National

Recovery Plan

Melaleuca deanei

F. Muell.

(Deane's Paperbark)

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Department of Environment, Climate Change and Water NSW

Australian Government

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Note: This recovery plan sets out the actions necessary to stop the decline of, and support the recovery of, the listed threatened species.

The plan has been developed with the involvement and cooperation of a broad range of stakeholders, but individual stakeholders have not necessarily committed to undertaking specific actions. The attainment of objectives and the provision of funds may be subject to budgetary and other constraints affecting the parties involved. Proposed actions may be subject to modification over the life of the plan due to changes in knowledge.

Requests for information or comments regarding the recovery program for *Melaleuca deanei* are best directed to:

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Recovery Plan for Deane's Paperbark (*Melaleuca deanei*)

Foreword

This document constitutes the formal National and NSW State Recovery Plan for *Melaleuca deanei* (Deane's Paperbark) (family Myrtaceae). It considers the conservation requirements of the species across its known range, and identifies the actions to be taken to ensure the long-term viability of *Melaleuca deanei* in nature and the parties who will undertake these actions.

Melaleuca deanei is listed as **vulnerable** under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and the NSW *Threatened Species Conservation Act 1995*. It is a single or multi-stemmed shrub to 5 metres high that occupies broad flat ridgetops, dry ridges and slopes in the Sydney Basin Bioregion. It is known from 94 populations between St. Albans to the north of Sydney, and Nowra to the south.

The overall objective of this recovery plan is to ensure the long-term survival of *Melaleuca deanei* in the wild by promoting in situ conservation. The recovery actions detailed in this plan include:

- to protect a representative sample of populations on public and private lands;
- to identify and manage the threats operating at sites that contain the species;
- to conduct surveys and research that will assist with the management of the species; and
- to raise awareness about the threats to the species and involve the community in the recovery program.

It is intended that the recovery plan will be implemented over a five-year period. The actions in this plan will primarily be undertaken by the Department of Environment, Climate Change and Water.

LISA CORBYN
Director-General

Acknowledgments

The Department of Environment, Climate Change and Water wishes to acknowledge the following individuals, and their respective organisations for their contributions to the development of this recovery plan:

- Ian Drinnan, Sutherland Shire Council
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- Marina Petersen, Department of Defence
- Nick Corkish, DECCW
- Ross Doig, Australian Plant Society
- Salli Felton, Sydney Water
- Steve Douglas, Consultant

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1 Introduction

Melaleuca deanei F. Muell. is a paperbark with a shrub habit, up to 5 metres high, with flaky bark. It occurs only in New South Wales (NSW), in an area between St. Albans and Nowra. Currently, it is only known from 94 populations, of which only very few are secure and reproductively viable. The species' range is divided into at least two distinct portions, as a consequence of urbanisation and unsuitable habitat across the Cumberland Plain.

This document constitutes the formal National and State Recovery Plan for *M. deanei* and, as such, considers the requirements of the species across its known range. It identifies the actions to be taken to ensure the long-term viability of *M. deanei* in nature and the parties who will undertake these actions. The attainment of the objectives of this recovery plan are subject to budgetary and other constraints affecting the parties involved.

This plan has been prepared by the Department of Environment, Climate Change and Water (NSW) (DECCW) in consultation with 12 local councils, Mount Annan Botanic Gardens, the Department of Defence, the Australian Plant Society, Sydney Catchment Management Authority, Rural Fire Service (RFS) and Roads and Traffic Authority, NSW (RTA). The information in this recovery plan was consistent with the best available knowledge on the date it was approved.

2 Legislative Context

2.1 Legal status

Melaleuca deanei is listed as vulnerable under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and as vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

2.2 Responsibilities under the Threatened Species Conservation Act 1995

Recovery plan preparation, exhibition and implementation

The TSC Act and the NSW *Threatened Species Conservation Amendment Act* 2002 (hereafter referred to jointly as the TSC Act) provide a legislative framework to protect and encourage the recovery of endangered and vulnerable species, endangered populations and endangered ecological communities in NSW. Under this legislation, the Director General of DECCW must prepare a Threatened Species Priorities Action Statement, which outlines a strategy for the recovery of each listed threatened species in NSW. The strategy for any particular species may include the requirement for a recovery plan to be prepared, however this is no longer a mandatory requirement for every threatened species. The TSC Act includes specific requirements for both the matters to be addressed by recovery plans and the process for preparing recovery plans. This recovery plan satisfies these provisions.

The TSC Act requires that a government agency must not undertake actions inconsistent with a recovery plan. The actions identified in this plan for the recovery of *M. deanei* in NSW are primarily the responsibility of DECCW. Other public authorities may have statutory responsibilities relevant to the conservation and protection of *M. deanei*. Public authorities with core legislative responsibilities relevant to the protection and management of *M. deanei* and its habitat are listed in Appendix 1.

Consultation with Aboriginal people

Involvement of Aboriginal communities in the development of the recovery plan has been sought by DECCW. Local Aboriginal Land Councils, Elders and other groups representing Aboriginal people in the areas where *Melaleuca deanei* occurs were identified and a copy of the draft recovery plan was sent to them with the opportunity to provide input. While no responses were received, DECCW will continue to seek input from and involvement of these Aboriginal communities in the implementation of the actions identified in this plan.

Critical Habitat

The TSC Act makes provision for the identification and declaration of critical habitat for species, populations and ecological communities listed as endangered. *Melaleuca deanei* is not currently eligible for declaration of critical habitat because it is not listed as endangered under Schedule 1 of the TSC Act.

Key Threatening Processes

A key threatening process (KTP) is a process listed under the TSC Act or the EPBC Act that threatens, or has the capability to threaten, the survival or evolutionary development of species, populations, or endangered ecological communities. As of February 2009 there are 39 Key Threatening Processes listed on the TSC Act.

Clearing of native vegetation has been observed to affect *M. deanei*. The Final Determination for this KTP defines clearing as 'the destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation so as to result in the loss, or long term modification, of the structure, composition and ecological function of a stand or stands' (NSW Scientific Committee 2001).

Other KTPs that may affect *M. deanei* are:

- Ecological consequences of high frequency fires (NSW Scientific Committee 2000);
- Invasion of native plant communities by exotic perennial grasses (NSW Scientific Committee 2003); and
- Invasion, establishment and spread of *Lantana camara* (NSW Scientific Committee 2006).

In addition to these KTPs, a number of other threats to the survival of *M. deanei* exist (see Section 6.2).

Licensing

Any activity not requiring development consent under the NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act) or the NSW *Native Vegetation Act* 2003 (NV Act), which is likely to impact on *M. deanei*, or damage its habitat, requires a licence from DECCW under the provisions of the TSC Act or NSW *National Parks and Wildlife Act* 1974 (NPW Act) as a defence against prosecution. If the impact is likely to be significant, a Species Impact Statement (SIS) is required.

Other conservation measures

The TSC Act includes provision for other measures that may be taken to conserve *M. deanei* and its habitat, including the making of a Stop Work Order or Joint Management Agreement.

2.3 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act provides a legislative framework for the protection of threatened species across Australia. In preparing a Commonwealth Recovery Plan, consideration must be given to the role and interests of Aboriginal people in the conservation of Australia's biodiversity. The Act also seeks to impose the obligation (arising from the listing) for responsible agencies (particularly Commonwealth) to adopt protective measures.

As *M. deanei* is listed nationally under the EPBC Act, any person proposing to undertake actions likely to have a significant impact on this species should refer the action to the Commonwealth Minister for Environment Protection, Heritage and the Arts for consideration. The Minister will then decide whether the action requires EPBC Act approval. This is in addition to any State or Local Government approval required.

Administrative guidelines are available from the Australian Government Department of the Environment, Water, Heritage and the Arts to assist proponents in determining whether their action is likely to have a significant impact.

2.4 Other legislation

Other legislation relevant for the conservation and recovery of *M. deanei* is listed in Appendix 2.

3 Description and Taxonomy

3.1 Description

Melaleuca deanei is a shrub up to 5 metres high with fibrous-flaky bark. Leaves are alternate, narrow-elliptic to lance-shaped in outline and 12-25 mm long and 3-6 mm wide. The leaves are moderately dark green in colour and twisted so the edges turn towards the stem, while the leaf tip ends in a sharp point. The mature plant is hairless, however new shoots are covered in white hairs. Flowers are creamy-yellow and arranged in a typical bottle-brush spike, up to 6 cm long. Within each flower, groups of stamen (17-28) are fused together at the base. Fruit is barrel-shaped, 3-5 mm in diameter, and the opening to the fruit is 3 mm in diameter.

3.2 Taxonomy

The type specimen for *M. deanei* was collected by Henry Deane at Lane Cove in December 1886. Compared to other *Melaleuca* species, *M. deanei* has the following distinct features:

- relatively flat and thick leaves with three rather indistinct nerves (von Mueller 1886, cited in Felton 1993); and
- the underside of leaves is heavily dotted with translucent oil glands, and leaf edges are twisting towards the stem (Robinson 1991).

4 Distribution and Habitat

In this recovery plan, *M. deanei* records within 500 metres of each other have been defined as belonging to the same population, as dispersal of the species is unlikely to exceed this distance (Felton 1993). Populations may consist of a

number of sites, as sites have been determined on the basis of tenure.

4.1 Current distribution

Melaleuca deanei is endemic to the Sydney Basin Bioregion (Figure 1). The distribution of the species extends from St. Albans (Hawkesbury LGA) in the north, Nowra (Shoalhaven LGA) in the south, and west to Faulconbridge (Blue Mountains LGA).

Table 1 Distribution of 94 *Melaleuca deanei* populations in different LGAs in their northern and southern range, and percentage of these populations found within formal conservation reserves.

