Fire Management Guidelines: Eastern Pygmy Possum

(Mark Schuster, Bushfire Technical Officer, Ku-ring-gai Council)

Introduction:

One of the threatened species within Ku-ring-gai LGA is the Eastern Pygmy-possum (*Cercartetus nanus*) listed as Vulnerable under the NSW *Biodiversity Conservation Act 2016*. The Eastern Pygmy-possum (EPP) is a small nocturnal marsupial, known to inhabit multiple vegetation types ranging from heath to rainforest and is rarely observed outside formal surveys. In the Ku-ring-gai context, the preferred habitat is either woodland or heath, as the species is highly dependent on flowering banksia species – particularly *Banksia ericifolia* (the heath banksia) as its primary food source (Ku-ring-gai Council, 2020).

The Eastern Pygmy-possum (*EPP*) could be termed a 'flagship' species for biodiversity in Ku-ring-gai LGA. This small marsupial, not much larger than a mouse, has been the subject of intensive research and recent field work in the bushland precincts of Ku-ring-gai, particularly from 2015 until today (see Ku-ring-gai Council and WildThings NSW 2017; Ku-ring-gai Council, 2019 and Ku-ring-gai Council, 2021).

EPPs feed primarily on nectar and pollen collected from banksias, eucalypts and bottlebrushes, making them important pollinators of heathland plants. When flowering is scarce, they supplement their diet with arthropods and soft fruit. Eastern Pygmy-possums shelter in a spherical nest of bark and leaves in a tree hollow or cranny. They appear to be mainly solitary, each individual using several nests, with males having non-exclusive home ranges of about 0.68 hectares and females about 0.35 hectares. Whilst young can be born whenever food sources are available, locally, it appears there are two main breeding events in June-September and another in November-February. Eastern Pygmy-possums can enter periods of torpor to reduce energy expenditure, particularly in winter, with their body curled, ears folded and internal temperature dropping to match their surroundings (sourced from Ku-ring-gai, 2020).

However, the heath banksia, *Banksia ericifolia*, is considered a particularly good and reliable food source for the species and is nearly always co-incident with EPP distribution.

Bushland reserves with large tracts of intact remnant vegetation and with connectivity to Ku-ring-gai Chase National Park and Garigal National Park in the north and east of the LGA remain a stronghold for the population of Eastern Pygmy-possums in Ku-ring-gai, with continuing evidence of successful breeding events (Ku-ring-gai Council, 2020).

Factors threatening the survival of the Eastern Pygmy-possum include habitat loss and fragmentation leading to isolated sub-populations with little opportunity for dispersal, inappropriate fire regimes that remove nectar-producing understorey plants, the loss of nest sites due to land clearing, and predation by foxes and cats. Fires may include prescribed burns (hazard reduction and ecological burns) or wild fires. Within the LGA, prescribed burns for either ecological or hazard reduction purposes are generally restricted in their frequency (depending on the vegetation type and proximity to residential areas), intensity and size (to ensure fauna connectivity of habitat to unburnt areas), however in some circumstances actions determined necessary to protect life and property are unavoidable (Ku-ring-gai Council, 2020).

The Action Plan for Australian Mammals 2012 (Woinarski et.al.,2014)states that for both Threatened and Near Threatened status species, impacts from inappropriate fire regime are the second highest threatening process of species survival – number one threatening process being predation by cats and the third ranking threat being predation by the red fox. There can be little doubt that inappropriate fire regimes threaten this cryptic species with its reliance on the mid-stratum of woodlands/forests for its life cycle needs.

Purpose:

With the Hornsby Ku-ring-gai Bushfire Risk Management Plan (HKBFRMP) and 5-year program nearing approval, a number of hazard reduction prescribed burns are planned by NSW National Parks and Wildlife Service (NPWS), Rural Fire Service (RFS) and Ku-ring-gai Council in the extensive bushland estate along the northern and eastern boundaries of the LGA – which are the primary habitat areas of existing EPP populations.

Typically, these hazard reduction burns are implemented to reduce fuel loads to lower levels and this often ‘ targets’ the minimisation/removal of the elevated stratum (shrub layer). This is because this layer is often the cause of fire laddering – where a ground-based fire can move into the canopy and also because this layer causes the fire to easily progress across the landscape (horizontal laddering). As EPPs heavily rely on the elevated stratum for food resources (i.e. particularly *Banksia* species), shelter and breeding, there may be potential impacts on species viability in areas scheduled for hazard reduction activities. Figure 1 illustrates the placement of the 2021-2026 regional burn program. It can be noted that many of these burn blocks overlay primary habitat and population concentrations of the EPP – along the bushland-urban interface zones of the northern and eastern sectors of the LGA.

