increase height to live crown	Requires longer flame length to begin torching	Less torching	Opens understorey, may increase surface wind
Decrease Crown Density	Makes tree to tree crown fire less probable	Reduces crown fire potential	Surface wind may increase and surface fuels may be drier
Keep big trees of resistant species	Less mortality for same fire intensity	Restores historic structure and improved wildlife habitat availability	Less economical (due to saleability of larger forest products).

Application of the principles contained in Table 1 above implies a three-part objective:

- **Reduce surface fuels**
- **Reduce ladder fuels**
- **Reduce crown density**

Figure 5 - Asset Protection is an important part of this plan.

[1] From Project Vesta (Gould, McCaw, & Cheney, 2007)

6. Silvicultural Treatment Management Plan

i. Fire Mitigation Zone

a. Thin from below to reduce crown density and remove ladder fuels that allow fire to transition from ground fire to crown fire.
b. Avoid increasing surface fuels by employing high utilisation harvesting systems.
c. Conduct prescribed burning to reduce surface fuels.
d. Treat coppice to prevent re-sprouting and rapid diminution of fire mitigation.

The thinning will be carried out in accordance with the relevant silviculture guideline, depending on the predominant species within a given area. The two relevant guidelines are "Silviculture Guideline for Wandoo Forest" (Department of Parks and Wildlife, 2014) and "Silviculture Guidelines for Jarrah Forest" (Department of Parks and Wildlife, 2014).

Figure 6 - Jarrah dominant forest thinned for fire mitigation

During tree-marking by expert foresters, specific silvicultural prescriptions will be selected for each stand based upon the structural development stage, regeneration status, existing impact of disease and practicality of management.

All Coarse Woody Debris (CWD) within 20 metres of boundaries of the Fire Management Zone will be either removed from the forest or pulled into the interior. This is to reduce the amount of material that could harbour embers and contribute to flare ups in the event of a bush fire. Beyond the 20m boundary buffer, CWD will be retained as marked for habitat.

Where practical, removed CWD may be transferred from the Fire Management Zone to nearby Regeneration Management Zone stands, to improve fauna habitat.

Legacy elements retained as marked, including large senescing Marri where they occur.

During tree-marking, trees selected for retention should have a moderate to high probability of bearing hollows. Both individual trees and groups of trees will be marked.

In the Fire Management Zone, natural regeneration from stump coppice will be supressed by the application of herbicides to cut stumps.

The target basal area for Jarrah dominant stands (with reference to Table 2) is 16m^2 per hectare.

Prescribed fire will be utilised, with a target return interval of four years.

Table 2. Thinning guidelines for eastern jarrah forest recommended by the Department of Parks and Wildlife

Development stage	**Mean dbhob of crop trees/ha (cm)**	**Target stocking (stems/ha)**	**Nominal stand density[a] (m^2/ha)**	**Spacing guide (m)**
Juvenile	<15	350	5	4.5
Immature	16 – 25	200	6	6
	26 - 35	100	7	10
	36 – 45	100	13	10
Mature	>45	100	16	10

[a] Does not include habitat trees

ii. Water Management Zone

e. Thin from below to reduce crown density and reduce foliar transpiration.
f. Treat coppice to prevent re-sprouting and rapid diminution of water yield improvements.

Forest thinning of high rainfall catchments increased water yield by a maximum of 8 to 18 per cent. The increase was dependent upon the characteristics of the catchment and the amount of vegetation removed.

However, the increases from thinning are not permanent and water yields returned to pre-thinning levels after 12-15 years. Control of regeneration and stump coppice development has been shown to prolong the increase in water yield for up to 25 years (Department of Parks and Wildlife, 2014).

The silviculture for this zone is based up "Silviculture for Water Production" (Department of Parks and Wildlife, 2014). Although this zone is Wandoo dominant and the water production silviculture is featured in the Jarrah silviculture reference, the principle is the same. Further, this management zone represents a specific sub catchment and Class 1 stream, feeding a dry dam.

Silvicultural practice in the wandoo forest is essentially a single tree selection system. In selecting trees for harvest, the aim is to maintain a stand with three major cohorts, regeneration, intermediate and mature or senescent trees. Even aged stands will be thinned until they are mature and eventually require regeneration. With reference to Figure 7 below, it can be seen that the stand is even aged.