Local Government Area (LGA)	Number of populations (% of all populations)	Number in formal conservation reserves (% of populations within LGA)
NORTHERN AREA		
Gosford	1 (1.1 %)	1 (100 %)
Hawkesbury	4 (4.3 %)	4 (100 %)
Blue Mountains	4 (4.3 %)	1 (25 %)
Baulkham Hills	2 (2.1 %)	0
Hornsby	26 (27.7 %)	23 (88.5 %)
Ku-ring-gai	5 (5.3 %)	3 (60 %)
Warringah	4 (4.3 %)	3 (75 %)
Ryde	2 (2.1 %)	1 (50 %)
Total northern	**48 (51.1 %)**	**36 (75 %)**
SOUTHERN AREA		
Liverpool	3 (3.2 %)	0
Sutherland	22 (23.4 %)	12 (54.5%)
Campbelltown	15 (16 %)	1 (6.7 %)
Wollondilly	3 (3.2 %)	1 (33.3 %)
Wingecarribee	1 (1.1 %)	0
Shoalhaven	2 (2.1 %)	2 (100 %)
Total southern	**46 (48.9 %)**	**16 (35 %)**
Total	**94 (100 %)**	**52 (55.4 %)**

Table 1 shows that the main distribution of the species can be divided into a northern and a southern range. The northern range extends north from Ryde LGA, including the Blue Mountains (48 populations), whereas the southern range extends south from Sutherland LGA (46 populations). The two ranges are separated by a distance of approximately 28 km. This is partly a consequence of unsuitable habitat for the species occurring on the Cumberland Plain in Western Sydney, but is also the result of the loss of habitat in northern, southern, and inner western Sydney to urban development.

Two other disjunct sites have been recorded in Morton NP and Colymea SCA, west of Nowra (Shoalhaven LGA). This is over 60 km south of the main distribution of the species.

It is likely that our understanding of the distribution of *M. deanei* is incomplete.

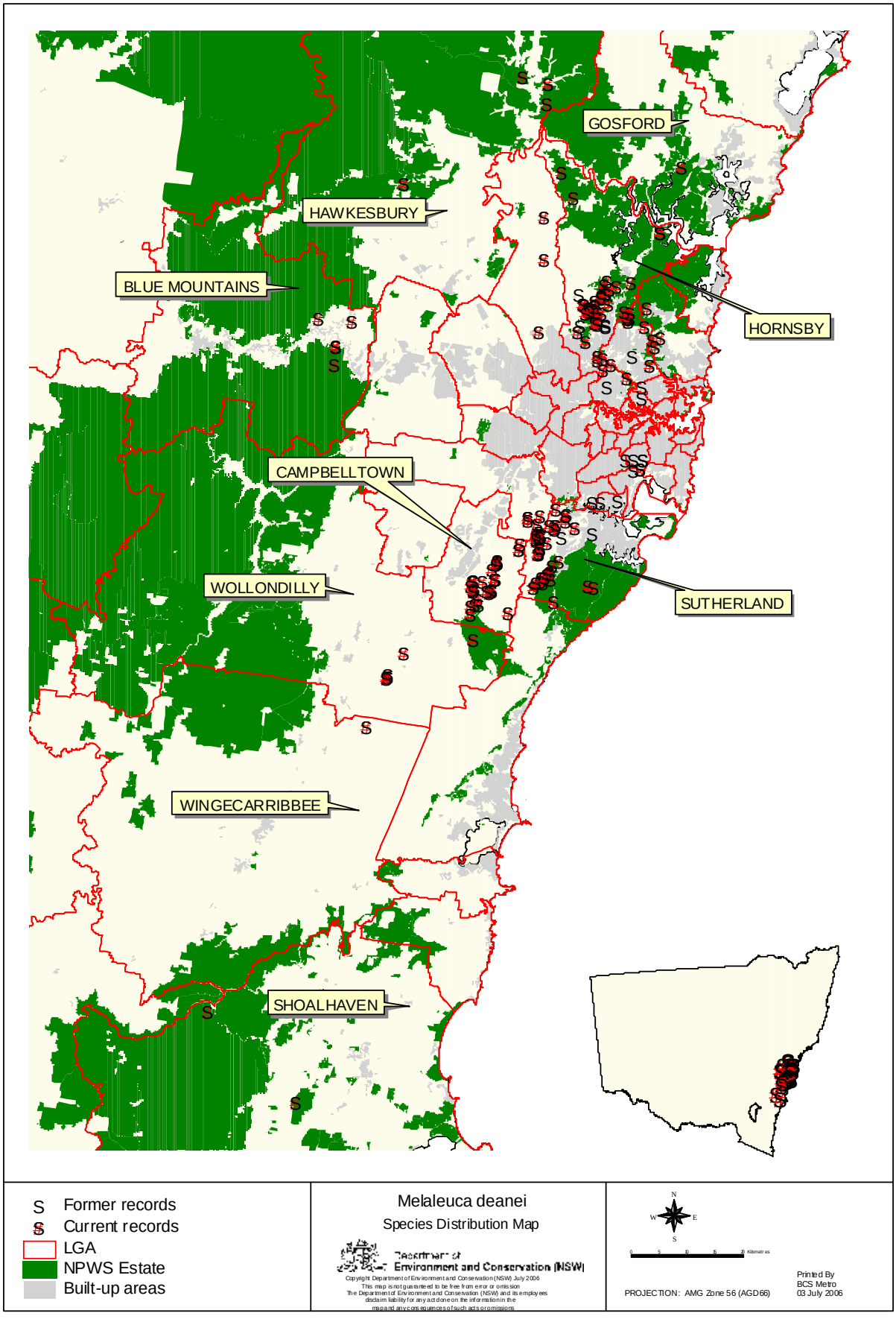

Figure 1. Known distribution of *Melaleuca deanei* in NSW

4.2 Historical distribution

A number of early collections were made from suburban areas where the species is now considered to be locally extinct. These areas include Kogarah (1884), Arncliffe (1897), Tempe (1898), Oatley (1899), Cooks River (1901), and Earlwood (1912). In the last ten years, sites have also been lost to residential development and road construction in Hornsby Heights (J. Slaven, Hornsby Council, pers. comm.), Bangor, and Menai (I. Drinnan, Sutherland Council, pers. comm.).

4.3 Population size

It is difficult to count individual plants within populations, because *M. deanei* is a clonal species. This means that an individual (or genet) may occur as a number of stem clumps (or ramets), which may appear as different plants (Myerscough 1998). Genetic analysis is the only means to determine the number of genetically distinct individuals in a population, but this has not yet been undertaken. Research by Felton (1993) suggests that for every 10-15 *M. deanei* ramets counted, two to three individuals may be present, while the NSW Scientific Committee (1999) notes that for this species 'ramet counts may overestimate population size by two or three times'.

This difficulty with identifying genetically distinct plants needs to be considered when discussing the size of populations based on ramet counts (Table 2). It also explains why no attempt has been made to determine the size of 28% of all populations. Generally, it is likely that the number of genetically distinct plants is lower than the number of ramets counted. The numbers in Table 2 thus give rise to concern: at least 52% of the populations contain less than 50 ramets, and thus most likely even less individual plants. Only four populations contain more than 500 ramets. Of these four, only one occurs in the northern part of the species' range, the other three are in the southern part.

Table 2. Size class distribution for the 94 known populations of *Melaleuca deanei*.

Size class*	Number of populations	% of total no. of populations
≤ 10	27	29
11 – 50	22	23
51 – 100	8	9
101 – 500	7	7
> 500	4	4
unknown	26	28

* based on number of ramets

4.4 Land tenure and zoning

Table 3 shows tenures for the land on which *M. deanei* occurs, and Table 4 describes the zoning of such land. More than 50% of all sites occur in DECCW estate and are zoned as National Park or Nature Reserve. Holsworthy Military Reserve, contains 17 % of the known *M. deanei* population, including large populations that extend along the ridgelines in the central and western section of the area. This reserve is owned by the Department of Defence, and most of it is presently zoned as land for Environment Protection, with a small proportion zoned as 'Special users'. Two large sites (both large populations) occur on land that is managed by the Sydney Catchment Authority, within the Nepean and Avon Dam catchments. The survival of the species has thus been largely dependent on the protection of lands that have not been subject to intensive land use or clearing.

Note that for the analysis in Tables 3 & 4, populations are counted as two different sites where they are distributed across two different tenures, and both tables thus list 100 sites (compared to the 94 populations in Table 1). More detail for these 100 sites is provided in Appendix 3. References to site numbers throughout this plan correspond to Appendix 3.

Table 3. Land tenures for 100 *Melaleuca deanei* sites.

Tenure – Land manager	Number of sites (%)
DECCW estate (NP = National Park):	
Berowra Valley Regional Park	17
Blue Mountains NP	1
Brisbane Waters NP	1
Colymea State Conservation Area	1
Dharawal State Conservation Area	2
Garrigal NP	4
Heathcote NP	10
Ku-ring-gai Chase NP	4
Lane Cove NP	4
Marramarra NP	2
Morton NP	1
Royal NP	2
Wollemi NP	1
Yengo NP	3
Total all DECCW estate	53 (53%)
Department of Defence	
Holsworthy Military Area	17 (17%)
Private (Freehold) Land	16 (16%)
Crown Land:	
Crown Land - Ku-ring-gai Council	1
Crown Land- Department of Lands	1
Crown Lands - Blue Mountains City Council	1
Total Crown Land	3 (3%)
Community Land:	
Community Land Sutherland Council	3
Community Land Ku-ring-gai Council	1
Community Land Hornsby Council	1
Community Land Ryde Council	1

Tenure – Land manager	Number of sites (%)
Total across all LGAs	6 (6%)
Sydney Catchment Authority	2 (2%)
Roads and Traffic Authority	2 (2%)
Waste Services NSW	1 (1%)

Table 4. Land-use zoning for 100 *Melaleuca deanei* sites.

