Distribution and Fire Response of Threatened and Significant Fauna Species within the Mt. Clarence/Mt. Adelaide Bush Reserves

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Introduction

Prescribed fire is a significant management tool for both hazard reduction and maintenance of biodiversity. However, inappropriate fire regimes may have undesirable consequences including declines or local extinctions of flora and fauna and decreased structural complexity of habitat.

Determining appropriate ecological fire regimes can be difficult as what may be an appropriate fire regime for one species or community may be inappropriate to another species or community. A major challenge for land managers is to be able to have enough background information on all components of an ecosystem and landscape functioning including; plants, animals and their habitat requirements for survival, natural hydrology of site, erosive qualities of soil type, regenerative capacity of the vegetation community, weed invasion threats, feral animal threats. It can take a long time for a manager to build this intimate knowledge of landscape functioning so that the most appropriate fire regime can be determined that reduces the potential for damaging bushfires but is optimal for biodiversity preservation.

This report details the distribution and response to fire of threatened and significant fauna species that occur Mt. Clarence/Mt. Adelaide bush reserves , provides a summary of their response to fire and outlines actions to mitigate impacts of fire on these species.

Fire responses of south coast fauna

There has been limited research into the fire response of the fauna of the south coast region, and therefore an increase in the understanding of the most appropriate fire regimes for the threatened species is a high priority for effective management (DEC 2009). In attempting to design ecological fire management guidelines for 'sensitive fauna' a number of factors should be taken into consideration including information on population conservation status, distribution and the specific taxon's habitat requirements where known. Additional threatening processes may impact on individuals that survive a fire disturbance event, for example through increased predation, lack of food resources, lack of suitable habitat for reproduction or through increased vulnerability of habitat to erosion events. Thus the capacity of populations to persist will also depend on both their immediate response to fire regimes, their resilience to post fire pressures and their capacity to recolonize suitable habitat. No fire regime is optimal for all species, but it is generally agreed that large scale, intense fires present the greatest threat to fauna species in the South Coast Region where as low intensity, patchy fire s has the last impact. The impact of large intense fires is compounded by the fragmented nature of the landscape (DEC 2009).

Behavioural patterns and requirements for shelter and food are two major factors that affect the responses of taxa to fire (Friend 1993). For example, species that nest in tree hollows may avoid the

acute effects of a low intensity fire. Conversely there may be limited food resources for sedentary species in the early post-fire period, whilst mobile species can migrate to unburnt patches to obtain food and shelter (Wilson *et al.* 2010). Fire sensitive fauna are often recognised as those that have specific characteristics such as late seral stage habitat requirements, strong site fidelity, low fecundity, poor dispersal capacity and are vulnerable to other threats such as predation. Fire sensitive fauna are often associated with mesic habitats, wetlands and rock outcrops (Burrows 2008).

The season is also an important factor of a fire regime for some threatened species as they are seasonally vulnerable and/or resistant to fires depending on their life cycle and behaviour .

Barrett *et al.* (2010) defines two general groups of south coast species in terms of their fire response:

Fire sensitive species: these species are generally late successional species, associated with fire sensitive habitats, exist in discrete dispersed populations, have low fecundity or dispersal capacity or are threatened by other processes.

Post fire opportunists. These species are generally flexible in the terms of their habitat and dietary requirements and breeding . They show resilience to diverse fire regimes and can benefit from fire induced habitat regeneration or increased availability of food resources following fire.

Vegetation Units on Mt Clarence/ Mt Adelaide

Sixteen major vegetation units have been recognized to occur in the Mt. Clarence/Mt. Adelaide bush reserves by the *Albany Regional Vegetation Survey* (Sandiford & Barrett, 2010). They are divided into four major groups.

Appendix 1 describes the vegetation units occurring on Mt Clarence / Mt Adelaide Reserve.

Appendix 2 contains a map of the distribution of the vegetation units on Mt Clarence / Mt Adelaide Reserve.

Appendix 3 provides detailed vegetation descriptions of these units and a summary of key points to be considered in relation to fire management in relation these vegetation units.

These vegetation groups and units constitute distinctive habitat types for fauna species present on Mt Clarence/ Mt Adelaide. The following section outlines the distribution of species across these major vegetation groups and units and how the species or groups of species respond to fire.

Distribution and fire responses of threatened and significant fauna species occurring on Mt. Clarence /Mt Adelaide

Threatened Fauna

Black-Cockatoos

All three black cockatoo species have been recorded in the Mt. Clarence/Mt. Adelaide bush reserves. They are all listed on the Threatened Fauna list under the Commonwealth *Environment Protection and Biodiversity Conservation (*EPBC) Act 1999. Increasing habitat clearance and fragmentation are a major threat to these cockatoos. *Phytophthora* dieback is an increasingly widespread disease that seriously impacts on the Banksia woodlands and other vegetation communities that are also vital black-cockatoo habitat.

Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*)

The Carnaby's Cockatoo is listed as 'Endangered' on the Threatened Fauna list under the *EPBC* Act 1999, and is listed under the *Wildlife Conservation Act 1950* under Schedule 1 species ('fauna that is rare or likely to become extinct'), and currently ranked as Endangered.

This species has a shorter, broader bill than the other two species of Black Cockatoo. It is affectionately called the 'Wheatbelt' White-tailed Black-Cockatoo as it mostly nests in wandoo and salmon gum in the cooler months. However, in the drier part of the year (Nov - May), most birds move closer to the south coast where they feed in shrublands, banksia woodlands and eucalypt woodlands. The Carnaby's Cockatoo has been recorded in the Mt. Clarence/Mt. Adelaide bush reserves mainly feeding on marri nuts in the woodland and forest areas (Upland Eucalypt Woodland/Forest). They also feed on pine cones.

Forest Red Tailed Black-Cockatoo *(Calyptorhynchus banksii naso)*

The Forest Red-tailed Black Cockatoo is listed as Vulnerable on the Threatened Fauna list under the *EPBC* Act 1999, and is listed under the *Wildlife Conservation Act 1950* under Schedule 1 species ('fauna that is rare or likely to become extinct'), and currently ranked as Vulnerable

In recent years small groups of the red tailed cockatoos have been regularly sighted in the Mt. Clarence/Mt. Adelaide bush reserves mainly feeding in the tall marri/jarrah woodland areas (Upland Eucalypt Woodland/Forest). There are no records of them breeding in the reserve but they are reliant

on mature forest trees (marri trees need to be 80 - 120 years to form hollows) for suitable breeding habitat.

Baudin's Black-Cockatoo (*Calyptorhynchus baudinii*)

Baudin's Cockatoo is listed as Vulnerable on the Threatened Fauna list under the *EPBC* Act 1999, and is listed under the *Wildlife Conservation Act 1950* under Schedule 1 species ('fauna that is rare or likely to become extinct'), and currently ranked as Endangered.