Figure 7 - Heavily stocked Wandoo forest in Water Management Zone

The Water Management Zone shall be thinned to a basal area of $10m^2$. At least $1m^2$ made up of at minimum three individual trees per hectare shall be marked for retention. The marking shall focus upon the removal of malformed and sub-dominant trees. There shall be no pressure upon tree-markers to remove any "commercial" trees. These shall be retained for future production and to improve the aesthetics of the forest.

Mature trees are more water efficient than young trees, so encouraging rapid maturing through thinning will minimise water usage per unit area of sapwood (Department of Parks and Wildlife, 2014).

Coppice shall be controlled by the targeted application of herbicides at the time of harvesting.

Overall, the increased focus on fire prevention upon the entire property will significantly reduce the chances of a stand replacing fire (a fire that causes massive re-shooting from stump level – which is juvenile foliage and thus heavy on water use).

Figure 8 - Thinned Jarrah forest, with habitat tree retention.

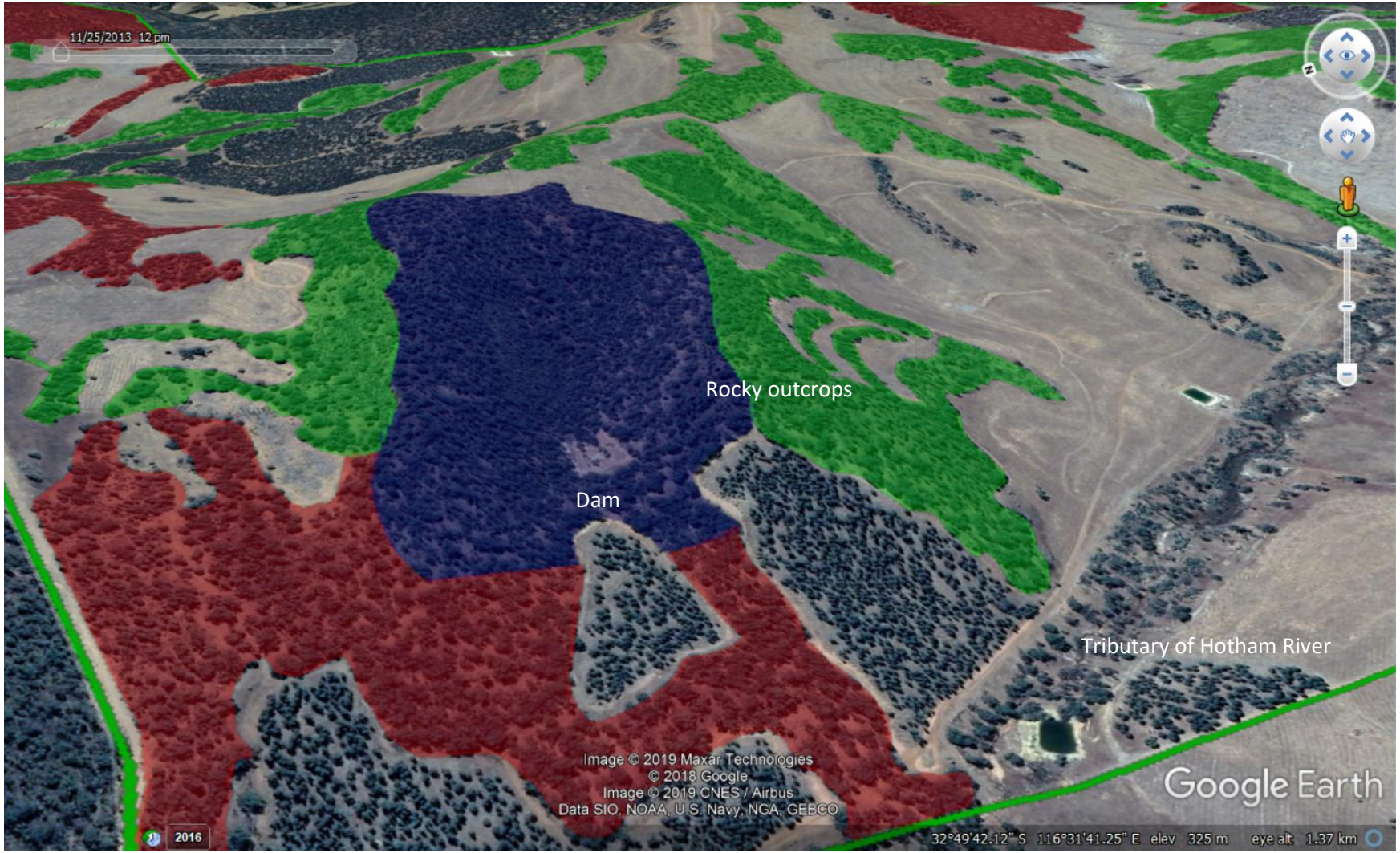

Figure 9 - Water Management Zone showing location of dam, water flow direction and rocky outcrop location.

iii. Regeneration Management Zone

g. Thin from below to remove less vigorous and or suppressed trees (mimicking the natural thinning process).

h. Deliberately utilise less than 100% of harvested trees, to ensure that material capable of forming ash beds remains.

i. Time the reintroduction of fire to coincide with high seed production year, which will find seed beds among the fresh ashes.

j. Improve habitat for threatened species.

In areas that are Wandoo dominant, the distribution of trees is very clumped, reflecting their dependence upon ash-bed for regeneration.

Successful wandoo regeneration is therefore dependent on the linking of several key factors:

- A fire that will create ash-bed from fallen log or crown debris (i.e. autumn, not spring);
- A fire that coincides with a seed year and;
- Where the ash-bed created is within seed throw of a wandoo seed tree.

Figure 10 - Clumped distribution of Wandoo

Protection of retained Wandoo trees during subsequent regeneration burns is crucial. Harvesting in Wandoo dominant stands will be conducted in such a way that tops and harvest residue are generated, and they are returned to the forest and placed more than ten metres from retained trees. Such formed heaps shall be driven over by forestry equipment to crush down and facilitate complete burning of the wood to ash.

Where heaps for ash-bed formation are deemed insufficient, then large material from other Management Zones shall be diverted from commercial sales, and placed instead as supplementary ash bed feedstock.

Retained basal area in Wandoo dominant areas will be at least $8m^2$. The maximum distance between trees is 40m, and marking shall be prescribed to ensure this occurs.

Harvest systems that utilise all the tree may be used in Jarrah dominant stands. In Jarrah dominant mature stands, at least $16m^2$ shall be marked for retention. All sites will have a minimum of 5 primary habitat trees per hectare. Habitat trees will be selected in crown senescence categories 4-8 (Figure 11) which is indicative of the presence of tree hollows.

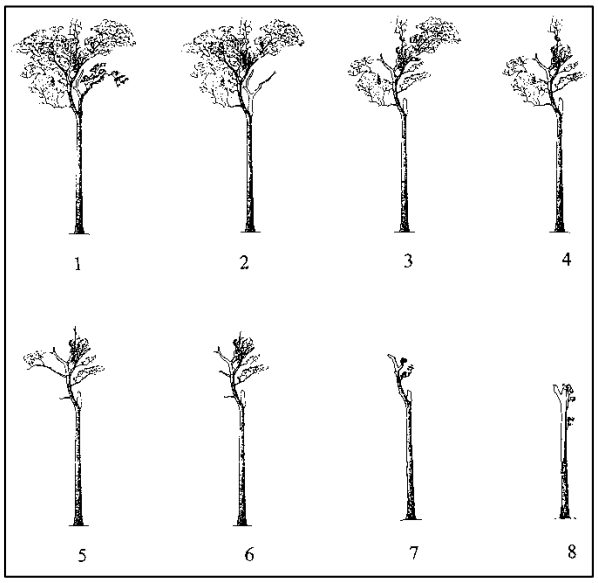

Figure 11. Crown senescence categories used to select habitat trees

Wandoo dominant areas planned for regeneration establishment burn will be surveyed for seed and capsule crop, to ensure than an adequate seed crop is available. Wandoo seeds irregularly. Burning will not be carried out until the presence of sufficient seed sources is confirmed (see 4. Seed crop assessment in *Silvicultural Practice in the Wandoo Forest)*. (Department of Conservation and Land Management, 2003).