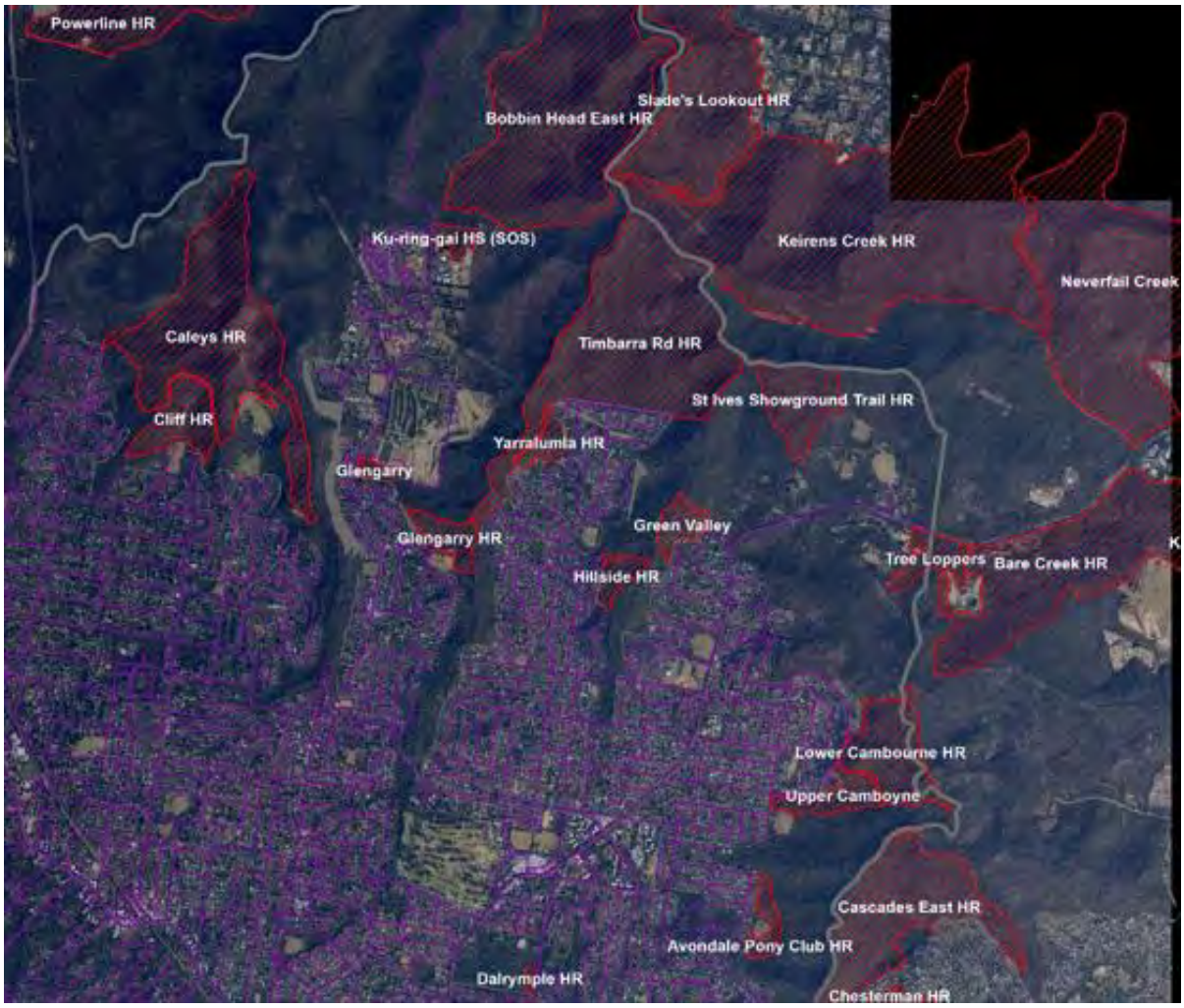

Figure 1. Depicts placement of Hazard Reduction Burns, northern and eastern sectors of Ku-ring-gai LGA – 2021 - 2026

The aim of this guideline is to develop a framework for adaptive fire management actions to ensure for the continuation of both EPP habitat and viable populations. Theses recommended actions can then be incorporated into the burn planning mechanisms prior to undertaking on-ground fire management.

Results - Distribution, Ecology and Fire Impacts

Figures 2 and 3 (below) shows the distribution of the EPP from the most recent 2020 survey (Ku-ring-gai Council, 2021) and from the earlier 2015 surveys. Many of these survey points will be impacted by Hazard Reduction burns during the next 5-year program, as well as large tracts of (unsurveyed) suitable habitat. Due to long-term occurrence of both wildfire and planned burning (for essential hazard reduction activities along the bushland-urban interface),

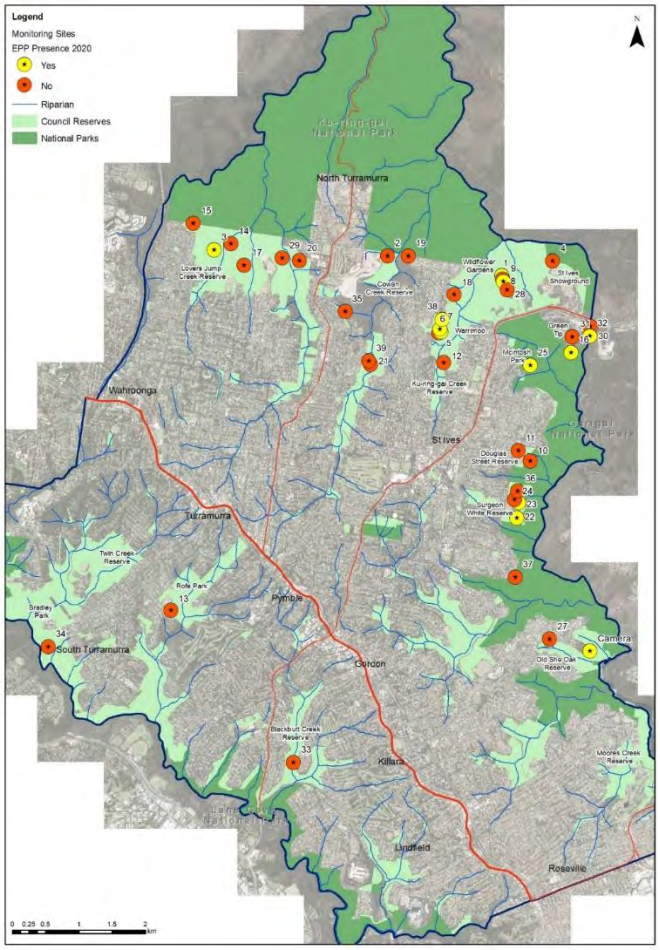

Figure 2. Indicates presence/absence of the EPP at the 2020 nest box survey sites (from Ku-ring-gai Council, 2021)