The species is affectionately called the 'forest cockatoo' as it mostly lives in the deep forests of the south west of Western Australia. They can be distinguished from the Carnaby Cockatoo by the distinctive long top bill which they use to neatly get seeds out of marri and jarrah nuts. The Baudin's Cockatoo has been sighted and officially recorded in the Mt. Clarence/Mt. Adelaide bush reserve many times over the past few decades. Flocks of up to 100 birds can be seen moving between the marri and jarrah forest/woodland areas (Upland Eucalypt Woodland/Forest) feeding on the nuts.

Fire Response of Black-Cockatoos

Fire is not considered a key threatening process acting on these species. The high mobility of these birds means they can escape from fire easily and are therefore not impacted directly by fire, unless very hot fires occur within the nesting season and kill young in the nest. The main impact of fire on these species is the degradation of their habitat through inappropriate fire regimes. Therefore fire intensity and frequency should be such to maintain suitable nesting and feeding trees, allowing for regeneration of marri and jarrah but also the retention of sufficient numbers old trees to enable hollow formation. Jarrah and Marri are both epicormic resprouters and therefore regenerate well after fire. However, if fires are intense and common, the shoot is killed but the plant survives as a coppice, precluding if from forming trunk or branch hollows and possibly limiting its suitability as a food plant (Gill, date unknown).

Some of the obligate seeding food plants that are an important part of the Carnaby Cockatoos diet, for example *Banksia* sp. may be impacted by frequent fire and inappropriate fire intervals.

Western Ringtail Possum

The Western Ringtail Possum is currently listed as VU under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and currently listed in Western Australia under the

Wildlife Conservation Act 1950 under Schedule 1 species ('fauna that is rare or likely to become extinct'), and currently ranked as Vulnerable.

The population of these possums in the Mt. Clarence/Mt. Adelaide bush reserve is part of a small south coastal population and is considered an important population in the species range. These possums particularly favour feeding in peppermint trees *(Agonis flexuosa).* They will also feed in Marri *(Corymbia calophylla)* and jarrah *(Eucalyptus marginata)* woodland/forest areas and in banksia woodland. They build a nest like structure called a dray to sleep in during the day. They favour thick shrubland and peppermint tree areas to build these structures so well established vegetation rather than young regenerating vegetation is more suited to this possum. They can be found generally over the whole of the Mt. Clarence/Mt. Adelaide bush reserve, with only small areas not occupied (Granite Outcrops)

Fire Response:

The Western Ringtail Possum is highly sensitive to fire, particularly where it occurs in a fragmented landscape with limited connectivity.

In Jarrah forests, on a local scale Western Ringtail Possum abundance is related to fire intensity and history: abundance is higher in areas where fire intensity has been low or in areas not burnt for more than 20 years (Wayne *et al* 2005). Other habitat types such as heaths and peppermint over heaths on the south coast are also prone to fire. These vegetation communities can carry hot fires leaving little available post-fire habitat for the western ringtail possum (DEC 2005).

Wayne *et al*. (2005) identified four presumed effects of fire on this species: reduced availability of food resources, loss of shelter sites, reduced canopy continuity and/or direct or indirect death of individuals.

Other Significant Fauna

Birds

The Mt. Clarence/Mt. Adelaide bush reserves fauna survey recognized at least 127 species of bird residing in the reserve (Leighton, 2012). The birds range from very large birds of prey like the sea eagle and southern boobook owl through to very tiny birds like the pardalotes, thornbills and blue wrens. All of these birds have very different feeding niches and habitat requirements.

Fire responses:

Inappropriate fire regimes are recognized as the main threat to many vulnerable and endangered Australian birds (Garnett 1992). In environments such as heath and mallee inappropriate fire regime is the main threat to most declining bird species. Most fire-sensitive threatened birds have low

reproductive output and limited dispersal ability. The persistence of these species is further threatened by habitat fragmentation, which further impacts on their ability to recolonise following fire (Wilson *et al.* 2010).

The abundance of birds decreases to very low levels immediately following a fire but usually recovers within 2-3 years (Burbidge 2003). Insectivores generally increase in abundance after fire and can exceed pre-fire abundance for up to 7 years. Conversely, nectivores decline following fire due to the reduction in the number of flowering plant species in burnt areas. However it is fire intensity that is one of the biggest determinants of post-fire richness and abundance. Low intensity burns have the least impact on bird persistance (Burbidge 2003).

Mammals

The Mt. Clarence/Mt. Adelaide bush reserves fauna survey determined nine native mammals officially residing in the reserve with another two mammals 'suspected' to occur there (Leighton, 2012). They range from large ground dwelling, highly mobile animals like the western grey that potentially could move over the whole area of the reserve through to the very small honey possum which is restricted to fairly dense structured vegetation with an all year round nectar supply.

The response of mammals to fire is variable and some species are recognised as fire sensitive. Recent studies in 2007 – 2010 in Banksia Woodlands in south western Australia provided strong evidence that post fire responses over time for mammals is related to variations in food productivity (Wilson *et al.* 2010). The rate of recovery of vegetation not time per se has been shown to be most important in the successional process for mammals (Fox and Monamy 2007).

Common Brushtail Possum – Koomal *(Trichosourus vulpecula vulpecula)*

In the Albany District the Brushtail Possum is not perceived under threat, although they are not seen in large numbers. The brush tail possum favours feeding in marri *(Corymbia calophylla)* and jarrah *(Eucalyptus marginata)* woodland/forest areas and in Banksia woodlands. These possums are reliant on tree hollows to shelter and rest. Much of their habitat area in the Albany hinterland has been dramatically reduced due to land clearing. Sometimes Brushtail Possums will find refuge in the roof space of human dwellings. The population of these possums in the Mt. Clarence/Mt. Adelaide bush reserve is fairly small as it is restricted to the few areas where there are woodland and forest trees of marri and jarrah trees of a mature enough age so that suitable hollows have formed (this usually is in excess of 100 - 150 years of age) (Marri/Jarrah Coastal Hills Forest- Unit 17).

Fire Response

The brushtail possum is regarded as a post fire opportunist.but it is sensitive to the loss of tree hollows in high intensity fire (Barrett *et al.* 2009, Appendix VII).

Aerial map of the Mt. Clarence and Mt. Adelaide bush reserves showing the main areas of 'known' brush tail possum presence. There may be a few other areas on the south side of the reserve in the Uphill Eucalypt Forests and Woodland areas which also have brushtail possum populations. Further spotlighting surveys in these areas would reveal whether they are present or not.

Honey Possum (*Tarsipes rostratus*)

This small possum is listed as common but limited in occurrence. The species is very diet specific requiring nectar producing plants all year round. They therefore favour proteaceous rich vegetation where plants produce high levels of nectar like Banksia's. During the Mt. Clarence Fauna survey a honey possum was trapped near a *Banksia formosa* thicket (Leighton, 2012). Unfortunately this kind of vegetation community is often flammable in summer months and can be susceptible to high intensity fire.