The fire will be prescribed in accordance with "Wandoo regeneration", Table 1 in "Wandoo Silviculture" (Department of Conservation and Land Management, 2003).

If twelve months have elapsed since the carrying out of the regeneration fire, and there is insufficient evidence of recruitment of seedlings (defined as seventy percent of all ash-beds having ten seedlings or more (Department of Conservation and Land Management, 2003)) then nursery grown seedlings shall be manually planted and fertilised. Ten seedlings per ash-bed shall be emplaced.

Retention of CWD will improve ground habitat for Numbats, Chuditch, Quenda and sheltering places for echidnas (Huston, 2001), (Hussey, Dead Wood and Wildlife, 2005). Relocated CWD from the Fire Management Zones will be emplaced where practical.

Particular attention will be placed upon retaining CWD that has hollows. These logs will be marked with a large “H” when observed, and shall be specifically excluded from forming part of heaps for ash-bed.

Figure 12 - Regeneration is noticeably absent

7. Rare Flora and Fauna

The improvement of the forest function for rare flora and fauna is a key consideration. From investigations carried out, some rare fauna were identified as being likely to inhabit the area:

Name ID	Species Name	Conservation Code
44901	Caladenia hopperiana	T
24731	Calyptorhynchus banksii subsp. naso (Forest Red-tailed Black Cockatoo)	T
48400	Calyptorhynchus sp. (white-tailed black cockatoo)	T
24557	Leipoa ocellata (Malleefowl)	T
4178	Pultenaea pauciflora (Narrogin Pea)	T
24733	Calyptorhynchus baudinii (Baudin's Cockatoo	T
24734	Calyptorhynchus latirostris (Carnaby's Cockatoo	T
24092	Dasyurus geoffroii (Chuditch	T
24146	Myrmecobius fasciatus (Numbat	T
24166	Pseudocheirus occidentalis (Western Ringtail Possum	T
24168	Macrotis lagotis (Bilby	T
25624	Falco peregrinus (Peregrine Falcon)	S
24098	Phascogale calura (Red-tailed Phascogale	S
48070	Phascogale tapoatafa subsp. wambenger (South-western Brush-tailed Phascogale	S

Figure 13 - Nature Map (DBCA) Flora and Fauna Records for 20km radius of property

The elements of the silvicultural plans which have been detailed above shall make specific provisions for several of these threatened species (Hussey & Mawson, 2004). These are summarised below in Table 3 - Habitat Improvements for Targeted Species.

Introduced predators (foxes and cats) are the most significant risk to native fauna. As budgets allow, trapping and baiting will be carried out (Blyth, 1997).

General improvements in landscape connectivity will be realised with the return of forested cover from planted pines. Echidnas have been observed using pine plantations for movement.

Figure 15 - Numbat

Figure 14 - Chudditch

Table 3 - Habitat Improvements for Targeted Species

Purpose	Management Actions
1. **Habitat restoration and enhancement for** Numbat **(*Myrmecobius fasciatus*) with secondary benefit for Echidna, Chuditch (Department of Environment and Conservation, 2012)** 2. **Mitigate effects of climate change upon NE facing (high evaporation) slopes.**	• Reduce tree density on NE facing slopes to create more open forest condition and promote hollow formation (see Figure 16). • Retain and import if necessary, logs, preferably hollow, including pine logs for rapid termite colonisation (if budget allows and in Regeneration Zone). • Establish low fuel buffers on surrounds. • Limit prescribed burning return interval (where safe, in Regeneration Zone) to 10 years to promote litter layer for forage (termites) and mulching to reduce evaporation. • Intensive predator baiting and trapping (if budget allows). • 50 – 100 ha in size. • Potential reintroduction of numbats ((Department of Conservation and Land Management, 2018).
Habitat restoration and enhancement for Quenda **(*Isodon obesulus*) with benefit for Echidna, Chuditch, Numbat**	• Establish low fuel buffers on surrounds. • Limit prescribed burning return interval to 15 years to promote litter layer. • Intensive predator baiting and trapping.
Habitat restoration and enhancement for Woylie **(*Tettongia penicillata*) with benefit for wallabies, ring tail possums, fairy wrens, scrub-wrens, thornbills and honey-eaters**	• Establish low fuel buffers on surrounds. • Intense prescribed burn to stimulate acacia and pea recruitment. • Seed *Gastrobium biloba* for shelter and secondary poisoning of predators. • Seed banksia and dryandra thickets (if budget allows). • Retain some patches of dense scrub, and avoid traversing heaths. • Intensive predator baiting and trapping. • Nest box installation for possums. • Maintain open area for wallaby grazing.
1. **Create defendable spaces by fuel reduction, creation of vertical fuel separation zones.** 2. **Maintain safe escape routes for employees and access for emergency services.**	• Reduce tree density. • Reduce presence of mid storey ladder fuels. • Prescribed fire at five-year intervals. • Control coppice re-development. • Remove large coarse woody debris from outer 30m to prevent spot fire escapes.