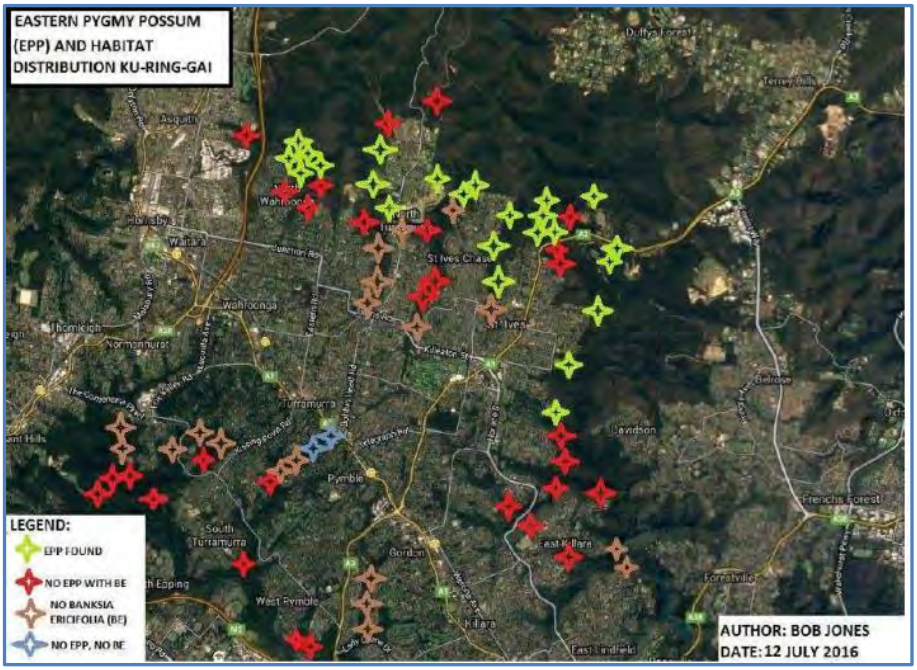

Figure 3. Shows presence/absence of EPPs, with distributional occurrence of *Banksia ericifolia*, from the original 20215-2016 surveys (from .

Table 1. Distribution of EPP observations throughout Ku-ring-gai, 2015 – 2020 (from Ku-ring-gai Council, 2021)

Area/reserve name	Presence 2015-2016	Presence 2016-2017	Presence 2017-2018	Presence 2019	Presence 2020
North of LGA (connectivity to Ku-ring-gai NP)					
Cowan Creek Reserve	Yes	Yes	Yes	Yes	No*
Ku-ring-gai Creek Reserve/ Warrimoo	Yes	Yes	Yes	Yes	Yes
Ku-ring-gai Wildflower Garden	Yes	Yes	Yes	Yes	Yes
Lovers Jump Creek Reserve	Yes	Yes	No*	Yes	Yes
St Ives Showground	Yes	Yes	No	Yes	No
East of LGA (connectivity to Garigal NP)					
Douglas Street Reserve (Acron Oval)	Yes	No	Yes	No	No
Green Tip	Yes	Yes	No	Yes	Yes
McIntosh Park	Not surveyed	Yes	No**	No	Yes
Old She Oak Reserve	Not surveyed	Not surveyed	No	No	Yes
Surgeon White Reserve	Yes	Yes	Yes	Yes	Yes
South west of LGA (Lane Cove NP)					
Bradley Park	No	No	No	No	No
Rofe Park	No	No	No	No	No
Sir Phillip Game Reserve North	Not surveyed	No	Not surveyed	Not surveyed	Not surveyed
Twin Creek Reserve	Not surveyed	No	Not surveyed	Not surveyed	Not surveyed
Blackbutt Creek Reserve	Not surveyed	Not surveyed	No	No	No

*NSW Atlas records show EPP presence north of the monitoring site

**Nest box was removed due to risk of hazard burns in the area, inactive between March and June 2018

A variety of ecological data were collected on the eastern pygmy-possum *Cercartetus nanus* at Jervis Bay, in south-eastern New South Wales between March 2006 and January 2007 by Harris et.al. (2007). Elliott traps, pitfall traps, nest-boxes and spotlighting were used to survey for the species. Data on habitat suitability including abundance of food plants (flowering trees and shrubs) and potential nest sites were also collected. Home range data were gathered via radio telemetry. Three individuals were caught in 2150 trap-nights and one animal was re-trapped once. Radio-collars were attached to one animal of each sex and tracked for 11 days during March 2006. These possums used areas (using minimum convex polygons) of 0.85 ha (male) and 0.19 ha (female). The average overnight distance moved was 44 m for the male (range = 4-81 m) and 19 m for the female (range = 0-56 m). Nest-sites included hollows in the proteaceous shrubs *Banksia*

serrata and *B. ericifolia*, and in the myrtaceous trees *Corymbia gummifera, Eucalyptus sclerophylla,* and *Syncarpia glomulifera. Cercartetus nanus* captures were confined to two sites that had the most prolific flowering of potential food plants and the highest availability of potential nest-sites. A review of literature and previous surveys of the surrounding area was a necessary precursor to field study and produced 57 records. The authors considered that a greater understanding of the impacts of development and fire are needed for conservation and management of this species.