Fire Response

The honey possum has been recognized as 'fire sensitive' at the species response level. They are sensitive to large, high intensity fires and frequent fires. Although honey possums *(Tarsipes rostratus)* are known to return to burnt areas within 2 – 4 years since fire (Bamford 1986; Everaardt 2003; Richardson and Wooller 1991), higher densities are recorded in older vegetation, with peaks in abundance in vegetation 20 – 30 years since last burnt (Bradshaw *et al.* 2007; Everaardt 2003). Smaller patch burns allow animals to move between burnt and unburnt vegetation with the latter providing refuge and food resources. Long unburnt (50 + years) vegetation still provide shelter and food resources. Resprouters and lignotuber plant species can be used as food resources. Increase in abundance up to 20 – 30 years post fire with capture rates generally low for 4 – 5 years post fire (Barrett *et al.* 2009, Appendix VII).

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Aerial map of the Mt. Clarence and Mt. Adelaide bush reserves showing the main areas in the reserve with the most suitable habitat for honeypossums. It incorporates the vegetation associations listed in the Coastal Dune System; Coastal Heath (unit 3), *Banksia coccinea* Shrubland/Sheoak Open Woodland (unit 14) and some of the Upland Eucalypt Woodland vegetation associations; Coastal Marri/Jarrah Mixed Mallee/Open Scrub (unit 17a), Marri/Jarrah Forest/Peppermint Woodland

Western Pygmy Possum *(Cercartetus concinnus)*

Although no pygmy possums have been recorded in the Mt. Clarence/Mt. Adelaide bush reserves it is suspected they may possibly be present. This small possum is listed as common but limited in occurrence. They have a very specific diet of an all year supply of nectar, pollen and insects and they shelter in flammable vegetation. They are found in floristically diverse vegetation associations mainly with plants from the Proteaceae and the Myrtaceae. They can breed at any time of the year .They seem to select habitat according to the availability of flowering plants rather than structural attributes and at night spend most of their time foraging in trees and large shrubs (Van Dyke & Strahan, 2008)

Fire Response

Western pygmy possums are possibly a little bit more resilient in their response to fire than the honeypossum due to their 'slightly' expanded dietary intake of nectar and invertebrates. Honey possums and western pygmy possums were more abundant in 11 year old Banksia woodland vegetation than in the younger regenerating Banksia woodland (Bamford, 1985; 1986)

Southern Brown Bandicoot (*Isoodon obesulus fusciventer*)

This subspecies of southern brown bandicoot is endemic to south-west Western Australia. The recent fauna survey of Mt. Clarence and Mt. Adelaide found the bandicoot is present in most areas of the reserve where there where dense low vegetation persists. The quenda was previously listed under the *Wildlife Conservation Act 1950* in 1990 as a threatened species. After extensive fox baiting and further surveys it was removed from the threatened list in 1998 and listed as a Priority 5 species (taxa in need

of monitoring - conservation dependent) meaning that its status needs to be kept under review. Quendas are omnivorous, eating insect larvae, fungi (truffles), seeds and some plant material. They leave distinct cone-shaped diggings when searching for food. They are solitary with a home range of three to five hectares and are mostly nocturnal, though sometimes active in the daytime. Weighing between 400g to 1.6kg, the quenda falls within the critical weight range (50g-5.5kg) of mammals that are particularly vulnerable to predation by foxes, cats, dogs and being run over by vehicles.

Fire Response

This mammal falls into a group of post fire opportunists. They are generally flexible in the terms of their habitat and dietary requirements and breeding periods (Barrett *et al*. 2009, Appendix VII).

Grey Bellied Dunnart *(Sminthopsis grisoventer)*

This small carnivorous Dasyurid is listed as common in its abundance. The recent fauna survey of Mt. Clarence and Mt. Adelaide only found one animal so its presence in the reserve is probably fairly limited. It was found in Coastal Marri/Jarrah Mixed Mallee/Open Scrub. Its diet is mainly made up of invertebrates but young lizards and soft fruits are occasionally eaten. Prey larger than 3 cm's is preferred. It tends to search for prey under leaf litter. It tends to shelter under logs and rocks in dense vegetation which is generally highly flammable in the direr months of the year. It breeds in winter and spring.

Fire Response

Dunnarts are not generally observed in vegetation until 22 months post fire. The Grey Bellied Dunnart was found to be most abundant in vegetation which was 5 years post fire (Barrett *et al*. 2009, Appendix VII).

Yellow Footed Antechinus – Mardo *(Antechinus flavipe leucogasters)*

This small carnivorous Dasyurid is listed as common in its abundance. Although none of these species were recorded in the recent fauna survey of Mt. Clarence and Mt. Adelaide it is still possible that this species inhabits the bush reserve. Its diet is mainly made up of invertebrates but may include almost anything from flowers and nectar to small birds and mice. Like most other antechinus's it breeds only once a year in late winter and spring.

Fire Response

It is recognised as a fire sensitive species as it prefers to live in long unburnt vegetation over ten years in age with well developed leaf litter (Barrett *et al.* 2009, Appendix VII).

Western Bush Rat – *(Rattus fuscipes)*

The bush rat is a cover seeking nocturnal animal probably the most common mammal species to be found in the Mt. Clarence/Mt. Adelaide bush reserve (Leighton, 2012).The Bush Rat has a varied diet feeding on other small animals, fibrous leaves , specific grasses, insects, fruits, seeds and fungi has been found to be an important part of the diet in winter. The bush rat is capable of breeding all year round but tends not to breed in winter due to food limitations. In a fine scale study of landscape change and habitat fragmentation in eucalypt remnants, bush rats found closest to the study population were more genetically alike than distant animals (over 500 metres) and that gene flow was so restricted that an animals genetic identity could pinpoint its genetic address. A complementary study found that rapid recovery of populations from such disturbances as fire was mostly surviving animals, not immigrants (Van Dyke & Strahan, 2008).

Fire Response

The bush rat can be impacted upon by habitat disturbance & inappropriate fire regimes as it requires good understorey (Van Dyke & Strahan, 2008).

Frogs

The effect of fire on reptile and frog communities is still largely unclear in Australia (Bamford and Roberts 2003; Friend 1993). In one broad scale experiment, the numbers of calling males of the of *Geocrinia lutea*, were reduced by two thirds after spring burning. This decline was considered to represent the decline in the general population at the time, not just that of the males (Gill date unknown). The recent fauna survey of Mt. Clarence and Mt. Adelaide recognised eight species of frog occurring in different vegetation associations on the bush reserves. These species ranged from the dampland dependent Crineas through to the larger sand burrowing frogs. Most frogs have generalised invertebrate diets so ground dwelling frogs generally require well developed leaf litter. The small Crinea frogs are a good example of a species that are attracted to the special mesic environment created by the granite outcrops surrounded by woodland systems in the Mt. Clarence/Mt. Adelaide bush reserve. These mesic environments may often act as refugia for special mesic adapted species (mesic environments are those with a well balanced supply of moisture) (Burrows *et al.* 2008). The water runoff and ponding effect in winter from the granites is especially important to many of the frog species dependent on water for egg laying and the tadpole phase of their life cycle.