Zoning	Number of sites (%)
National Park or Nature Reserve (DECCW estate)	53 (53%)
Environmental Protection	22 (22%)
Rural	8 (8%)
Recreation – Public open space	4 (4%)
Bushland conservation	3 (3%)
Water catchment	3 (3%)
Residential	3 (3%)
Special users – Military purposes	3 (3%)
Special users – Recreation purposes	1 (1%)

4.5 Habitat

4.5.1 Landform, Climate, Geology and Soils

Melaleuca deanei mostly occupies broad flat ridgetops, dry ridges and slopes (Benson & McDougall 1998). In southern Sydney, the species is most often found on flat broad ridge tops more than 100 metres wide (Travers Morgan 1990). The altitudinal range of *M. deanei* is between 20 and 410 metres above sea level, and annual rainfall in the species' distribution ranges from 1,000 to 1,400 mm (Benson & McDougall 1998).

Melaleuca deanei is strongly associated with sandy loam soils that are low in nutrients, sometimes with ironstone present (Benson & McDougall 1998). In a study of ten populations in southern Sydney, Travers Morgan (1990) found that the species most frequently occurred on deep and well developed lateritic soils, i.e. soils where an indurated iron-rich layer usually overlies a mottled clay and a pallid clay (Murphy 1993).

4.5.2 Associated Vegetation

Table 5 shows that *M. deanei* occurs in a wide range of vegetation communities, but is most often found in Coastal Sandstone Ridgetop Woodland (Tindall *et al.* 2004, Table 5).

Table 5. Distribution of sites by broad vegetation class*.

Vegetation Map Unit	Sites**	%
Coastal Sandstone Ridgetop Woodland	37	46%
Hinterland Sandstone Gully Forest	18	23%
Sydney Hinterland Transition Woodland	8	10%
Coastal Sandstone Gully Forest	7	9%
Coastal Sandstone Plateau Heath	4	5%
Sydney Shale-Ironstone Cap Forest	2	3%
Cumberland Shale Sandstone Transition Forest	1	1%
Morton Mallee Heath/Shoalhaven Sandstone Forest	1	1%
Morton Mallee-Heath/Yalwal Shale - Sandstone Transition Forest	1	1%
Sandstone Riparian Scrub	1	1%

* according to the vegetation mapping in Tindall *et al.* (2004)
**excludes 14 populations located in areas of Gosford, Hawkesbury, Hornsby, Liverpool, Sutherland and Campbelltown LGAs that are not covered by Tindall *et al.* (2004)

Specht (1981) describes the following four different vegetation associations for *M. deanei*: (1) forest, open forest, woodland and open woodland; (2) low open forest, low woodland and low open woodland; (3) scrub, open scrub and tall scubland; and (4) heathland, open heathland and shrubland.

Several authors state that there seems to be no obvious association between *M. deanei* and any particular components of the ridgetop flora (Specht 1981; Travers Morgan 1990; Felton 1993; Benson & McDougall 1998).

4.5.3 Habitat Critical to Survival

Habitat critical to the survival of *M. deanei* includes:

- the area of occupancy of populations;
- areas of similar habitat surrounding and linking populations;
- additional occurrences of similar habitat that may contain undiscovered populations of the species or be suitable for future translocations.

Apart from the area of occupancy of known populations, the location of habitat critical to survival has not been mapped.

5 Biology and Ecology

5.1 Habit and life cycle

Melaleuca deanei is a single or multi-stemmed shrub to 3 metres high (Benson & McDougall 1998). The longevity of individuals is reported to be greater than 100 years (Benson & McDougall 1998). As a clonal species, *M. deanei* has the ability to re-sprout from a swollen rootstock (lignotuber) to produce coppiced growth, and it can also sucker from its rootstock (Felton 1993).

The exact age at which *M. deanei* starts to produce flowers and seed is unknown. Some observers estimate this age as 3-4 years (Wrigley pers. comm. cited in Maryott-Brown & Wilks 1993), while others claim that it may take as long

as 10 years (Ross Doig, Australian Plant Society, pers. comm.). *Melaleuca* seedlings, in general, take between 7 and 20 years to start flowering (Holiday 1999, cited in Virtue 1991).

5.2 Pollination, flowering and seed production

It is not known how *M. deanei* is pollinated, though insects are the most likely group of pollinators (Turnbull & Doran 1997 cited in Virtue 1991). Self-fertilisation of *M. deanei* should also not be ruled out (Virtue 1991).

Clonal plants, such as *M. deanei*, are known to produce flowers and seed infrequently and at irregular periods of time (Benson & McDougall 1998). Flowering has been observed in spring (Fairley & Moore 1989; Wrigley & Fagg, 1993) and summer (Beadle *et al.*, 1983; Maryott-Brown & Wilks 1993).

Infrequent flowering was evident when some populations did not flower for more than 4-5 years (Benson & McDougall 1998), for 15 years (R. Payne pers. comm., cited in Benson & McDougall 1998), or for many years (Doig & Thumm, pers. obs.). In contrast, one population in Royal National Park has flowered annually for a number of years (Felton 1993). In the populations surveyed for the present recovery plan, only approximately half (20 of 43 surveyed) showed evidence of flowering (including the presence of fruit; Table 6**,** Appendix 3).

Seed production is described as poor and infrequent by several authors (Virtue 1991; Travers Morgan 1990). For example, only 5 of 28 populations surveyed were carrying seed capsules (Felton 1993).

Low levels of flowering are apparently common in many other *Melaleuca* species (Travers Morgan 1990; Virtue 1991). Felton (1993) suggests that in *M. deanei*, this may be a result of the following two factors: first, this species can re-sprout and hence often invests energy in vegetative reproduction rather than flower and seed production. Second, a specific stimulus (or set of stimuli) may need to trigger flowering in the species, e.g. fire or high/prolonged rainfall. However, Felton also observed that time since last fire did not influence flowering of *M. deanei*, nor did other variables, such as plant height.

The only variable of importance in Felton's study was the size of *M. deanei* populations, as low density stands appeared less likely to flower than high density stands. The important role of population size is supported by Virtue (1991) who observed that seed set appeared to be greater in large populations. It is also supported by the data in this recovery plan (Appendix 3, analysed in Table 6): all populations with more than 100 ramets produced seed, and populations with less than 10 ramets were most likely to contain no seed.

Table 6. Presence of seed by population size class

Size class of population	Populations with seed absent	Populations with seed present
Not recorded	1	2
<10	13 (59%)	1 (6%)
11-50	7 (32%)	4 (24%)
51-100	2 (9%)	4 (24%)
101-500	0	5 (24%)
>500	0	4 (24%)

The relationship between population size and fruit or seed production may be explained by crossbreeding. Virtue (1991) suggests a requirement for crossbreeding in the species, that is, for breeding between different individuals.

In summary, observations so far indicate that recruitment of *M. deanei* is more likely to result from vegetative reproduction rather than from seedlings. Further research is required to determine the detailed causes for the limited recruitment from seed in this species.

5.3 Seed dispersal and seed bank dynamics

Seed in *M. deanei* is produced in barrel shaped woody capsules that contain 500-600 seeds (Felton 1993). It is held in the canopy of the plant for several years (possibly up to 15 years) until dehydration allows the capsules to open (Benson & McDougall 1998). Seed release is triggered by fire, occasionally also by drought or frost (Virtue 1991; Felton 1993).

Melaleuca deanei seed is wind dispersed. Light winds are sufficient to empty most capsules of *M. quinquenervia*, which has similar sized seed (Virtue 1991). It is unknown whether *M. deanei* possesses a persistent soil seedbank. Its seeds remain viable for at least nine weeks following release from the capsules, but their viability after this period is unknown (Felton 1993). Felton suggests that the species does not require a persistent soil seedbank as the requirements for germination are provided by fire, which also triggers the release of the seed from its capsule.

Under laboratory conditions, seeds germinated readily and had high levels of viability (Virtue 1991; Felton 1993). Germination seems to be greatest in seeds that are sourced from large populations (Virtue 1991). However, in the wild,

no seedlings have been observed during the field work associated with the preparation of this recovery plan, or in previous studies (Travers Morgan 1990; Virtue 1991; Felton 1993). Doig (pers. comm.) notes that despite setting lots of potentially viable seed, germination in the wild is poor and many seedlings do not survive. Seedling establishment is most likely also dependent on prolonged moisture availability (Virtue 1991). It appears that overall, this species relies predominantly on clonal reproduction and produces seed infrequently.

5.4 Disturbance ecology

Melaleuca deanei frequently produces coppiced growth and suckers from its roots, particularly after fire or the disturbance and death of a major stem (Travers Morgan 1990). The species has also been observed to regenerate from epicormic buds that are protected from fire by thick papery bark (Felton 1993).

It has been suggested that fire is required to provide the right conditions for germination and seedling growth and that seedlings very rarely establish at any time other than after fire (Felton 1993). It has also been suggested that fire may be required to stimulate flowering of *M. deanei* (L. McDougall pers. comm. cited in Benson & McDougall 1998), however Felton (1993) states that some populations flower annually regardless of time since the last fire.

Melaleuca deanei has been observed growing most commonly and vigorously in sites exposed to direct sunlight, or in places where light penetration has been increased by disturbance, such as the edge of fire trails (Travers Morgan 1990; S. Douglas, pers. comm.). The species' preference for light may explain its habitat preference for open ridgetop vegetation (Felton 1993). Shaded plants seem to have fewer and shorter new stems and leaves, and a shorter internodal distance (Travers Morgan 1990).

It is therefore likely that fire, and possibly other physical disturbances that increase light levels without impacting upon the soil, play a role in providing for the recruitment and long term persistence of the species.