In terms of EPPs, fire history and population status (i.e. post-fire recovery) Tulloch and Dickman (2006) investigated the structural and floristic habitat resources used and selected by *C. nanus* in Royal National Park (which was heavily burnt by bushfire in 1994) and Heathcote National Park (most of which had remained unburnt for over two decades at the time of study), in central-coastal New South Wales. Live-trapping in different habitats revealed higher numbers of C. nanus in unburnt and burnt woodland, burnt heathland and burnt coastal complex than in unburnt coastal complex and burnt and unburnt rainforest. To identify the components of habitat contributing to this pattern, the authors scored floristic and structural features of vegetation around trap stations and then quantified habitat components further by using spool- and radio-tracking. They found little evidence that C. nanus responded to any structural components of habitat, although arboreal activity was greater, not surprisingly, in wooded than in burnt heathland habitats. *C. nanus* was associated most strongly with the abundance of certain plants in the Proteaceae and Myrtaceae. In particular, the species preferred *Banksia spp*. (probably for food) and *Eucalyptus* and *Xanthorrhoea spp*. (probably for shelter).

Sutherland et.al. (2004) found that during ground-trapping studies of small mammals in open forest at two locations, EPPs appeared in substantial numbers 12-13 months after a major fire. For the three years preceding the intense fire of December 1972 in Nadgee Nature Reserve, *C. nanus* had not been caught and its presence was unknown at the study site. Following the early summer fire at Nadgee, EPPs were caught occasionally 2-3 months post-fire and then not recorded again until spring, with a peak number of individuals caught 12 months post-fire. Captures of EPP ceased after September 1974, but an individual was observed on the study site in December 1974 (24 months post-fire) and another in September 1980. In Ku-ring-gai Chase National Park, the first captures of *C.nanus* occurred 13 months after the January 1994 fires. Populations persisted in the study area at least until trapping ceased 37 months post-fire. However, simultaneous trapping in nearby unburnt areas throughout this period did not record *C. Nanus*. At both locations, *C nanus* reproduced 12-21 months post-fire. The alteration of the habitat by fire, specifically the loss of the mid-storey, presumably forced *C. nanus* to move across the ground where it was caught in Elliott traps. With the regrowth of the vegetation, or where the vegetation was not burnt, *C. nanus* was not caught. It appears that *C. nanus* is a mid-storey species and its capture on the ground was due to the loss of this part of the habitat after fire.

The authors concluded that for this vulnerable, small arboreal marsupial, the impact of fire on population abundance and dynamics is yet to be determined. Their findings indicated that it does survive and breed in a post-fire forest, but it does not follow that populations are resilient to fire effects. EPPs may be more exposed to competition with other ground-dwelling mammals or to predation from ground-dwelling predators, particularly exotic species such dogs, foxes and cats, if it is forced to move across the ground in a post-fire environment. Gaining even further knowledge on the fire ecology of this species is crucial for long-term species conservation.

An earlier post-fire fauna survey after the extensive 1994 wildfires by Debbie Andrew in Royal and Heathcote National Parks (Sutherland area) found that of ten captures (in pitfall traps) across 6

sites, 8 were in long-unburnt woodland and open forest of Heathcote National Park and 2 were in Royal National Park, one within burnt and the other on an unburnt site. Both captures in Royal National Park came from the edge of the escarpment, within a few hundred metres of unburnt forest on the coastal escarpment (Andrew, 2001). She also cites the fieldwork of Ward (1994) who between march 1994 and May 1995 recorded two captures of EPPs in unburnt patches in burnt heathland sites on Bertram Stevens Drive, Royal National Park (Ward, 1994).

Closer to home, with respect to local fire impacts to possible impacts from hazard reduction burns, it was found that EPPs were detected at McIntosh Park and Old She Oak Reserve (both in eastern St Ives) two sites which have lacked records of EPP activity since 20217. It was considered that recovery and extensive flowering of Proteaceae species (particularly *Banksia ericifolia* in Old She Oak Reserve) two years after widespread hazard reduction burns in that section of Garigal National Park has provided good foraging habitat in 2020, encouraging EPPs back into these areas. In fact, Goldingay and Rueegger (2018) found that the number of lactating females over time was highly correlated (R = 0.9) with the abundance of flowers on *B. ericifolia*, suggesting that flower availability has a substantial influence on breeding. At their coastal study site, the authors found that EPPs produced 1-3 litters (frequently of 5-6 young) over an 8-month period within the flowering period of the dominant food plant (*Banksia ericifolia*).

In addition, the apparent absence of EPP from the Cowan Creek Reserve or the lower Ku-ring-gai Creek Reserve during 2020 surveys (both areas having previous EPP activity) could also be related to previous hazard reduction burns conducted in May 2019. Following the hazard reduction burn there was a noticeable lack of flowering Proteaceae species to provide suitable foraging habitat, but with recent vegetation recovery, monitoring will be required to assess for future signs of EPP activity as the vegetation recovers post-burn (Ku-ring-gai Council, 2021).