3. **Protection of community.** 4. **Protect plantations.** 5. **Promotion of water yield to dams.**	
Enhancement of avian habitat – Pardalotes and Tree Martin	• Retain all standing dead trees > 15cm in diameter – small tree hollows. • Limit tree removal of trees > 20cm DBH.
Enhancement of avian habitat (Black Cockatoos)	• Maintain dams on site. • Install cameras to record visitations. • Protect pine plantations to ensure continuous supply of pine cones (a favoured food source).

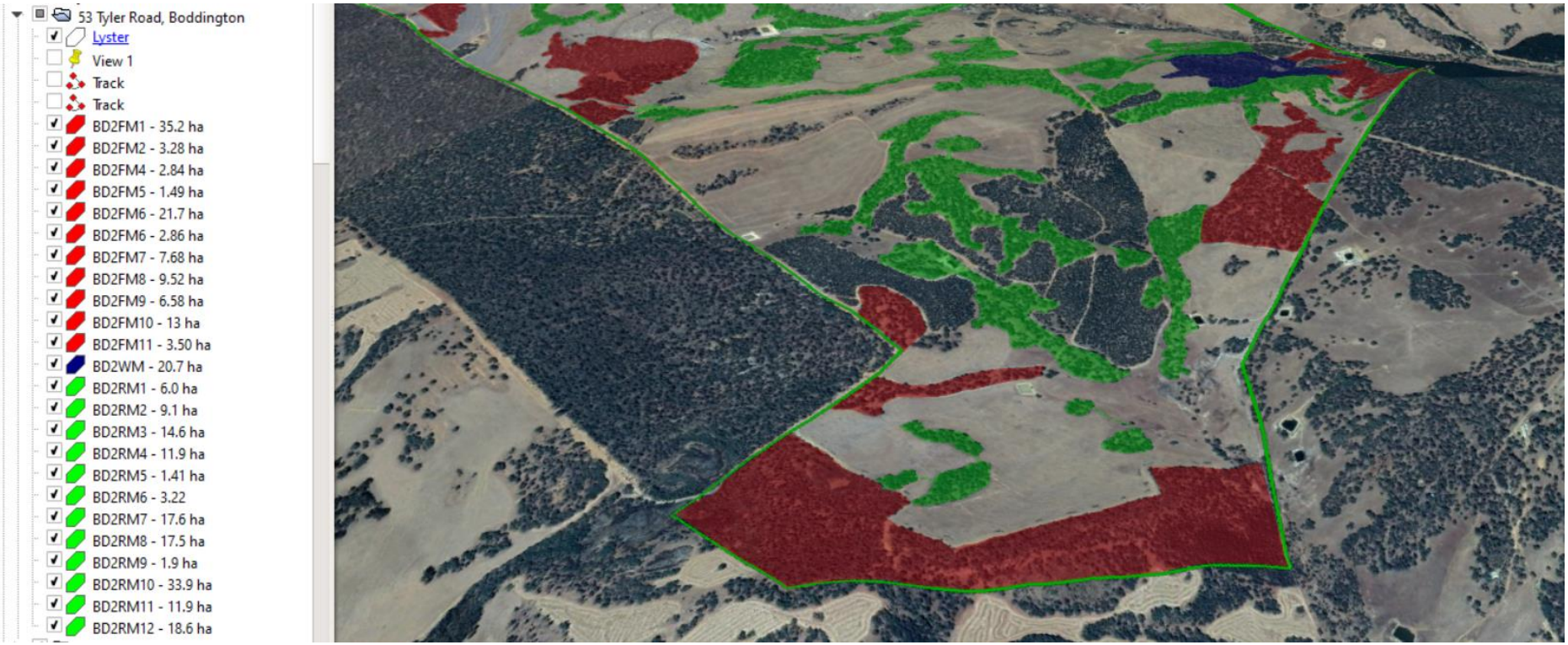

Figure 16 - North East facing slopes, particularly prone to effects of reduced rainfall, due to high evaporation potential.