6 Threats and Management Issues

6.1 Threatening processes

6.1.1 Low fecundity and viability

Melaleuca deanei appears to have low fecundity levels as exhibited by infrequent flowering, poor seed production, and poor seedling vigour (Virtue 1991; Felton 1993; Travers Morgan 1990; R. Johnstone, pers. comm.). Also, larger populations seem to have greater seed viability and are more likely to produce fruit than smaller populations (Virtue 1991). A number of small populations (i.e. less than 10 ramets) have been lost or have suffered significant declines in population size in the last 10 years, even though habitat conditions at these sites do not appear to have changed (R. Doig, pers. comm.).

The causes of this low fecundity are not known and warrant further research, to determine both its exact cause and its implications for the viability of small *M. deanei* populations (see Table 7). Possible reasons could be inbreeding depression, the absence of a specific stimulus, or set of stimuli, that would trigger flowering, or a natural tendency towards vegetative reproduction.

Actions that counteract the low fecundity levels will depend on the outcome of such research. However, results so far indicate that until the research has been conducted, fecundity is likely to be enhanced by increased cross-breeding between individuals of the same or different populations. To facilitate such cross-breeding, care must be taken to retain genetic links between populations by providing contiguous habitat between them. Also, careful in-situ management of existing populations should focus on increasing the number of individual plants, and this should include the application of fire to stimulate seed release into favourable conditions for germination and establishment.

6.1.2 Habitat loss and fragmentation

The available habitat for *M. deanei* has been severely reduced and fragmented by urban development, quarrying, and associated disturbances. This is primarily a consequence of the species' distributional range being centred upon the Sydney region, and its apparent preference for ridge-top locations and sites with lateritic soils. The urbanisation of the Sydney region has divided the species' historical distribution into two distinct areas (ie northern and southern populations). Ongoing urban consolidation and expansion continues to threaten a number of populations. For example,

undetected, though probably small, populations may be present in the rural-residential areas of Baulkham Hills and Hornsby LGAs where the threat of clearing is substantial (S. Douglas, pers. comm.).

Holsworthy Military Area contains a number of highly significant populations and large areas of contiguous and relatively undisturbed habitat, which are largely zoned as land for Environmental Protection. The Department of Defence is currently considering the development of a conservation agreement for Holsworthy with the Commonwealth Minister for Environment Protection, Heritage and the Arts, which would safeguard this area from negative impacts arising from future development (D. Carter, pers. comm.).

Sites that are considered to be at high risk of habitat loss and fragmentation include the 17 sites that have been recorded from freehold land. Only five of these sites are zoned as land for Environmental Protection (Sites BM1, 2, 3a; SU10; WA11), all others are zoned as either Rural, Residential or Special Users, and thus are potentially subject to development or disturbance.

Of the eight known sites on crown or public land, four are in council reserves which are zoned as land for Environmental Protection (Sites RY2, SU2b, SU3, SU7a-f). Here, appropriate management can safeguard them against further habitat loss. A fifth site along a fire trail is also zoned for Bushland Conservation (Site BM3b), whereas the remaining three sites are zoned as Rural or Open Space and should thus be considered to be potentially at risk of loss (Sites HO4, KU3&4).

6.1.3 Inappropriate fire regimes

Frequent fires over a long period have the capacity to eliminate resprouting species such as *M. deanei* because juveniles have a slow growth rate and therefore take a longer period of time to become fire resistant (Felton 1993). High frequency fire has been recorded as a threat to *M. deanei* populations within Holsworthy Military Area (Felton 1993), and possibly elsewhere.

Populations within Holsworthy Military Area were reportedly burnt every 1 to 5 years (Travers Morgan 1990). However military practices have subsequently changed, and no fires as a result of military exercises have occurred in the area since 1996 (M. Peterson, pers. comm.). Lightning strike and arson are now the major cause of fire with suppression of those fires hindered by unexploded ordnance (M. Peterson, pers. comm.).

It is also likely that fire exclusion is impacting on the species, particularly those populations that inhabit small urban bushland remnants. As discussed in Section 5, fire is likely to play an essential role in the maintenance of *M. deanei* populations by:

- triggering seed release and possibly flowering;
- providing soil and light conditions that are conducive to germination and seedling growth; and
- increasing stem density through vegetative growth.

Further research into aspects of the fire ecology of *M. deanei* are required to determine the appropriate fire regime for the species (see Table 7). In the absence of this information, it is important that land managers apply an appropriately conservative fire regime for the species that comprises:

- a minimum fire frequency of 8 years;
- moderate intensity fires in preference to high intensity fires, until the intensity of fire that the lignotuber can withstand has been determined; and
- late summer or autumn burns, as seedlings emerging at these times should encounter favourable moisture conditions and therefore have a greater chance of establishment (Auld & Bradstock 1996).

Low intensity fires in habitat for the species should be avoided where possible (with the exception of those conducted and monitored under experimental conditions) until it can be demonstrated that such fires will trigger the release of seed and provide the appropriate conditions for seedling establishment.

The maximum fire-free interval for the species is not known. However, given the susceptibility of the species to shading and the potential for aging to reduce seed viability, it is recommended that fire exclusion for periods of greater than 20 years be avoided.

At sites where fire cannot be applied (e.g. due to remnant size or proximity to urban areas), other methods to trigger seedling recruitment could be trialled in an experimental manner. Such methods could include placing seeds in burn piles and burning the piles immediately.

6.1.4 Mechanical methods of bushfire fuel hazard reduction

Populations of *M. deanei* that are located in close proximity to residential developments or other assets are potentially threatened by mechanical methods of bush fire hazard reduction. Any Bush Fire Hazard Reduction Certificates issued under the *Rural Fires Act* 1997 must incorporate the mitigative actions for *M. deanei* identified in the Threatened Species Hazard Reduction List (TSHRL). Currently the TSHRL requires that no slashing, trittering or tree removal occurs at *M. deanei* sites. It is thus essential that the NPWS Wildlife Atlas contains records of all locations of the species that are accurate to within 100 metres.

In circumstances where the application of mechanical methods of fuel reduction cannot be avoided, selective hand removal of tree and shrub species (other than *M. deanei*) within 5 metres of *M. deanei* stands should be considered.

6.1.5 Construction and maintenance of tracks and easements

Track construction should be considered a significant threat due to the species' preference for ridgetop habitat, where it is often easiest to build roads and powerlines. Also, several *M. deanei* populations occur on the edge of fire trails and along powerline easements, where they are at risk from mechanical damage during the maintenance and/or widening of these areas (Sites BM3b; HO9a-b, 10a-e, 18e; SU9c&d; WO1, see Appendix 3). One population (Site BH2) has most likely been destroyed by the re-establishment of a fire trail along which it grew (S. Douglas, pers. comm.).

Repeated disturbance in the form of mowing, slashing, or trittering is likely to destroy *M. deanei* plants, or to at least prevent flowering and seed set. To avoid further losses of populations along fire trails and easements, several measures should be taken: first, the NPWS Wildlife Atlas contains all known records, and the appropriate authority should ensure that the Atlas is consulted for location records and updated where new populations are found. Further surveys should be conducted in areas where the species is suspected to occur, and field staff should be trained in the identification of the species. Populations should then be marked, e.g. by coloured survey pegs. Wherever possible, physical disturbance at such sites should be avoided or not occur in intervals of less than 8 years. Note that a s132C licence (NPW Act) may be required for works that will impact on this species.

6.1.6 Unrestricted access and rubbish dumping

Unrestricted access, the creation of new tracks and the dumping of rubbish threaten several *M. deanei* populations, through mechanical damage, soil compaction and introduction of weed propagules. It also leads to associated changes in runoff and weed encroachment.

Examples of such disturbances are informal tracks for trail bikes (Site HO1, S. Douglas, pers. comm.), or four-wheel drives (Site SU5a-5d, Travers Morgan 1990). Dumping of rubbish, including green waste, building debris and car bodies, has also caused disturbance at several sites (Site SU5a-5d, Travers Morgan 1990; SU9a-b, M. Bremner pers. comm.; HO26, S. Douglas, pers. comm.). These combined threats are best addressed through the installation of barriers to prevent physical damage to *M. deanei* sites.

6.1.7 Weed invasion

Weed invasion has been recorded as a threat to *M. deanei* at a small number of sites. Weeds present at these sites include *Lantana camara* (Lantana), *Asparagus densiflorus* (Asparagus Fern), *Eragrostis curvula* (African Love Grass) and *Ehrharta erecta* (Panic Veldt Grass). The impact of weeds on *M. deanei* include direct competition to mature plants through shading, as well as the disruption of life cycle processes including recruitment.

The management of weeds at *M. deanei* sites requires targeted bush regeneration efforts that aim to restore and maintain areas of suitable habitat. However, it is important that land managers are aware that weed control measures have the potential to impact negatively upon the species and caution should be used when applying herbicides within or near habitat for the species.

The small tree species *Pittosporum undulatum* (Native Daphne) is also a threat to *M. deanei* at sites where fire has been excluded for a long period. This species contributes to a mesic shift in vegetation and will potentially shade out *M. deanei.* At sites where fire cannot be applied, this species should be treated as a weed and selectively culled to maintain light levels. A second native species found to compete with *M. deanei* is Devil's Twine (*Cassytha glabella*), a leafless parasitic vine common in heath and woodland (Felton 1993). This species attaches to its host plant by means of suckers and extracts water and nutrients from the host. At least half of the populations visited by Felton were covered with this vine. Where possible, this species should

be removed from *M. deanei* plants to avoid shading and competition for resources.

6.1.8 Hybridisation

The hybridisation of *M. deanei* with other species of *Melaleuca* and *Callistemon* is a potential threat, particularly to those populations that occur in close proximity to urban areas. For example, the germination of seed collected from one site (SU3) revealed that only approximately 20% of progeny were 'pure' *M. deanei*, with the remaining progeny being hybrids with other *Melaleuca* and *Callistemon* species (probably *M. armillaris* and *C. viminalis;* R. Johnstone RBG pers. comm.). Further research is required to determine the extent of such hybridisation. Until this is done, the planting of other species of *Melaleuca* and *Callistemon* in close proximity to *M. deanei* sites should be avoided.