Fire Response

The burrowing frogs like the moaning frog *(Heleioporus eyrei)* and banjo frog *(Limnodynastes dorsalis)* may be protected from the effects of fire by the insulating properties of soil. However, frogs like the tree frog which spend more time off the ground up in foliage areas may be vulnerable to intense fire. Some of the small frogs also use the cryptograms (lichens, algae and mosses) on the granite outcrop

areas for shelter. The cryptogram community is considered fire intolerant with no beneficial effect of fire apparent.

Reptiles

Mt. Clarence and Mt. Adelaide have the full range of reptiles from large goannas through to small skinks and geckoes. They are found in all vegetation communities in all parts of the landscape in the Mt. Clarence/Mt. Adelaide bush reserves. Most reptiles are predatory on smaller organisms. They may require logs or well developed leaf litter as part of their habitat requirements. Some of the reptiles favour the granite outcrop areas for shelter and thermal qualities.

Fire Response

Studies suggest that many species of snakes and lizards are resilient to the short-term effects of fire, due to their preference for open microhabitats and use of burrows, whereas arboreal or surface-dwelling species are less protected (Fox 1978; Friend 1993). Dell and How (1995) examined the response of reptiles to wildfire at Kings Park and found that the longest unburnt sites supported the highest lizard diversity, while the most recently burnt sites were found to have the lowest lizard diversity. Species numbers and abundance was lower in the first year post-fire but appeared to return to pre-fire levels by the second year post-fire. Migration from burnt to adjacent unburnt sites was apparent. Recent studies at Gnangara also confirmed that the response of reptiles to fire was found to be dependent on microhabitat variables associated with time since last fire. A number of species including the common dwarf skink (*Menetia greyii*) preferred older melaleuca sites (more than 16 years since the last fire) compared to younger sites (less than 11 years since the last fire). In contrast the abundance of the skink *Cryptoblepharus buchanni* was correlated with canopy cover. The studies revealed that different habitats created by a range of time since last fire are required to support the reptiles, and the older aged habitat is important for a number of species (Wilson *et al.* 2010).

The burrowing behaviour of most reptiles generally reduces vulnerability to low – medium intensity fires. Direct impact of high intensity fires may be detrimental to non burrowing species. High intensity fire at short intervals possibly would not provide time for suitable habitat to regenerate. Many reptiles may be mid – late successional species (Barrett *et al.* 2009, Appendix VII).

Invertebrates

Invertebrates are a diverse group and exhibit a wide range of life histories and morphologies and are found in many different habitat types. During the Mt. Clarence and Mt. Adelaide bush reserve fauna survey a diverse range of invertebrates were recognized to live in all areas of the reserve ranging from;

millipedes, scorpions, beetles, land snails and a wide range of ground and web dwelling spiders. The Moggridgea trap door group of spiders trapped were found within the Peppermint low forest, Sheoak Open Woodland & Coastal Jarrah/Peppermint mixed mallee/open scrub. This group of spiders is recognised as a relictual invertebrate and some species have been listed as Threatened.

Fire Response

Fire directly impacts on invertebrates by killing them, as well as indirectly by affecting their habitat. Some invertebrate species survive the direct effect of fire by either moving ahead of the fire front, by being protected in the soil or other refugia (e.g. termite mounds) or if they are dormant (Whelan *et al.* 2002). Some species may also survive due to the patchiness of a fire, providing refugia in the unburnt pockets (Whelan *et al.* 2002). Most invertebrates subsequently recolonise burnt areas from unburnt patches (Whelan *et al.*2002), dense crowns of plants (Gandar 1982; Main 1981; Whelan *et al.* 1980), thick layers of leaf litter (Andrew et al. 2000), thick bark on trees, and soil under rocks and in burrows (Main 1981; Warren *et al.* 1987). Species recolonise at different rates, depending on their dispersal ability. The patchiness, intensity, extent and season will all influence the recolonisation capacity of invertebrates (Whelan *et al.* 2002)

Suggestion of Procedures to Minimise Impacts on Significant Fauna With Respect to Fuel Reduction Operations (i.e. Primarily Prescribed Burns.

In terms of fauna, the reserve should be managed for the most fire sensitive, threatened species ie the Western Ringtail Possum, as long as this regime is not detrimental to other threatened or significant species that occur in the reserve.

Therefore a regime of low intensity, low frequency, patchy burns in all vegetation units that this species occurs in is recommended. Ideally the fire interval should be twice the juvenile period of the slowest maturing fire sensitive understorey plant species in the vegetation unit.

This fire regime will benefit the suite of fire sensitive species that occur in the reserve including the, honey possum, the Moggridgea spider, frog species and some of the reptile species as well as fire sensitive plants. There are no foreseen detrimental effects of this fire regime to other threatened or significant fauna occurring within the reserve. The isolated nature of the Mt. Clarence/Mt. Adelaide bush reserve with limited wildlife corridor connections to other bush reserve areas, compounds the impact of fire as animals are unable to escape large fires and have limited sources of other occupied habitat for recolonisation. Therefore fires that are too hot and intense or too frequent could

potentially cause local extinctions of some of the fauna species, even those that are considered post-fire opportunist.

This fire regime also meets the needs of fire sensitive flora. It provides a level of protection to fire sensitive habitats from severe wildfires and it provides for the infrequent burning of these specialized habitats, which is necessary to regenerate them as they begin to senesce some 30–40 years after fire (Burrows 2008).

In addition, consideration should be given to the creation of fire exclusion areas in refugial vegetation units supporting highly restricted, fire sensitive fauna (mesic habitats, rock outcrops and the wetland/dampland areas).

Ongoing monitoring of post-fire habitat regeneration and of Western Ringtail Possum, Black-Cockatoos and other significant fauna populations is highly recommended to establish whether or not fire management aims are being achieve, and that fire opportunist species are not being adversely affected by this regime.

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Appendix 1

Vegetation Descriptions of Vegetation Units Occurring in the Mt. Clarence/Mt. Adelaide Bush Reserves.

(Descriptions extracted from: *Albany Regional Vegetation Survey*, Sandiford & Barrett 2010)

Upland Eucalypt Woodland/Forest Units

Marri/Jarrah Coastal Hills Forest (unit 17) **:** is a diverse unit associated with the granitic coastal hills. It occurs on a variety of soils from gravelly loam, gravelly sand to sandy loam and sand, with granite and lateritic exposures frequently. The structure of this unit is highly variable with both Marri and Jarrah occurring as shrubs or low mallees on the windswept exposed coastal slopes and occurring as an open forest on the deeper soil of more protected slopes and gullies. High floristic diversity, dense tall shrub layers and a sedgeland frequently dominated by *Lepidosperma gracile* and *Cyathochaeta avenacea* are typical of this unit as is the dominance or co-dominance of *Corymbia calophylla* in the overstorey. A wide variety of tall to medium shrubs may dominate or codominate the understorey including *Gastrolobium coriaceum*, *Hakea trifurcata, Hibbertia furfuracea*, *Banksia*

formosa, Taxandria angustifolia, Beaufortia decussata, Hakea elliptica, Bossiaea linophylla, *Hovea elliptica,Acacia leioderma* and *Agonis theiformis.* Common lower shrubs include *Sphaerolobium alatum, Acaciabrowniana* subsp. *browniana, Grevillea pulchella* and *Chorizema rhombeum*.