Even though large tracts of suitable habitat, and an abundance of Banksia species (including *B. ericifolia*) are found in the Lane Cove catchment, the real absence of EPP from this large sector could possibly be due to fire impacts. Figure 4 (below) shows the extensive impacts in the Lane Cove catchment resulting from the 1994 bushfires – in terms of both intensity and aerial coverage this bushfire may have destroyed much available EPP habitat – and post-fire recovery (from extant or any adjacent EPP populations) may have been not possible. In addition, the more recent absence of the ground-dwelling Superb Lyrebird (*Menura novaehollandia*), may add weight to this argument. Possibly the extra pressure from post-burn predation (particularly populations of the Red Fox) may have made post-fire recolonization unviable – leading to localised population extinctions on the western and south-west margins of Ku-ring-gai LGA..

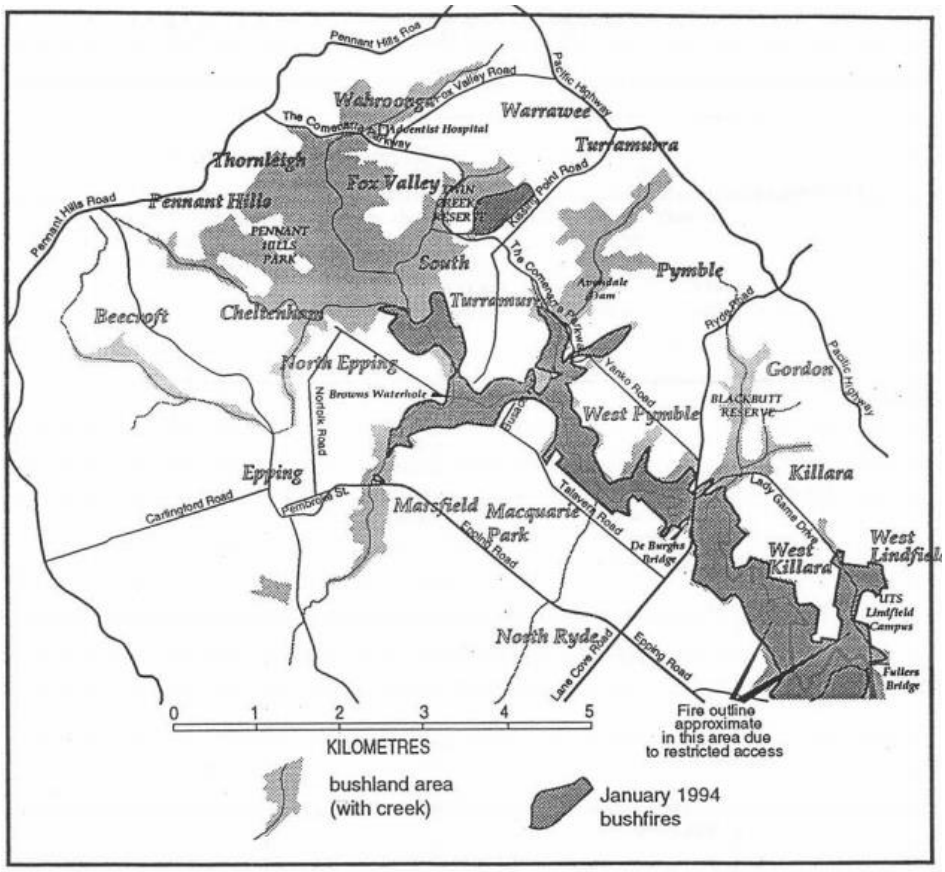

Figure 4. Illustrates fire impacts in Lane Cove catchment from the 1994 bushfires (after Martyn, 1994)

It is apparent that with further long-term monitoring of EPP distributions and fire activity (both planned hazard reduction burns and wildfire events) within the LGA, more definitive conclusions can be made with respect to fire impacts on EPP populations and species viability. Until further data is collected in the forthcoming years, it is critical that the precautionary principle is applied with respect to hazard reduction burning and EPP populations, life cycle needs and habitat suitability.