Table 7. Limits to current knowledge of *Melaleuca deanei*. The justification of the research and the methodology that may be used to address each question is broadly defined, as are the potential benefits of the increased knowledge.

Knowledge Gap	Justification	Potential Methodologies	Benefits of increased knowledge
The species' capacity to regenerate, including the cause of low fecundity levels.	Implications for long-term viability of the species.	Investigate the breeding system and the species' ability to self-pollinate. Investigate the level of gene flow within and among populations. Investigate the need for a specific stimulus to trigger flowering.	Results will enable consent and determining authorities to effectively determine the impact of proposed developments on the species. Better allocation of resources for the recovery program.
Appropriate fire regime	Inappropriate fire regimes are a threat to the species.	Investigations of specific aspects of the fire ecology of the species including seedbank longevity; the time required for seedlings to become fire resistant; the age of reproductive maturity; the effect of capsule age on seed viability; the minimum fire intensity that will trigger the release of seed; and the maximum fire intensity that the lignotuber can withstand.	Potential to increase population size through seedling recruitment.
Extent of hybridisation with other *Melaleuca* and *Callistemon* species	Hybridisation has been observed in at least one population.	Germination of seed collected from urban and non-urban populations. Investigations of source of genetic 'contamination' at sites where hybrids occur.	Land managers will be aware of the actual degree of this threat and will be able to implement appropriate threat abatement measures, eg removal of inappropriate plantings. The community can be informed of the safe distance at which other *Melaleuca* and *Callistemon* species can be planted.

6.2 Limits to current knowledge

Our ability to manage a threatened species is dependent on our knowledge of the ecological requirements of that species, and the circumstances that threaten population persistence. In order to effectively manage and conserve *M. deanei*, greater understanding is required of: (i) the species' capacity to regenerate; (ii) appropriate fire regimes; and (iii) the hybridisation with other species (Table 7).

6.3 Translocation and ex situ conservation

Translocation is the deliberate transfer of plants or regenerative plant material from an *ex-situ* collection or natural population to a location in the wild, including existing or new sites or those where the taxon is now locally extinct (Vallee *et al*. 2004). Translocation is often touted as a possible method of conserving threatened flora. However, given the high cost and risk associated with the technique, translocation should only be considered as a last resort when all other management options are deemed inappropriate or have failed. As stated by Vallee *et al*. (2004), 'where possible, resources will be more effective when directed towards conserving existing populations *in-situ* through habitat protection and/or habitat rehabilitation measures and through the control of threatening processes'.

Translocation is not currently considered necessary for the survival of *M. deanei* as the *in-situ* conservation measures proposed in this recovery plan are expected to meet the conservation needs of the species. Further, primarily due to the uncertainty of success and the risks associated with translocation, the technique should not be considered by consent or determining authorities to be an appropriate means of ameliorating the impact of a proposal on threatened species (Vallee *et al*. 2004). In short, translocation does not decrease the significance of an impact.

There is currently no plan to establish an *ex-situ* collection of this species, and this is not listed as a

priority action for its survival. However, the establishment of an *ex-situ* seed collection is considered to be a prudent contingency measure to protect against the loss of genetic material that may result from unexpected local extinctions. Currently, Mt Annan Botanical Gardens has a large collection of seed from a population near Nepean Dam, but it is unknown whether this would suffice to ensure good capture of the species' genetic inventory (R. Johnstone, pers. comm.).

7 Previous Recovery Actions

7.1 Surveys and research

The majority of known *M. deanei* populations described in this recovery plan (85%) were located after 1990. Two research projects focused on the distribution, seed ecology and other ecological aspects of this species, and these provided detailed accounts of some populations (Virtue 1991; Felton 1993). Opportunistic surveys by consultants and other experts located further populations. In particular, two surveys focused exclusively on locating *M. deanei* in the Heathcote district, West Menai and the Southern Sydney region (Travers Morgan 1990; KMA 2001). Other surveys located *M. deanei* as part of more general flora surveys, in areas such as Holsworthy Military Reserve (French *et al*. 2000) or the area impacted upon by the construction of the Bangor Bypass (RTA 2002). In addition, many of the known, and some suspected, sites were surveyed in 2005 and 2006 for the preparation of this recovery plan.

7.2 Threatened species data collection and audit

The DECCW has conducted a literature review, and an audit of RBG NSW Herbarium, NSW NPWS Atlas of Wildlife, State Forests and other records prior to the preparation of this recovery plan.

7.3 Profile and environmental impact assessment guidelines

A species profile and environmental impact assessment guidelines have been prepared for *M. deanei* (Appendix 4). The aim of these documents is to assist the assessment of potential impacts on the species and community during the preparation and review of assessments under Parts 4 and 5 of the EP&A Act and Part 6 of the TSC Act.

7.4 Establishment of a recovery team

A recovery team has not been established for *M. deanei*. However, consultation has occurred with members of a recovery plan reference group, comprising representatives of relevant public authorities that will be responsible for the planning and/or management of this species and scientists who have special knowledge of the species.

7.5 In-situ protection

Two local councils (Sutherland Shire and Liverpool City Council) have reduced illegal dumping of rubbish along one major road (Heathcote road) where such dumping threatens *M. deanei* populations, through patrols by Enforcement Officers, the installation of surveillance cameras, building of access barriers, and community awareness programs (DEC 2005). Management plans have been prepared for two sites containing significant populations of *M. deanei* (Site SU3, Sutherland Shire Council 2000; Site Su7a-7f, NECS 2001).

More than 50% of all populations occur on DECCW estate and are zoned as National Park or Nature Reserve.

8 Proposed Recovery Objectives, Actions and Performance Criteria

The overall objective of this recovery plan is to prevent the status of *M. deanei* from becoming critically endangered by reducing the further loss of populations and, by implementing in-situ management regimes aimed at maintaining representative populations of the species' across its natural range.

Specific objectives of the recovery plan for the species are listed below. For each of these objectives a number of recovery actions have been developed, each with a performance criterion.

Specific objective 1: Coordinate the recovery of *M. deanei*

A coordinated approach is essential to oversee and assist in the implementation of the actions outlined in this recovery plan in a timely, cost-effective and efficient manner. Some of the tasks undertaken during the coordination of this plan (e.g. liaison with other public authorities) will overlap with other identified actions.

Action 1.1: *DECCW will coordinate the implementation of the actions outlined in this recovery plan.*

Performance Criterion 1.1: *DECCW has coordinated the recovery actions included in this recovery plan for the life of the plan.*

Specific objective 2: Protect known occurrences of *M. deanei* using land-use and conservation planning mechanisms

More than half of known *M. deanei* sites (53%) occur within conservation reserves, but most of these sites are concentrated in the northern part of the species range (Section 4.4). In addition, conservation reserves protect only seven of the 16 larger populations (e.g. ramet counts >40). This objective aims to increase the legislative protection afforded to high priority sites through the following mechanisms:

- Conservation agreements and covenants under the NPW Act and *Conveyancing Act 1919*;
- Joint management agreements and property management plans under the *TSC Act;*
- Environmental planning instruments under Part 3 of the EP&A Act;
- Classification of land as community land under the *Local Government Act* 1993 and subsequent consideration of the species in plans of management for such land.

Action 2.1: *DECCW (EPRD or PWD) will advise relevant public authorities of the presence of* M. deanei *on lands under their control or management and encourage appropriate zoning and agreements.*

Performance Criterion 2.1: *Advice given to relevant public authorities on appropriate zoning and agreements.*

Action 2.2: *Councils and the Department of Planning will ensure that all relevant Environmental Planning Instruments (prepared under Part 3 of the EP&A Act) are prepared, or reviewed, with reference to this recovery plan and any further advice from the DECCW regarding this species.*

Action 2.3: *All relevant consent and determining authorities (under Part 4 & 5 of the EP&A Act) will assess developments and activities with reference to this recovery plan, environmental impact assessment guidelines (Appendix 4) and any further advice from the DECCW regarding the species.*

For the purpose of Action 2.3, consent and determining authorities include:

- the DECCW;
- the Department of Planning; and
- the local governments of Baulkham Hills, Blue Mountains, Campbelltown, Hawkesbury, Hornsby, Ku-ring-gai, Liverpool, Ryde, Sutherland, Warringah, Wingecarribee, and Wollondilly.

Performance Criterion for actions 2.2 and 2.3: *The level of protection afforded* M. deanei *populations and habitat is increased through conservation planning and land-use decisions.*

Specific objective 3: To identify and minimise the threats operating at *M. deanei* sites

Threats operating at *M. deanei* sites that are additional to land clearing are described in Section 6.2. Lack of knowledge about the species (and specifically the cause of population losses and declines at sites where habitat has remained intact) is an additional possible threat that may be affecting the species. Actions under this objective aim to minimise threats through: (1) providing information regarding the management of *M. deanei* to relevant land managers and public authorities; (2) incorporating appropriate threat abatement measures into relevant management plans; and (3) implementing appropriate *in situ* abatement measures.

Priority sites for this action have been identified based on (i) the size of the population; (ii) the distance from the nearest conserved population; (iii) the confirmed ability of the population to produce fruit; and (iv) the size and/or condition of proximate habitat at the site. Lists of priority sites are based on the information available at the date of this recovery plan being published, and may change as the level of legislative protection changes, or as new sites are discovered.

Threat abatement measures for *M. deanei* may include (but should not be restricted to):

- weed control and bush regeneration activities;
- the creation or maintenance of vegetation corridors between and within populations, as *M. deanei* may require cross-breeding for successful seed production (see Section 5.2);
- sensitive trail and easement maintenance protocols;
- regular monitoring to assess the status of the population and the effectiveness of threat abatement measures;

- the application of appropriate fire regimes (see also Action 3.11 below);
- avoiding planting other species of Melaleuca and Callistemon in close proximity to *M. deanei* sites; and
- installation of barriers to prevent physical damage to *M. deanei* sites.