8. Roading

It will be possible to manage all harvesting and transport from existing roads which were upgraded for harvesting of blue gums upon the property.

Truck turn around will be easily accommodated. No additional roads will need to be constructed.

9. Weeds and other vegetation

The native forest is contained within a larger area production forestry operation. Previous land use was blue gum (Eucalyptus globulus) and prior to that, farming. There are significant potential weed sources. Wilding pines will be managed through regular prescribed burning. Provided fire interval is 7 – 10 years, then pine trees will not be able to reach reproductive maturity before being killed by low intensity fire.

10. Fire

Fire has not been intentionally lit at the property. A significant bushfire burned through the property in 2013, which destroyed significant areas of blue gum plantation.

Fire breaks are maintained chemically or with earthmoving equipment seasonally, in accordance with Shire bushfire notices.

The owners may elect to conduct post-harvest burning under benign conditions.

11. Dieback Management

There is no occurrence of dieback currently expressed in the vegetation as it is not vulnerable. Whether it is present in the soil is unknown.

Notwithstanding consideration of the above, vehicle movements associated with any tree harvesting are preferred to be undertaken in drier soil conditions, and will be required to arrive at the harvest area clean of soil and plant material.

References

Agee, J. K., & Skinner, C. N. (2005). Basic Principles of forest fuel reduction treatments. *Forest Ecology and Management*.

Blyth, J. (1997). *Stream Corridors for bird movement.* Department of Conservation and Land Management.

Burrows, N. D., Neyland, M., & Ruprecht, J. K. (2011). *Review of silviculture in forests of south-west Western Australia.* DPAW.

Department of Conservation and Land Management. (2003). *Silvicultural Practice in the Wandoo Forest.*

Department of Conservation and Land Management. (2018). *Numbat Fauna Profile.*

Department of Environment and Conservation. (2012). *Chuditch (Dasyrus geoffroii) National Recovery Plan - Wildlife Management Program No.54.* Perth: DEC.

Department of Parks and Wildlife. (2014). *FEM Guideline No. 1: Silviculture Guideline for Jarrah Forest.* Department of Parks and Wildlife.

Department of Parks and Wildlife. (2014). *FEM Guideline No.2: Silviculture Guideline for Wandoo Forest.* Department of Parks and Wildlife.

Gould, J., McCaw, L., & Cheney, P. (2007). *Project Vesta Summary.* Retrieved from Bushfire CRC: http://www.bushfirecrc.com/sites/default/files/managed/resource/jim-gould-lachie-mccaw-phil-cheney.pdf

Hussey, P. (2005). *Dead Wood and Wildlife.* Department of Conservation and Land Management.

Hussey, P., & Mawson, P. (2004). *Requirements for native mammals.* Department of Conservation and Land Management.

Huston, R. (2001). *Living with Echidnas.* Department of Conservation and Land Management.

McCaw, W. L. (2012). Managing forest fuels using prescribed fire - A perspective from southern Australia. *Forest Ecology and Management*.

McCaw, W. L., Gould, J. S., Cheney, P. N., Ellis, F. M., & Anderson, W. R. (2012). Changes in behaviour of fire in dry eucalypt forest as fuel increases with age. *Forest Ecology and Management, 271*, 170-181.

Sneeuwjagt, R., & Higgs, N. (1995). Fighting Wildfires: breaking the triangle. *Landscope*.

Sullivan, A. L., Cruz, M. G., Ellis, P. F., Gould, J. S., Plucinski, M. P., Hurley, R., & Koul, V. (2014). *Fire Development, Transitions and Suppression.* CSIRO.

USDA. (2006). *Implementation of the Healthy Forests Initiative Report No. 08601-6-AT.*