This unit often merges with Marri/Jarrah Forest/Peppermint Woodland which occurs on deeper moister soil. Less frequently it merges with Jarrah/Marri/Sheoak Laterite Forest (12), which occurs down slope and on shallower more lateritic soil.

Two described sub-units are influenced by landform, soil depth, hydrology and exposure factors causing differentiation in the floristic differences of these sub-units.

17a Coastal Marri/Jarrah Mixed Mallee/Open Scrub

This sub-unit occurs on shallower often laterized soils of the lower coastal hills of Mt Martin and Mt Taylor and is often a stunted closed tall scrub or tall open scrub. Common species include *Corymbia calophylla, Eucalyptus marginata, Hakea elliptica, Hakea trifurcata, Agonis theiformis, Gastrolobium*

coriaceum, Acacia browniana subsp *browniana, Kingia australis, Anarthria prolifera* and *Tetraria octandra.*

17b Marri/Jarrah Open Forest

This sub-unit occurs on mid to upper slopes of the coastal hills on deeper soil than sub-unit 17a. Common species include *Agonis theiformis, Gastrolobium coriaceum, Hakea trifurcata, Hakea elliptica, Bossiaea linophylla, Leucopogon verticillatus, Hovea elliptica, Hibbertia furfuracea, Hakea florida, Banksia formosa, Acacia browniana* subsp *browniana, Xanthosia rotundifolia, Chorizema rhombeum, Xanthorrhoea preissii, Xanthorrhoea platyphylla, Crowea angustifolia* subsp *angustifolia, Sphaerolobium alatum, Lepidosperma gracile, Cyathochaeta avenacea, Tetraria octandra, Stylidium spathulatum, Lomandra pauciflora* and *Tetrarrhena laevis.*

Marri/Jarrah Forest/Peppermint Woodland (unit 10)**:** is found on well drained sand and sandy loam on hill slopes and adjacent to larger creeks and rivers. The structure varies from a low open forest on exposed coastal slopes to open forest in protected gullies. *Eucalyptus marginata* may be a sub-dominant canopy species with *Agonis flexuosa* usually forming a sparse secondary tree stratum. The understorey is not very diverse and often dominated by a *Hibbertia furfuracea* Open Heath over *Tremandra stelligera* Low Open Shrubland, Mixed Open Sedgeland and *Pteridium esculentum* Herbland. A tall shrubland of *Bossiaea linophylla* is sometimes present with *Gastrolobium bilobum* present near granite outcrops and *Trymalium odoratissimum* and *Lasiopetalum floribundum* present on wetter sites. Sedges include those typical of both sandy and granitic soils and the grasses *Tetrarrhena laevis* and *Microlaena stipoides* frequently occur on damper sites. On Mt. Clarence/Mt Adelaide this unit usually merges with Marri/Jarrah Coastal Hills Forest (17) which occurs on drier shallow soils and with *Gastrolobium bilobum/Hakea elliptica* Granite Shrubland/Yate Woodland around granite outcrops.

Jarrah Woodland (unit 11)**:** is found on grey sand on lower to middle slopes on the coastal and near coastal hills including Mt Clarence/Mt. Adelaide. It is not as diverse floristically as other Jarrah dominated units and has an understorey dominated by species typical of deep well-drained sandy soils. The canopy is relatively open with *Corymbia calophylla* occasionally present. The understorey is often a *Taxandria parviceps* tall shrubland above one or two lower open shrub layers, an *Anarthria scabra/Hypolaena exsulca* Sedgeland and mixed open herbland dominated by *Dasypogon bromeliifolius*, and/or *Patersonia umbrosa* and *Pteridium esculentum*. Common understorey shrubs include *Pultenaea reticulata,Melaleuca thymoides, Acacia pulchella, Bossiaea praetermissa, Leucopogon rubricaulis, Xanthosia rotundifolia* and *Boronia crenulata.* Jarrah Woodland often occurs down slope from Marri/Jarrah Forest/Peppermint Woodland. This unit has floristic affinities with

Coastal *Banksia ilicifolia/*Peppermint Low Woodland (4) but differs in the presence and dominance of *Eucalyptus marginata, Taxandria parviceps, Pteridium esculentum* and *Patersonia umbrosa* and the absence of *Agonis flexuosa, Adenanthos cuneatus, Astroloma baxteri, Amperea ericoides* and *Hibbertia racemosa.* Around the lower slopes of Mt Adelaide these two units appear to intergrade.

Jarrah/Marri/Sheoak Laterite Forest (unit 12): Jarrah/Marri/Sheoak Laterite Forest is found on well drained shallow loamy/sandy soil, with outcropping laterite, usually occurring on the crests and middle slopes of low relief hills and plateaus with occasional occurrences on lower slopes. Canopy structure varies from a low woodland to an open forest and both *Eucalyptus marginata* and *Allocasuarina fraseriana* may be present as sole canopy species. *Banksia grandis* is often present as a secondary tree strata or a tall shrub layer. The understorey is often relatively open though structurally diverse with shrub, sedge and herb layers well developed. Common shrub species include *Bossiaea linophylla, Beaufortia*

decussata, Hakea florida, Hakea amplexicaulis, Agonis theiformis, Leucopogon verticillatus, Isopogon

longifolius, Xanthorrhoea platyphylla, Acacia browniana subsp *browniana, Xanthosia rotundifolia, Tetratheca setigera, Sphaerolobium alatum, Hovea chorizemifolia, Hibbertia amplexicaulis* and in western areas *Bossiaea ornata.* The sedge layer is typified by the co-dominance of four sedges *Anarthria prolifera, Tetraria octandra,Tetraria capillaris* and *Desmocladus fasciculatus* with *Cyathochaeta avenacea* and *Lepidosperma gracile* occasionally present. Common herbs include *Stylidium amoenum, Conostylis setigera, Logania serpyllifolia, Patersonia umbrosa, Opercularia hispidula, Lomandra pauciflora, Lindsaea linearis* and *Lomandra sericea..*

Where drainage is impeded over lateritc soils, this unit often abuts *Hakea* spp Shrubland/

Woodland Complex (31). It is floristically most similar to Marri/Jarrah Coastal Hills Forest (17) and differs in its more open structure, the absence of *Hibbertia furfuracea, Crowea angustifolia, Hovea elliptica, Hakea elliptica, Gastrolobium coriaceum, Chorizema rhombeum,* and *Stylidium spathulatum* and rarity of *Banksia formosa* and *Hakea trifurcata,.*