Management of threats to *M. deanei* on DECCW estate:

Action 3.1: *The DECCW will prepare site management statements for populations located on DECCW estate.*

The DECCW will survey known sites located on DECCW estate, then prepare site management statements (following the proforma in Appendix 5) that detail any specific threat abatement measures required and a timetable to implement these measures. Priority sites for this action are located in Heathcote NP, Ku-ring-gai Chase NP, Berowra Valley RP, and Wollemi NP (see Appendix 3).

Performance Criterion 3.1: *Site management statements for relevant populations prepared within 3 years.*

Action 3.2: *The DECCW will implement any necessary threat abatement measures in accordance with the site management statements prepared under Action 3.1.*

Performance Criterion 3.2: *On-site threat abatement measures implemented for* M. deanei *on DECCW estate as required.*

Action 3.3: *The DECCW is to ensure that any Plan of Management or Fire Management Plan for DECCW estate supporting* M. deanei *provides for the species' conservation.*

Performance Criterion 3.3: *Plans of Management for DECCW estate supporting* M. deanei *provide for the conservation of this species.*

Management of threats to *M. deanei* on community land managed by local government:

Action 3.4: *Local governments will consider incorporating site specific threat abatement measures into Plans of Management for land where* M. deanei *occurs and will review the zoning of sites where* M. deanei *occurs as land zoned for Environmental Protection where such land is not already zoned as such.*

The following local governments currently manage community land that supports *M. deanei*: Blue Mountains, Ku-ring-gai, Ryde, Hornsby and Sutherland (see Appendix 3 for site details). These councils, and other councils subsequently found to manage *M. deanei*, will incorporate site specific *in situ* protection measures for the species into Plans of Management for community land where the species occurs. Site specific information will be collected in a Site Management Statement (Appendix 5) for each site at which *M. deanei* occurs. Three sites (KU4, KU3 and HO12) occur on land that is not currently zoned for Environmental Protection and the relevant councils will consider rezoning this land for Environmental Protection.

Performance Criterion 3.4: *In situ protection measures for the species are incorporated into Plans of Management for community land managed by local governments within 3 years.*

Action 3.5: *Councils will implement threat abatement measures in accordance with the site-specific recommendations incorporated into the Plans of Management prepared under Action 3.4.*

Performance Criterion 3.5: *Threat abatement measures for relevant sites are implemented in accordance with Plans of Management by year 5.*

Management of threats to *M. deanei* on land managed by other public authorities:

Action 3.6: *The DECCW will encourage other public authorities that manage land that supports* M. deanei *to prepare site management statements (following the proforma in Appendix 5) for* M. deanei *habitat under their management.*

For the purpose of this action 'other public authorities' include:

- Department of Defence
- Sydney Catchment Authority
- RTA
- Waste Services NSW

Priority sites for this action are situated at Nepean Dam (WI1), Avon Dam Catchment (WO3a-d), Springwood (BM3b), Mt. Ku-ring-gai (HO5),

Akuna Avenue (SU4), and Holsworthy Defence Reserve (CA1-11; LI1-3; SU7g).

Performance Criterion 3.6: *Site management statements for relevant populations are prepared within 3 years.*

Action 3.7: *The DECCW will liaise with other public authorities (as identified in Action 3.6) to implement any necessary and feasible threat abatement measures within the habitat of* M. deanei *to mitigate against habitat destruction and degradation related to unrestricted access and frequent fire, in accordance with the site management statements prepared under Action 3.6.*

Performance Criterion 3.7: *Threat abatement measures are implemented in accordance with the site management statements by year 5 of the plan.*

Action 3.8*: The DECCW will liaise with the Commonwealth Department of Defence to facilitate the implementation of threat abatement measures at all priority sites within Holsworthy Military Reserve (see Appendix 3 for site details).*

Performance Criterion 3.8*: Threat abatement measures implemented at all sites within Holsworthy Military Reserve within 5 years.*

Management of threats to *M. deanei* on private property:

Action 3.9*: The DECCW will encourage and assist private landholders in the preparation of site management statements (following the proforma in Appendix 5) for sites located on freehold land where necessary, to guide management at those sites..*

Priority sites for this action are located at Springwood (BM3a), Menai (SU5a-d), Lucas Heights (SU7h&I), and Wilton (WO2).

Performance Criterion 3.9*: Site management statements prepared for at least 4 sites on freehold land within 3 years, subject to landholder approval.*

Action 3.10*: The DECCW will encourage landholders to implement threat abatement measures on freehold land in accordance with the site management statements prepared under Action 3.9.*

The DECCW will encourage interested private landholders of sites that support *M. deanei*, to implement on-ground works to mitigate or reduce threats, in accordance with Site Management Statements prepared under Action 3.9. Where landholders are interested, and at appropriate sites, the DECCW will encourage landholders to enter into Voluntary Conservation Agreements or Biobanking Agreements. The sites will also be monitored by the DECCW on a regular basis to assess the success of any on-ground works that have been implemented.

Performance Criterion 3.10*: Threat abatement measures for relevant sites implemented in accordance with site management statements within 5 years, subject to landholder approval.*

Strategic management of frequent fire:

Action 3.11: *DECCW and the NSW RFS will review the conditions for* M. deanei *in the Threatened Species Hazard Reduction List of the Bush Fire Environmental Assessment Code.*

DECCW and RFS will use available biological and ecological information to reassess the immediate and cumulative impact of bush fire hazard reduction works on *M. deanei*, and to reassess the adequacy of the mitigative conditions in the Threatened Species Hazard Reduction List. DECCW and RFS will also use available biological and ecological information to reassess the impacts of wildfires on *M. deanei*, and, if appropriate, develop preferred mitigative measures to minimise the potential impact of wildfires and/or wildfire suppression operations.

If appropriate, measures for the protection of *M. deanei* are to be included in relevant Bush Fire Risk Management Plans and Operation Maps (pursuant to section 52 of the *Rural Fires Act* 1997).

Performance Criterion 3.11: *Bush Fire Risk Management Plans and Operations Maps include measures (as appropriate) for the protection of* M. deanei, *and the mitigative conditions for* M. deanei *on the Threatened Species Hazard Reduction List are reviewed by year 5 of the implementation of this recovery*

plan or as relevant information becomes available.

Action 3.12: *The DECCW will provide updated Atlas of NSW Wildlife data to the RFS for incorporation into relevant datasets (including the Threatened Species Hazard Reduction List of the Bush Fire Environmental Assessment Code) and make this data available to the other approval or public authorities.*

Performance Criterion 3.12: *Updated Atlas of NSW Wildlife data is incorporated and used by approval and other public authorities in decision making.*

Specific objective 4: To improve awareness of *M. deanei* amongst operational staff working within easements, walking tracks and fire trails

The removal of vegetation within easements (particularly under electricity transmission lines) and along walking tracks and fire-trails has been identified as a threat at a number of *M. deanei* sites. Under this action, land managers will ensure that operational staff with track, fire trail and easement maintenance responsibilities undertake these duties in a manner that does not impact upon the long term viability of *M. deanei* populations.

Action 4.1: *The DECCW will liaise with relevant authorities to ensure that operational staff working within easements, walking tracks and fire trails are aware of* M. deanei *populations and minimise the impacts of their activities on this species.*

For the purpose of this action 'relevant authorities' are:

- Sydney Catchment Authority
- Department of Defence
- the local governments of Baulkham Hills, Blue Mountains, Ku-ring-gai, Ryde, and Sutherland.

Under this action, land managers will ensure that operational staff with track, fire trail and easement maintenance responsibilities undertake these duties in a manner that does not impact upon the long term viability of *M. deanei* populations. This will involve:

- Training operational staff in identifying *M. deanei;*
- Informing operational staff of the location of relevant sites;
- Marking of such sites in the field prior to any maintenance works;
- Establishing buffer zones around sites within which more sensitive maintenance practices are carried out (e.g. retention of *M. deanei* and selective hand pruning of other vegetation).

Performance Criterion 4.1: *Impacts of operational works on* M. deanei *are minimised through the implementation of protection procedures within 2 years of the publication of this plan.*

Specific objective 5: To promote surveys, research and monitoring that will assist with the management of *M. deanei*

Action 5.1: *The DECCW will undertake surveys of previously unsurveyed sites to confirm the presence or absence of* M. deanei, *and will continue to monitor known sites.*

The DECCW will undertake surveys to confirm the presence of all *M. deanei* sites not surveyed during the preparation of this recovery plan. These surveys are required to document the size, habitat characteristics and threats present at these sites. The DECCW will also continue to monitor known *M. deanei* sites and will analyse any monitoring data that was collected during threat abatement or other on-ground activities. This information can then be used to enter site specific actions for the species into the Priorities Actions Statement (PAS).

Performance Criterion 5.1: *Information regarding population size (ramet numbers and area occupied), habitat characteristics and threats collected for all known sites within 5 years.*

Action 5.2: *The DECCW will identify potential habitat for* M. deanei *and facilitate surveys for the species within potential habitat.*

It is likely that our current understanding of the distribution of *M. deanei* is not complete. It is important to establish the full extent of the distribution of potential habitat for *M. deanei*, through both on-ground surveys and predictive modelling.

Performance Criterion 5.2: *At least one survey will be conducted annually for* M. deanei *and*

further potential habitat for the species has been identified.

Action 5.3: *The DECCW will promote the priority research projects identified in this recovery plan.*

As outlined in Section 6.2, a number of potential research projects could assist with the conservation management of *M. deanei*. The DECCW will encourage tertiary and research institutions to conduct research consistent with the priorities outlined in section 6.3 and will assist these institution in applying for external funding. Where possible, the DECCW will undertake components of this research program.