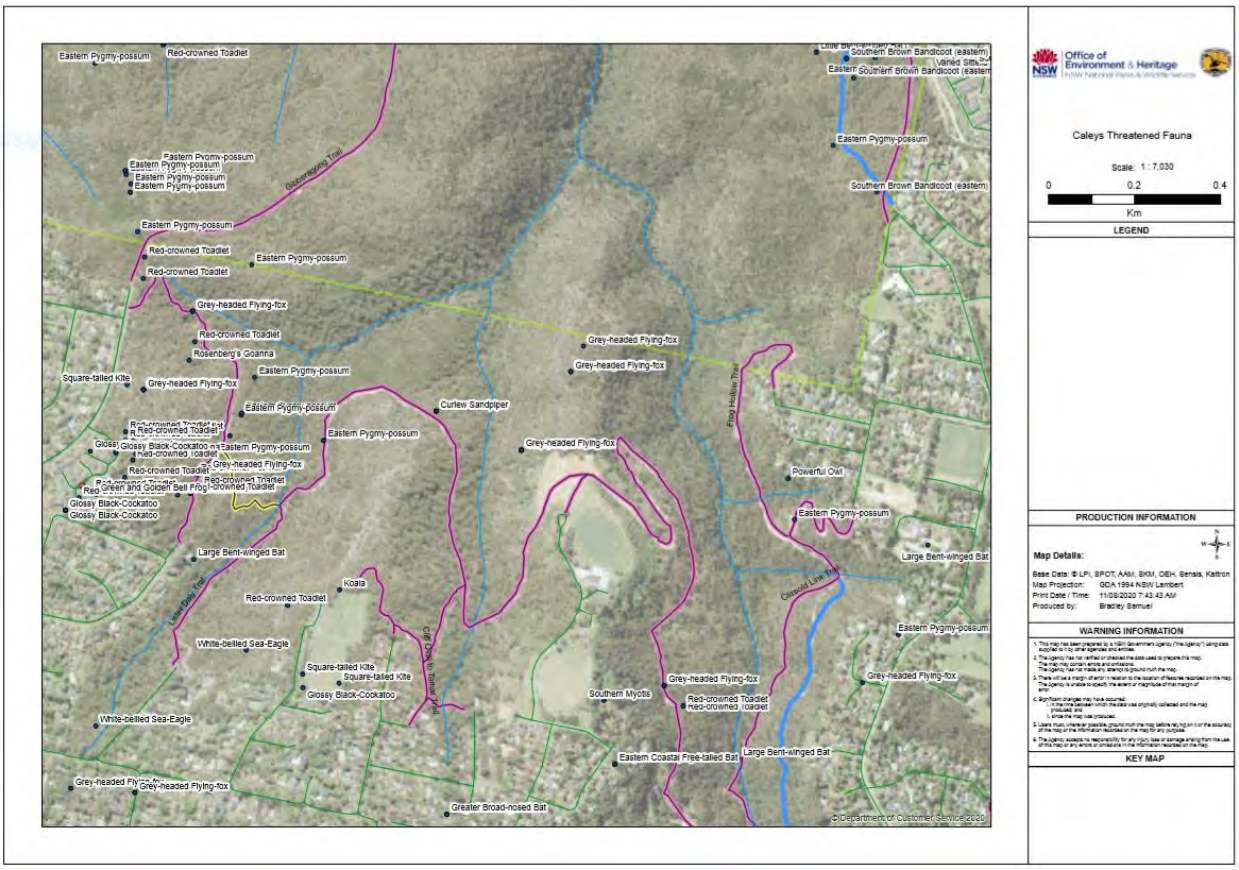

Figure 5. Illustrates point distribution of Threatened and Near Threatened species in an NPWS Burn Plan document (including known EPP records).

Although when developing pre-requisite burn plans (lodged through the recent RFS GUARDIAN system) the location of EPPs (from known records in State and Federal databases such as BIOBASE) is displayed on mapping, no species specific conditions are required in the environmental assessment phase of planning.

With regard to the EPP in the *Bush Fire Environmental Assessment Code for NSW* (Rural Fire Service, 2021a), the listing has no specific species conditions relating to the use of fire and the condition of 'No slashing, trittering or tree removal' in the instance of usage of mechanical forms of hazard reduction.

As *Banksia ericifolia*, along with other flowering Proteaceae within the LGA, are not a listed threatened species, then no species specific conditions for hazard reduction are given in the BFEAC.

This means that specific conditions for either the EPP or its major food source, *Banksia ericifolia* (and other banksia species), are not included when developed either burn plans or on-ground hazard reduction actions when putting fire on the ground. Due to the lack of species-specific conditions in hazard reduction burning, factors related to EPP population viability and critical habitat factors are not considered – hence the need for 'extra' guidelines.

In addition, the research of Bradstock and O'Connell (2006) into the fire ecology of *Banksia ericifolia* provides insights that can be used for species management with regard to a recommended fire regime. The authors found that late summer/autumn fires of high intensity favour high establishment of the species. **Such fires at 8–10 year intervals would be tolerated without any sustained decline in numbers. Fires at 10–15 year intervals could occur**

regardless of season or intensity with little risk of a population decline. Large increases in numbers and density would follow fires spaced at 15–30 years. Enough seeds would be available for replacement up to about 50 years in the species. Viable seed-release in unburnt conditions was sufficient to compensate for deaths in stands over 20 years old, even with very low levels of establishment.

The RFS supporting document to the *Bush Fire Environmental Assessment Code*, ' Fire Intervals for Strategic Fire Advantage Zones and Land Management Zones' (see Rural Fire Service, 2021b) gives prescriptive details of the Minimum Fire Interval (i.e. time between consecutive fire impacts) based on ecological thresholds. As all Ku-ring-gai LGA burn blocks are either SFAZ or LMZs, 7 years is the lower interval for 'Sydney Coastal Dry Sclerophyll Forests (i.e. the vegetation type where EPPs habitat occurs). Based on the research work of Bradstock and O'Connell (2006) the lower recommended threshold would be too low to allow for seeding/maturation of *Banksia ericifolia* populations. The non-alignment of the recommended minimum interval (7 years) for prescribed burning in woodlands/forests with the needs for at least 10 years, or preferably 15 years without fire for seeding of banksia species, is an issue of concern.

Further impacts of planned burning may also result in further habitat modification/loss. A typical result with hazard reduction burning is the very frequent loss (often 100% loss in moderate intensity hazard reduction burning) of the mid-stratum (elevated) vegetation layer. This then means that the EPP habitat – shelter, food sources and breeding needs - is fully eliminated for a significant period. Recolonization may only be possible if the aerial extent of the burn has been limited (allowing for recolonization from unburnt 'edges') or if mosaic (i.e. patch-burning) has been undertaken. This is a critical aspect post-burn or local population extinction can easily occur.