Jarrah/Sheoak Sandy Woodland (unit 13) **:** is found on the northern gentle middle to lower on Mt. Clarence/Mt. Adelaide on sandy soil overlying laterite. This unit usually occurs between Jarrah/Marri/Sheoak Laterite Forest (12) and *Banksia coccinea* Shrubland /Sheoak Open Woodland (14) and shares many species with these units. The identifying features of this unit are a canopy of *Eucalyptus marginata,* and *Allocasuarina fraseriana* over secondary low tree stratum containing *Banksia attenuate & B grandis.*The understorey is typically very diverse though species and structural diversity decreases with age. A low open woodland of *Banksia attenuata* is often present as a

secondary tree strata over a tall open scrub, open heath, low shrubland, sedgeland and herbland. Dominant understorey species include *Banksia grandis*, *Beaufortia decussata*, *Persoonia longifolia*, *Melaleuca thymoides*, *Adenanthos cuneatus, Agonis theiformis*, *Isopogon longifolius*, *Leucopogon glabellus*, *Gompholobium scabrum*, *Daviesiaflexuosa*, *Daviesia incrassata*, *Xanthosia rotundifolia*, *Beaufortia anisandra, Astroloma baxteri, Cyathochaeta equitans, Anarthria scabra, Tricostularia elatior* subsp. *elatior, Anarthria prolifera* and *Dasypogon bromeliifolius.* On lower slopes *Eucalyptus marginata* is usually absent and *Taxandria parviceps* is often the dominant shrub over a less diverse lower shrub layer and dense *Anarthria scabra, Dasypogon bromeliifolius* sedgeland/herbland.

Comments

Key structural components of this unit are highly susceptible to Phytophthora dieback including *Banksia attenuata, B. grandis, Gompholobium* spp. and *Daviesia* spp. and occurrences with dieback infestations were structurally and floristically depauperate.

Coastal Dune System Units

Coastal Heath (unit 3) **:** The mixed open heath is very diverse, occurring with clumps of *Agonis flexuosa* common. They typically occur on a range of soils but most commonly light grey sand . Common larger shrubs include those; *Bossiaea linophylla, Banksia grandis, Hakea florida, Hibbertia furfuracea* (typical of lateritic and granitic soils)*, Jacksonia horrida, Adenanthos cuneatus, Leucopogon obovatus,* (acidic sand) and *Acacia cochlearis*, *Spyridium globulosum* and less frequently *Adenanthos sericeus* and *Banksia praemorsa* (alkaline soils). Other typical species include *Hibbertia racemosa, Pimelea rosea* subsp *rosea, Amperea ericoides, Logania serpyllifolia, Allocasuarina humilis, Platysace compressa, Loxocarya cinerea, Lepidosperma densiflora, Anarthria prolifera* and *Lyginia* spp.

Four sub-units are described:

3a Coastal heath

This is the most widespread of the sub-units and is described above.

3c *Darwinia diosmoides* Coastal heath - This sub-unit is found on the lower slopes of Mt Adelaide and is distinguished by the dominance of *Darwinia diosmoides* in the understorey.

3d *Allocasuarina fraseriana* Woodland/Coastal Heath.

A large area of this sub-unit is found on the protected northern slopes of the coastal hills west of the prison. This sub-unit was not sampled but the common understorey species appear the same as those in the coastal heath subunit (3a).

Peppermint Low Forest (unit 2): A dense canopy of *Agonis flexuosa* (Peppermint) is characteristic of this unit with the structure varying from a closed heath on exposed coastal slopes to a low closed forest in swales with shrub species often sub or codominant in exposed areas. A tall shrubland of *Spyridium globulosum, Adenanthos cuneatus, Bossiaea linophylla* and *Leucopogon obovatus* is usually present over an open or closed sedgeland with *Rhagodia baccata, Hardenbergia comptoniana* and *Clematis pubescens* common. Only a small area of this unit is to be found on the southern slopes of Mt. Clarence where the soil profile of sandy soils becomes deep enough.

***Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland** (unit 14)**:** This unit has been nominated as a Threatened Ecological Community and is currently a Priority 1 ecological community as it is highly susceptible to Phytophthora dieback with infestations resulting in greatly reduced floristic and structural diversity. This unit appears to be restricted to the Albany region. It

is found on deep white/light grey sand on the lower slopes and valleys, usually occurring just upslope of seasonally wet drainage lines. With the exception of occurrences on the lower slopes of Mt. Martin and Mt. Adelaide, it is absent from the coastal fringe. This unit is floristically very diverse and structurally quite variable. On the western lower slopes of Mt. Adelaide it can be identified by the Bankisa coccinea tall shrub layer over a diverse heath dominated by *Melaleuca thymoides* and *Jacksonia spinosa.* Typically *Allocasuarina fraseriana,* and *Banksia attenuata* can be present as emergents or as a low open woodland above the *Banksia coccinea.* Dominant heath species are *Melaleuca thymoides, Adenanthos cuneatus, Leucopogon rubricaulis, Phyllota barbata, Hypocalymma strictum* and *Leucopogon glabellus.* Common sedges and herbs include *Anarthria scabra, Lyginia barbata, Schoenus caespititius, Anarthria prolifera, Anarthria gracilis* and *Cyathochaeta equitans*. *Banksia coccinea* sometimes forms dense thickets over a sparse understorey and dense sedgeland. *Banksia coccinea* is a serotinous obligate reseeder and the absence of this species from otherwise healthy and diverse vegetation suggests that past fire regimes may be responsible.

Granite Outcrops Units

***Hakea* spp Transitional Shrubland** (unit 17) **:** is a restricted to colluvial gravelly/sandy soil overlying or around granitic pans and exposures. A tall shrub layer dominated by one of three *Hakea* species - *Hakea trifurcata, H. prostrata* or *H. undulata,* often in association with *Agonis theiformis,* is characteristic of this unit which may have an emergent or very open canopy of *Eucalyptus marginata* and *Corymbia calophylla..* This unit can be found on the north western side of the Mt. Adelaide hill and the boardwalk takes people through theis vegetation community. The structure of this unit varies with areas dominated by *Hakea trifurcata* tending to be denser than those dominated by either *Hakea prostrata* or *Hakea undulata*. Lower shrub strata are open, typically an open low shrubland occurs over an open to very open sedgeland. Understorey species are often those indicative of gravelly soils including *Agonis theiformis, Bossiaea ornata, Banksia dallanneyi, Hovea trisperma, Astroloma*

pallidum, Calectasia grandiflora, Mesomelaena tetragona and Mesomelaena stygia subsp. *stygia*. This unit often grades into adjacent vegetation, usually Marri/Jarrah Coastal Hills Forest (17) or Marri/Jarrah Forest/Peppermint Woodland (10) and compared to other granitic shrublands appears restricted to deeper sandier soil overlying or surrounding granitic pans.