While all research outlined in Section 6.3 is regarded as important, particular emphasis will be placed upon research into the hybridisation of *M. deanei* with other species (Section 6.2.8). Knowledge of the extent of this threatening process is an essential prerequisite for developing management strategies.

Performance Criterion 5.3: *All major tertiary and research institutions within the Sydney/Illawarra regions have been contacted regarding potential research areas within 3 years.*

Specific objective 6: To provide stakeholders with information that assist in conserving *M. deanei*

The prompt and effective distribution of information on *M. deanei* is an important component of ensuring that the conservation requirements of the species are appropriately considered in decisions regarding land-use planning and field management. Actions under this objective aim to aid the dissemination of information regarding the taxon to stakeholders including land managers, consent and determining authorities, environmental consultants, bushland contractors, and community groups.

Action 6.1: *The DECCW will provide public land managers with the site information that was collected during the preparation of this recovery plan.*

Performance Criterion 6.1: *Relevant public land managers will have received site information within 6 months of publishing this plan and will be able to incorporate this information in relevant land-use and planning decisions.*

Action 6.2: *The DECCW will update the profile and environmental impact assessment guidelines for the species to incorporate information acquired during the implementation of the recovery plan.*

Performance Criterion 6.2: *Profile and environmental impact assessment guidelines for the species updated as required.*

Specific objective 7: To raise awareness about the threats to the species and involve the community in the recovery program

In order to enhance the social benefits of the recovery program and to assist in its implementation, actions under this objective aim to raise awareness of the recovery program and encourage community involvement in its implementation. A potential area of involvement of the community is in the implementation of threat and habitat management programs and the monitoring of their success, which is an action that public authorities will undertake (see Action 3.6). Community groups can use the Site Management Proforma (Appendix 5) to monitor sites supporting *M. deanei*.

Action 7.1: *The DECCW will distribute information on the progress of the recovery program to raise awareness of the program and encourage community involvement in its implementation.*

The DECCW will distribute information on the progress of the *M. deanei* recovery program via existing DECCW newsletters and will also use relevant local media for such distribution. This information will be aimed at public authorities, community groups, interested individuals and selected affected landholders.

Performance Criterion 7.1: *Relevant information distributed annually.*

Action 7.2: *The DECCW will liaise with local governments, landcare groups and regional bodies such as Catchment Management Authorities to incorporate the implementation of recovery actions (including bush regeneration and site monitoring) into existing bushcare programs.*

Performance Criterion 7.2: *Recovery actions implemented into existing bushcare programs and at least four bushcare groups involved in the recovery program annually.*

Specific Objective 8: To coordinate an ex-situ conservation program to safeguard genetic material from extinction

As discussed in Section 6.4, the establishment of a comprehensive ex-situ germ plasm collection for *M. deanei* is not considered necessary for the survival of the species. However, to provide protection against the unexpected loss of genetic material, it would be prudent to maintain an ex-situ collection of seed collected from priority sites.

Populations that are considered to be a high priority for seed collection are those that are known to contain less than 100 ramets. Care must be taken that seeds are not hybrids, that is a proportion of seed should be tested genetically before being included in the seedbank. Appendix 3 lists population size for those populations where this is known, and future surveys will reveal population sizes for additional populations.

Action 8.1*: The DECCW will coordinate the collection of a representative sample of seed from each priority population and place in long-term seed storage.*

Performance Criterion 8.1*: A representative sample of seed collected from each priority population and placed in long-term storage within 3 years, subject to landholder approval.*

9 Implementation

Appendix 1 outlines the statutory responsibilities for Public Authorities in relation to this species. Table 8 outlines the costs and parties responsible for implementation of recovery actions specified in this recovery plan.

10 Social and Economic Consequences

10.1 Social consequences

The implementation of this recovery plan is not expected to affect responsible public land usage to any great extent, and modification of private land management patterns will occur at the land manager's discretion. Liaison with the local community, affected landholders and government agencies will address and minimise any unforeseen negative social impacts arising from the conservation of *M. deanei.*

It is expected that the implementation of this recovery plan will have positive social impacts. The main social benefit of conserving *M. deanei* habitat is in meeting the desire of many in the community that further loss of remnant bushland and threatened species should be prevented. The involvement of the local communities in the implementation of recovery actions (including site monitoring, surveys and site protection measures) will provide benefits for the environment and enhance the general well being of the community and individuals involved.

10.2 Economic consequences

The economic consequences of this recovery plan are those costs that are associated with its implementation. Actions involving on-ground management programs and the long-term monitoring of sites will have the greatest economic consequences for land managers. Many of the costs will be met by seeking funding from external sources. The costs will be minimised by:

- implementing a long-term strategic framework for managing the species and its habitat; and
- adopting a co-operative approach to management, which involves the DECCW, other relevant landholders and the community.

The improved environmental impact assessment that will result from mechanisms established in this recovery plan will assist land managers and consent and determining authorities to meet their statutory responsibilities.

11 Biodiversity Benefits

The conservation and study of *M. deanei* will benefit other threatened species that share the same habitat, particularly *Darwinia biflora, Tetratheca glandulosa, Acacia bynoeana, and Pseudophryne australis* (S. Douglas pers. comm.).

Increased awareness of *M. deanei* resulting from the implementation of this recovery plan will raise the profile in the community of all threatened species. This in turn will lead to greater opportunities for the conservation of threatened species and increased protection of biodiversity.

12 Preparation Details

This recovery plan has been prepared by Martin Bremner and Ann Goeth from the DECCW

Biodiversity Conservation Section, Metropolitan Region. The information in this recovery plan was based on the best available knowledge on the date it was approved.

13 Review Date

This recovery plan will be reviewed and updated by DECCW within 5 years of the date of its publication.

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15 Abbreviations Used in this Document

DECCW	Department of Environment, Climate Change and Water (NSW)
EP&A Act	NSW *Environmental Planning and Assessment Act* 1979
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999
LEP	Local Environmental Plan
NPW Act	NSW *National Parks and Wildlife Act* 1974
NPWS	NSW National Parks and Wildlife Service
NV Act	NSW *Native Vegetation Act* 2003
RFS	Rural Fire Service
RTA	Roads and Traffic Authority, NSW
SEPP	State Environmental Planning Policy
TSC Act	NSW *Threatened Species Conservation Act* 1995

Table 8. Estimated costs, funding source and responsible parties for implementing the actions identified in the Recovery Plan.

Action No.	Description	Responsible party[1]	Priority[2]	Fund source[3]	Estimated cost/yr[4]					Total Cost
					Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	
1.1	Co-ordinate recovery program	DECCW	1	In-kind	$8340	$8340	$8340	$8340	$8340	$ 41700
2.1.	Advice to public authorities	DECCW	1	#						
2.2	Reference to this plan when preparing Planning Instruments	Councils [5]	1	#						
2.3	Reference to this plan when assessing developments & activities	Councils [5]	1	#						
3.1	Site management statements	DECCW	2	Unsecured	$4170	$4170	$4170	$4170	$4170	$ 20850
3.2	DECCW Implementation of threat abatement measures	DECCW	1	Unsecured	$8340	$8340	$8340	-	-	$ 25020
3.3	Review of Plans of Management or Fire Management Plans	DECCW	2	In-kind	-	$4170	-	$4170	-	$ 8430
3.4	Incorporate threat abatement measures into management plans for community land	Councils [5]	1	#						
3.5	Local Government Implementation of threat abatement measures	Councils [5]	1	#						
3.6	DECCW to encourage site management statements	DECCW	1	#						
3.7	Public authorities Implementation threat abatement measures	Public authorities [6]	1	#						
3.8	Liaise with Dept. of Defence regarding Holsworthy	DECCW	1	Unsecured	-	$4170	-	-	-	$ 4170
3.9	Prepare site management statements for private landholders	DECCW	2	Unsecured	$4170	$4170	-	-	-	$ 8430
3.10	Encourage private landholders to implement threat abatement measures	DECCW	2	In-kind	-	-	$4170	-	$4170	$ 8430
3.11	Review Bush Fire Environmental Assessment Code	DECCW, RFS	2	#						
3.12	Provide updated NSW Atlas data to other relevant datasets	DECCW	2	Unsecured	-	$4170	-	$4170	-	$ 8340
4.1	DECCW to encourage operational staff to reduce impact on species	DECCW	1	In-kind	$4170	-	$4170	-	-	$ 8340
5.1	Undertake surveys of previously unsurveyed sites	DECCW	2	Unsecured	$4170	$4170	$4170	-	-	$ 12510
5.2.	Identify potential habitat and facilitate surveys	DECCW	2	Unsecured	$4170	-	-	$8340	-	$ 12510
5.3	Promote the priority research projects	DECCW	2	#						
6.1	Provide public land managers with site information	DECCW	1	In-kind	$4170	-	-	-	-	$ 4170
6.2	Update profile & Environmental Impact Assessment Guidelines	DECCW	2	#						
7.1	Raise awareness of recovery program in the community	DECCW	3	Unsecured		$4170				$ 4170
7.2	DECCW to liaise with councils regarding bushcare programs	DECCW	3	Unsecured			$4170			$ 4170
8.1	Create long-term seed storage	DECCW	3	Unsecured	-	$4170	-	$4170	-	$ 8430
	Annual and total cost			Unsecured						$108420
				In-kind						$ 70890
				TOTAL						$179310

[1] **DECCW** : Department of Environment, Climate Change and Water

[2] **Priority ratings are: 1 -** Action critical to meeting plan objectives, **2 -** Action contributing to meeting plan objectives, **3** – Desirable but not essential action.

[3] **In kind** funds represent the salary component of permanent staff and recurrent resources. Salary for in-kind contributions is calculated at $350 per day, which includes officer salary and on-costs, provision of office space, vehicles, administration support and staff management. **Unsecured** funds will be sought from sources including DECCW annual provisions for the implementation of threatened species programs, Caring for Our Country, Environmental Trust, industry sponsors, the NSW State Biodiversity Program, Threatened Species Network, and Threatened Species Appeal.