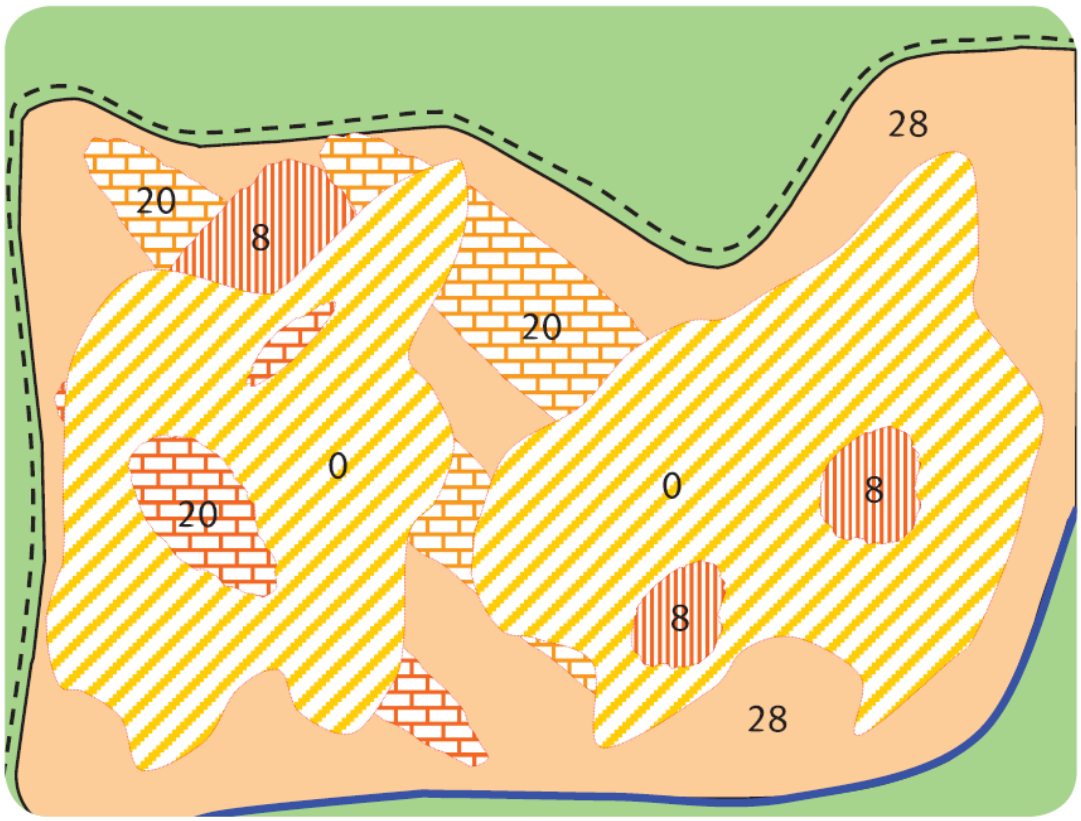

Figure 5: Fire history summary—year 28.
Wildfire and mosaic burn patterns overlaid (with years since last burnt).

Figure 6. Illustrating the principles and spatial/time placement for 'mosaic burning' (from Planned Burn Guidelines, Department of National Parks, Recreation, Sport and Racing (Qld), 2012)

Bob Jones, KMC's Jacob Sife and Inge Buchanan (2015) recommended the following strategies/actions regarding the eastern Pygmy Possum Program and Recovery Plan for Ku-ring-gai Municipality. Input into fire control planning undertaken over the two areas identified and adjacent areas so that:

- **fire intensity is sufficient** to regenerate essential pygmy possum flora such as *Banksia ericifolia*.
- **fire frequency is not too frequent** that it reduces such flora by preventing seeding.
- **fire frequency is not too infrequent** that it reduces such flora by senescence and overgrowth with species that are less suitable for pygmy possums.
- **Fire is excluded at the peak *Banksia ericifolia* flowering time** (late Autumn – Winter), as the species is fully dependant on this plant for its food resources.

The key result from these prescriptive management actions is to maintain appropriate habitat for the EPP to maintain viable populations.

Figure 7 (below) these fire regime elements (fire frequency, intensity and seasonality) into management needs to maintain suitable EPP habitat. In addition, mosaic (patch) burning must be incorporated to fully maintain habitat values for EPP viability. This is due to the fact that the importance of maintaining at least "clumpings" or thickets of mid-storey *Banksia* and other flower producing mid-story plants is critical for maintaining EPP populations – at the local scale. Mosaic burning, if undertaken appropriately and with the correct prescription, can allow for the persistence of areas of mid-storey vegetation within a burn block.