(Comments from Libby Sandiford - This unit was not well surveyed and it appears to be a transitional unit between true granitic outcrop units and adjacent woodland/forest units particularly Units 10 and 17 with which it merges. The boundaries between these units are not always clear, especially where *Hakea trifurcata* dominates. Further work is required to clearly define this unit and other shrublands associated with granite which, in south Western Australia, are known for their floristic variability (Wardell-Johnson and Williams 1996; Smith and Sage 2006). The distribution of this unit outside the survey area is not known however the overlap of common species within this unit suggest it may be restricted to the southern areas of the Darling Botanical District.)

***Taxandria marginata* Granite Shrubland** (unit 24)**:** is restricted to granite outcrops where it occurs on skeletal grey/brown or dark brown gravelly loam. *Taxandria marginata* is the dominant shrub with *Hakea drupacea* and/or *Anthocercis viscosa* sometimes forming a taller shrub stratum. *Lepidosperma angustatum* is the dominant sedge with *L drummondii* co-dominant in some areas and a very open shrubland or low shrubland including *Dodonaea ceratocarpa, Eutaxia myrtifolia Verticordia plumosa, Andersonia sprengelioides* and *Pimelea imbricata* subsp *imbricata* is often present. *Borya nitida, Borya sphaerocephala, Stypandra glauca* and *Cheilanthes austrotenuifolia* are the dominant perennial herbs. Moss beds may occur on the broad granite sheets between the shrublands, supporting a very diverse geophyte and annual flora. This unit is frequently surrounded by *Gastrolobium bilobum/Hakea elliptica* Granite Shrubland/Yate Woodland (23).

(Comments from Libby Sandiford - Granite exposures between the shrublands were included when mapping this unit as these frequently contained moss swards. Degradation of moss beds by weed invasion & rabbit grazing, were observed during the survey. Grazing by rabbits resulted in the loss of moss beds, increased weed presence and decreased density and diversity of geophytes. Common weeds observed included members of the Iridaceae with infestations of **Watsonia* spp., **Gladiolus undulatus* and **Romulea rosea* common on outcrops on Mt Melville, Mt Clarence, Mt Adelaide and around Quaranup).

***Gastrolobium bilobum/Hakea elliptica* Granite Shrubland/Yate Woodland** (unit 23) **:** is found fringing granite outcrops with most occurrences on upper slopes and hill crests. Soils are typically orange brown or brown clay loams. Dense stands of *Gastrolobium bilobum* are the distinctive feature of this unit with a sparse overstorey of *Eucalyptus cornuta* often present. In some areas *Hakea elliptica* is the dominant shrub forming thickets (23b). These areas often grade into Marri/Jarrah Coastal Hills Forest (17) and Marri/Jarrah Forest/Peppermint Woodland (10) units that occur down slope.

***Acacia sulcata/Leucopogon assimilis* Granite Shrubland** (unit 25)**:** is found on and around broken granite exposures on skeletal loam or gravelly loam soil which appear to have some clay content. The structure is usually an open shrubland over low shrubland over an open sedgeland and very open grassland of *Neurachne alopecuroidea.* Common species include those typical of either granite outcrops or gravelly clay soil including *Acacia sulcata* subsp *sulcata, Leucopogon* aff *assimilis, Hemigenia podalyrina, Dodonaea ceratocarpa, Leucopogon pendulus,Allocasuarina humilis, Leucopogon* sp. Coujinup*, Andersonia sprengelioides, Hibbertia microphylla, , Boronia subsessilis, Calytrix* sp Esperance, *Anarthria gracilis, Mesomelaena stygia, Desmocladus asciculatus, Lepidosperma angustatum, Conostylis setigera* subsp *setigera* and *Goodenia caerulea.* This vegetation association has been recognised on the north eastern slopes of Mt. Adelaide and the south western slopes of Mt. Clarence.

Wetlands & Damplands Units

***Callistachys* spp Thicket** (unit 36) **:** occurs where local soaks or seepages occur on minor drainage lines, flats, gullies and slopes, on sandy to peaty soil. This vegetation association occurs in small patches most noticeably on the southern sides of Mt. Clarence and Mt. Adelaide. It is dominated by a canopy of *Callistachys lanceolata*, either as shrubs or trees. The understorey is heterogeneous reflecting both small patch size and soil moisture. Species diversity and density appears to thin as the canopy closes over. Commonly recorded species include *Pteridium esculentum, Leptocarpus tenax, Baumea juncea, Lepidosperma striatum, Leucopogon obovatus, Hibbertia cuneiformis, Homalospermum firmum, Aotus intermedia, Gahnia decomposita* and *Anarthria prolifera*.

Mixed *Banksia littoralis* Open Woodland (unit 45) **:** was a patchy unit encompassing *Banksia littoralis* low open woodland on the lowest eastern slopes of Mt. Adelaide. It grows in small depressions or along minor drainage lines but does not show uniformity in understorey species. The understorey is either a shrubland or open heath over a sedgeland. Dominant shrub species, recorded at different sites included *Astartea laricifolia, Taxandria parviceps, Taxandria fragrans* and *Xanthorrhoea preissii*. *Lepidosperma effusum* was a dominant in some modified sites. The presence of species more typical of well drained sandy sites including *Melaleuca thymoides, Dasypogon bromeliifolius* and *Patersonia umbrosa* suggest that some sites are reasonably free draining.

(Comments from Libby Sandiford - All areas of this unit were small in size and unhealthy *Banksia littoralis* trees were frequently observed, possibly reflecting changing hydrology or the presence of Phytophthora dieback. The dominant species, *B. littoralis* is highly susceptible to Phytophthora dieback).

Appendix 3

A Summary of Key Points to be Considered in Relation to Fire Management in Relation to the Mt. Clarence/Mt. Adelaide Vegetation Units.

The Upland Eucalypt Woodland/Forest

Marri/Jarrah Coastal Hills Forest (unit 17)

Coastal Marri/Jarrah Mixed Mallee/Open Scrub (unit 17a)

Marri/Jarrah Open Forest (unit 17b)

Marri/Jarrah Forest/Peppermint Woodland (unit 10)

Jarrah Woodland (unit 11)

Jarrah/Marri/Sheoak Laterite Forest (unit 12)

Jarrah/Sheoak Sandy Woodland (unit 13)

Mt. Clarence has over half of it's area vegetated with these upland eucalypt woodlands and forests units. It is these units that create the best habitat for many of the 'Threatened Species Listed Fauna' like the Black Cockatoos and the western ring tailed possum.

- Marri/jarrah woodlands & forest are sensitive to moderate to high intensity of fire that will kill mature plants. Flame residence time is an important factor.
- Jarrah and Marri are both epicormic resprouters and therefore regenerate well after fire. However, if fires are intense and common, the shoot is killed but the plant survives as a coppice, precluding if from forming trunk or branch hollows and possibly limiting its suitability as a food plant.
- There can be a significant build up of leaf litter around the tree base which may increase fire intensity and flame height
- Of 639 plants surveyed in the jarrah forest and associated ecosystems, 97% of understorey species reached flowering age within three years and all by five years (Burrows et al, 2008)
- Even where trees are not killed outright by fire, considerable limb death may occur and it may take decades for the canopy to recover fully. Recovery by basal coppicing can also be unreliable
- Decline of some of the members of the Proteaceae may occur with long fire free interval and requires monitoring

Coastal Dune System

Coastal Heath (unit 3)

Peppermint Low Forest (unit 2)

Banksia coccinea Shrubland/Sheoak Open Woodland (unit 14)

The coastal dune systems are mainly present in the Mt. Clarence/Mt. Adelaide bush reserves down the eastern and south eastern ends of the reserve.

- Serotinous obligate seeders are dominant in many of these mallee heath systems
- Successful recruitment of seeder species may be dependent on adequate rainfall in early years after fire, seedling mortality may be high
- The mallee component of these systems appear to be resilient to frequent intense fires, however recruitment appears to be sporadic and is poorly understood
- Consider presence of *Phytophthora* and the potential to increase impact on spread of the pathogen afte fire or to introduce pathogen during fire management
- Decline of some of the members of the Proteaceae may occur with long fire free interval and requires monitoring

Granite Outcrops:

Hakea spp Transitional Shrubland (unit 17)

Taxandria marginata Granite Shrubland (unit 24

Gastrolobium bilobum/Hakea elliptica Granite Shrubland/Yate Woodland (unit 23)

Acacia sulcata/Leucopogon assimilis Granite Shrubland (unit 25)

The granite outcrop areas on Mt. Clarence have many mesic environments as a result of the rocks harvesting water abilities and therefore refugial opportunities are provided for fire sensitive species.

- The thin bark cover/ smooth bark on the yate trees can make them more susceptible to being killed by even mild fire
- Granite outcrops and their surrounds within woodland systems may act as refugia for mesic adapted species (mesic environments are those with a well balanced supply of moisture)
- Due to the higher ratio of seeders to resprouters in granite communities they are sensitive to fire and frequent fire
- Granite communities are frequently characterised by endemic flora including threatened flora

- Successful recruitment after fire may depend on adequate rainfall in early years and seedling mortality is high
- Cryptograms (lichens, algae and mosses) gnamma and Borya communities are considered fire intolerant with no beneficial effect of fire apparent
- Runoff and ponding of water may predispose susceptible plant species to Phyopthora dieback , consider the potential to increase impact of spread of this pathogen after fire
- Coastal granite communities in particular may be affected by aerial cankar which may affect population viability and vigour.

Wetlands and Damplands

Callistachys spp Thicket (unit 36

Mixed *Banksia littoralis* Open Woodland (unit 45)

Mt. Clarence/Mt. Adelaide bush reserves has a few areas on its slopes which are seasonally wet and contain, *Callistachus lanceolata* Thicket and low open woodland of mixed *Banksia littoralis*/ paperbark woodland . These tend to all be on the eastern and southern sides of the bush reserve.

- Wetlands often accumulate organic rich soils which accumulate over many years.
- Loss of fringing and catchment vegetation due to fire events can result in altered hydrology and water quality.
- Removal of the organic rich soils may have consequences changing the soil nutrient status, its water retention capacity, root exposure, cracked soils and some of the sloping sites may have excessive erosion rendering the site unsuitable for seedling reestablishment.
- Dominant resprouter species may fail to resprout after hot fires due to lignotuber damage
- Many dominant rushes (Restionaceae) are killed by fire and rely on soil stored seed for recruitment
- Intense fire can damage the structure of paperbark (*Melaleuca preissiana, M. rhaphiophylla, M. cuticularis*) woodlands
- Wet areas are vulnerable to weed invasion especially after fire
- Several frog and crustacean species are dependant on wetland reed and rush habitat

Coastal Dune System

Coastal Heath (unit 3)

Peppermint Low Forest (unit 2)

Banksia coccinea Shrubland/Sheoak Open Woodland (unit 14)

The coastal dune systems are mainly present in the Mt. Clarence/Mt. Adelaide bush reserves down the eastern and south eastern ends of the reserve.

- Serotinous obligate seeders are dominant in may of these mallee heath systems
- Successful recruitment of seeder species may be dependent on adequate rainfall in early years after fire, seedling mortality may be high
- The mallee component of these systems appear to be resilient to frequent intense fires, however recruitment appears to be sporadic and is poorly understood
- Consider presence of *Phytophthora* and the potential to increase impact on spread of the pathogen after fire or to introduce pathogen during fire management

Granite Outcrops:

Hakea spp Transitional Shrubland (unit 17)

Taxandria marginata Granite Shrubland (unit 24

Gastrolobium bilobum/Hakea elliptica Granite Shrubland/Yate Woodland (unit 23)

Acacia sulcata/Leucopogon assimilis Granite Shrubland (unit 25)

The granite outcrop areas on Mt. Clarence have many mesic environments as a result of the rocks water harvesting abilities and therefore refugial opportunities are provided for fire sensitive species.

- The thin bark cover/ smooth bark on the yate trees can make them more susceptible to being killed by even mild fire .
- Granite outcrops and their surrounds within woodland systems may act as refugia for mesic adapted species (mesic environments are those with a well balanced supply of moisture)
- Due to the higher ratio of seeders to resprouters in granite communities they are sensitive to fire and frequent fire
- Granite communities are frequently characterised by endemic flora including threatened flora
- Successful recruitment after fire may depend on adequate rainfall in early years and seedling mortality is high
- Cryptograms (lichens, algae and mosses) gnamma and *Borya* communities are considered fire intolerant with no beneficial effect of fire apparent
- Runoff and ponding of water may predispose susceptible plant species to *Phytopthora* dieback , consider the potential to increase impact of spread of this pathogen after fire

Wetlands and Damplands

Callistachys spp Thicket (unit 36)

Mixed *Banksia littoralis* Open Woodland (unit 45)

Mt. Clarence does have a few areas on its slopes which are seasonally wet and contain, *Callistachus lanceolata* thicket and low open woodland of mixed *Banksia littoralis* and paperbark woodland . Wetlands often accumulate organic rich soils which accumulate over many years. Loss of fringing and catchment vegetation due to fire events can result in altered hydrology and water quality. Removal of the organic rich soils may have consequences changing the soil nutrient status, its water retention capacity, root exposure, cracked soils and some of the sloping sites may have excessive erosion rendering the site unsuitable for seedling reestablishment. Wetland fauna may be susceptible to fire disturbance in these systems.

- Dominant resprouter species may fail to resprout after hot fires due to lignotuber damage
- Many dominant rushes (Restionaceae) are killed by fire and rely on soil stored seed for recruitment
- Intense fire can damage the structure of paperbark (*Melaleuca preissiana, M. rhaphiophylla, M. cuticularis*) woodlands
- Wet areas are vulnerable to weed invasion especially after fire
- Several frog and crustacean species are dependant on wetland reed and rush habitat