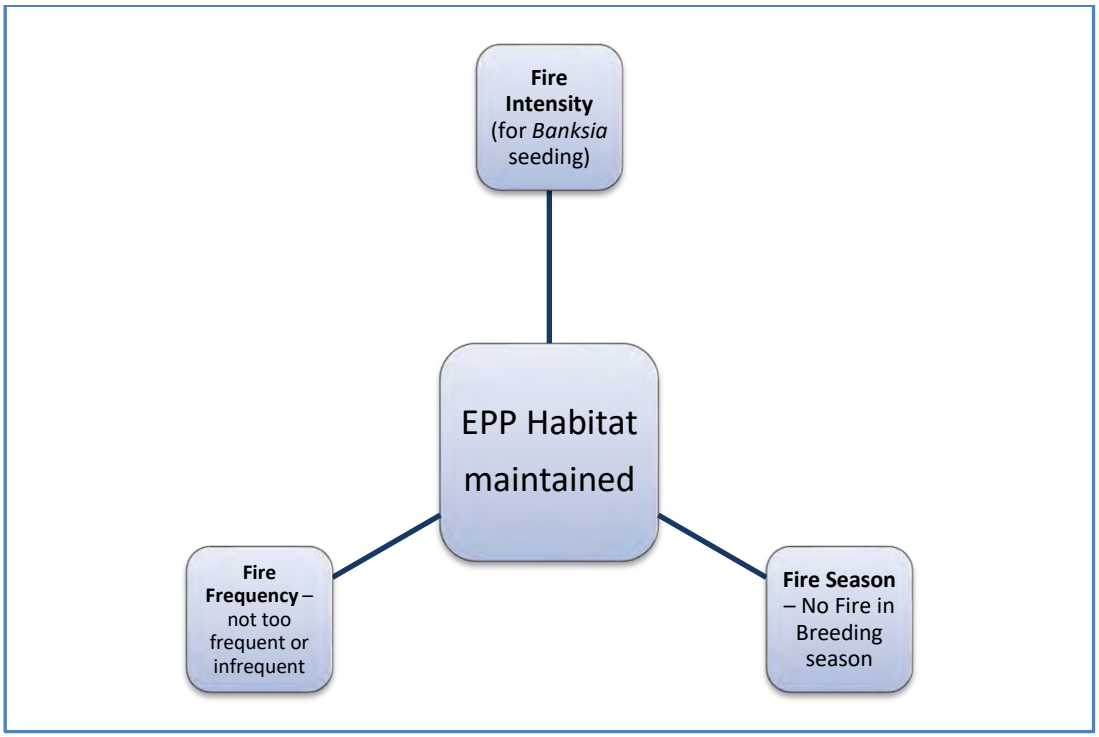

Figure 7. Illustrates the fire regime factors that influence the continuity of EPP habitat and hence species survival.

Only with judicious forward planning and on-ground application of the fire can loss of the elevated layer (shrub) be avoided, or minimised. A long-term monitoring plan to research fire impacts on EPP populations and habitat, from both planned burns and wildfire, must be undertaken to inform adaptive management for best-practice fire management of our bushland remnants to provide long-term continuity of habitat and species viability.

Recommendations:

Based on previous aspects in this guideline, some factors that must be considered when planning/implementing the burn include:

1. ***Burn planning*** phase:
    - Ensure **burn prescription** needs are targeted to achieve **Low-Moderate intensity** fire and burning on high soil moisture (i.e. KBDI = <100; RH = > 30%; Temp = 24 - 28^{0}C; Maximum Flame Height < 1.5m; Maximum Scorch Height < 6m and ROS <5 metres/minute);
    - Ensure the **Time Since Fire** (TSF) exceeds 12 years for the entirety of the burn block;
    - Ensure prescription specifies **Mosaic** (patch) burn and that 25 – 40% remains unburnt in the burn block;
    - Ensure that hazard reduction burning is not undertaken during EPP torpor periods (i.e. winter) or in the peak of *Banksia spp*. flowering season. **Burning should be avoided from July – September in EPP habitat areas**;
    - Specifically **add ecological criteria** for both Eastern Pygmy-possum and Banksia spp. In the burn plan;
    - Delineate **burn exclusions areas** within the burn plan map (i.e. areas with high concentrations of Banksia spp.);
    - If possible, incorporate **long unburnt areas** (i.e. TSF >25 years) along the northern and eastern bushland-urban interface that have suitable EPP habitat into Council's ecoburn program;
    - **Coordinate with other fire agencies** (NSW National Parks & Wildlife Service, Rural Fire Service and Fire and Rescue NSW) to ensure that the EPP guidelines can be discussed and incorporated into their burn programs. NSW NPWS manages large areas of EPP habitat in both Ku-ring-gai Chase National Park and Garigal National Park.

2. ***Operational*** (on-ground) phase;
    - Specific **lighting patterns** to achieve mosaic burning (i.e. judicious placement of **spot lights** – depending on terrain/fuel loadings and delineated 'fire exclusion' zones (habitat patches with high *Banksia* concentrations);
    - Use specific **lighting patterns** (**limited strip lighting**) to achieve variation of fire intensity within the burn block – i.e. sufficient fire intensity to trigger banksia seed release, but also taking care to ensure the mid-stratum is not fully destroyed by fire. **Burning on high soil moisture** will aid in this process;
    - Specific attention to **maintaining patchiness** throughout the burn – i.e. so 25 – 40% of the block remains unburnt

The dilemma of having **sufficient fire intensity** to trigger *Banksia* (and other flowering species) seeding is a difficult issue – as a more intense fire can readily destroy the mid-stratum of vegetation. Although each burn must be approached on a case-by-case basis, having a Low-Moderate fire – with some variation in intensity at spots within the burn block may allow us to achieve both aims – sufficient fire intensity for *Banksia* seeding, as well as not destroying the totality of the mid-stratum layer. Burning on high soil moisture also will assist in achieving this aim. Further research is urgently required on the topic of fire intensity, plant seeding/germination and the persistence of the elevated (mid-storey stratum) for EPP life cycle requirements.

Long-term monitoring at a number of EPP sites will be required – to further inform and refine these fire management guidelines for the EPP and its habitat requirements.

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