[3, 4] **#** - No direct cost (either cost of action is negligible or action is a statutory responsibility of the responsible party).

[5] Councils in this recovery plan, are the local governments of: Baulkham Hills, Blue Mountains, Campbelltown, Hawkesbury, Hornsby, Ku-ring-gai, Liverpool, Ryde, Sutherland, Warringah, Wingecarribee, and Wollondilly.

[6] Public authorities in this recovery plan, are the RTA, Waste Services NSW, and Sydney Catchment Authority.

Appendix 1: Public Authority responsibilities under NSW legislation

Public authority	Relevant responsibilities
Department of Environment, Climate Change and Water	• Assessment of section 91 licence applications under the TSC Act • Assessment of section 132C licence applications (eg for bushland regeneration activities) under the NPW Act • Assessment of proposed activities on DECCW estate. • Consideration of objectives and actions of a recovery plan when undertaking assessment of significance under section 5A of EP& A Act • Advice to consent and determining authorities, with a possible concurrence role under the EP&A Act • Preparation of priority action statements and co-ordination of implementation. • Preparation of plans of management for DECCW estate.
Relevant local governments	• Preparation of local environmental plans (LEPs) under Part 3 of EP&A Act. Consultation with DECCW is required if the LEP will or may affect threatened species, populations, communities or their habitats. • Assessment of development applications under Part 4 of EP&A Act. • Assessment of council works under Part 5 of EP&A Act. • Consideration of objectives and actions of a recovery plan when undertaking assessment of significance under section 5A of EP& A Act • Consideration of conditions in Threatened Species Hazard Reduction List when issuing Bush Fire Hazard Reduction Certificates under *Rural Fires Act* 1997. • Plans of management for community land must be prepared or amended to take into account council's obligations under a recovery plan.
Department of Planning	• Development of policy and strategies, including SEPPs, for land use planning and environmental assessment. • Assessment of major development applications. • Determination of certain development proposals under Part 4 of the EP&A Act. • Approval of certain activities under Part 5 of EP&A Act. • Consideration of objectives and actions of a recovery plan when undertaking assessment of significance under section 5A of EP& A Act
Rural Fire Service	• Consideration of impacts on threatened species, populations, communities and their habitats when exercising functions and when preparing Bush Fire Risk Management Plans and Plans of Operations. • Approval authority for works under Part 5 of EP&A Act • Consideration of objectives and actions of a recovery plan when undertaking assessment of significance under section 5A of EP& A Act • Consideration of conditions in Threatened Species Hazard Reduction List when issuing Bush Fire Hazard Reduction Certificates. • Consideration of objectives and actions of a recovery plan when undertaking assessment of significance under section 5A of EP& A Act
Roads and Traffic Authority	• Appropriate management of lands with known or potential habitat.
Sydney Catchment Authority	• Appropriate management of lands with known or potential habitat.
Waste Services NSW	• Appropriate management of lands with known or potential habitat.

Appendix 2: Additional legislation relevant for the conservation and recovery of *M. deanei*

Additional legislation relevant to the conservation and recovery of *M. deanei* in NSW includes the following:

- *National Parks and Wildlife Act* 1974;
- *Environmental Planning and Assessment Act 1979;*
- *Local Government Act 1993*;
- *Native Vegetation Act 2003*;
- *Rural Fires Act 1997*;
- *Rural Fires and Environmental Assessment Legislation Amendment Act 2002;*
- *Crown Lands Act 1989;* and
- *Rural Lands Protection Act 1998.*

The most significant implications of the above legislation with regard to *M. deanei* are described below, and the major existing obligations of public authorities in relation to *M. deanei* are outlined in Appendix 1.

Environmental Planning & Assessment Act 1979

Consent and determining authorities are required to consider potential impacts on *M. deanei* and its habitat when considering development or activity proposals under parts 4 and 5 of the EP&A Act.

Part 3 of the EP&A Act provides for the preparation of environmental planning instruments (EPIs) and this presents opportunities to conserve important habitat for *M. deanei* at the landscape level. For example, important sites that contain *M. deanei* can be protected under an appropriate environmental zoning when councils prepare or review local environment plans (LEPs). This is a more effective means of providing for the conservation requirements of a species than through the assessment of individual development applications.

An action that does not require a consent or approval under the EP&A Act and which is likely to affect *M. deanei*, requires a licence to be issued by the Director General of DECCW under Section 91 of the TSC Act.

Rural Fires Act 1997

The RF Act requires all parties involved in fire suppression and prevention to have regard to the principles of ecologically sustainable development when exercising their functions and when preparing plans of operation or bush fire risk management plans. Within this, consideration must be given to the impact on threatened species and their habitats.

Under the RF Act, certain public authorities can authorise bush fire hazard reduction work (including prescribed burning and mechanical vegetation clearance) in habitat for a threatened species by issuing a Bush Fire Hazard Reduction Certificate (BFHRC). These certificates can only be issued for works that comply with the Bush Fire Environmental Assessment Code (BFEAC), and occur on land that is subject to a Bush Fire Risk Management Plan. The Threatened Species Hazard Reduction List forms part of the BFEAC and contains specific conditions for sites that support threatened species. The specific conditions in the list that relate to *M. deanei* are detailed in Section 8.

Where proposed bush fire hazard reduction activities do not meet the criteria necessary to allow a BFHRC to be issued, then an approval under Parts 4 or 5 of the EP&A Act or s91 of the TSC Act is required.

Local Government Act 1993

The LG Act defines the powers, duties and functions of all local councils in NSW. Section 8(1) of the Act requires councils 'to properly manage, develop, protect, restore, enhance and conserve the environment of the area for which it is responsible, in a manner that is consistent with and promotes the principles of

sustainable development'. This includes the integration of biodiversity considerations into the decision-making process.

Chapter 6 of the Act requires councils to prepare plans of management for community land that take into account council's obligations under approved recovery plans.

Crown Lands Act 1989

Part 3 of the CL Act sets out the process for assessing Crown land against prescribed land evaluation criteria. This leads to an assessment of the land's use for community or public purposes, environmental protection, nature conservation, water conservation, or other purposes. In identifying uses for Crown land, the Minister is to have regard to the views of any government department.

Under the Act, the Minister for Lands may place restrictions on the transfer or use of Crown land or impose a public positive covenant on Crown land for the purposes of protecting the environment or natural resources, and/or protecting other significant values of the land.

Appendix 3: *Melaleuca deanei* general location details and population specific information

Given concerns that the publication of exact location details for populations of *M. deanei* may compromise conservation, specific location information (Eastings and Northings) is not included. Public authorities, land managers, or others with genuine reasons for requiring the data, may request this additional information contacting the Threatened Species Unit or may obtain the information via the NPWS Wildlife Atlas.

Site codes marked with * show priority sites as described in Section 8 of this recovery plan.

Code	General Location	Land manager	Tenure	LGA	Zoning	Last surveyed	Count	Flowers/fruit	Source[1]
BM3b*	Springwood (fire trail off Lalor Dr)	Blue Mountains City Council	Crown	Blue Mountains	Bushland Conservation (LEP1991)	1991	11 (1991)	No flowers or fruit (2001)	M. Thompson, pers. comm.
GO1	Brisbane Waters NP (Leochares Peak)	DECCW	NPWS Estate	Gosford	8(a) National Park	1990	none provided	-	J. Benson, pers. comm. in Felton (1993)
HA1	Yengo NP (Womerah Range)	DECCW	NPWS Estate	Hawkesbury	8(a) National Park	-	none provided	-	K. Maryott-Brown, pers. comm. in Felton (1993)
HA2	St. Albans	DECCW	NPWS Estate	Hawkesbury	8(a) National Park	1983	none provided	-	D. Lambert, pers.comm.
HA3	Yengo NP (Books Ferry)	DECCW	NPWS Estate	Hawkesbury	8(a) National Park	1983	none provided	-	D. Lambert, pers.comm
BM4	Blue Mountains NP (ridge between St Helena and Glenbrook Creeks)	DECCW (Blue Mountains)	NPWS Estate	Blue Mountains	National Park	2006	none provided	Fruit present (2006)	A.E. Orme, pers. comm.
SH1	Morton NP (Tallowa Dam)	DECCW (Highlands)	NPWS Estate	Shoalhaven	8(a) National Park	1987	not recorded	-	KMA 2001.
CA12	Dharawal SCA (O'Hares Creek)	DECCW (Illawarra)	NPWS Estate	Campbelltown	Environmental Protection	1989	not recorded	-	Payne in Felton 1993
WO1	Dharawal SCA (10B Firetrail)	DECCW (Illawarra)	NPWS Estate	Wollondilly	5c1 Water Catchment zone	1987	not recorded	-	KMA (2001)
HO24	Lane Cove NP (Cheltenham 2)	DECCW (Lane Cove)	NPWS Estate	Hornsby	National Park and Nature Reserve	2006	4 ramets (2006)	No flowers or fruit (2006)	R Coveny & M. Bremner pers. comm.
HO25	Lane Cove NP (Cheltenham 1)	DECCW (Lane Cove)	NPWS Estate	Hornsby	National Park and Nature Reserve	1985	1 (1985); possibly extinct (2006)	-	R Coveny & R. Doig pers. comm.
HO26	Lane Cove NP (North Epping)	DECCW (Lane Cove)	NPWS Estate	Hornsby	National Park and Nature Reserve	1998	6 (now possibly extinct)	-	R Doig pers.comm.
RY1	North Ryde (Lane Cove NP)	DECCW (Lane Cove)	NPWS Estate	Ryde	8(a) National Park	2004	not recorded	-	Paul Kubiak, pers. comm.
HO1	Marramarra NP (Ashdale Creek)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1999	1 (1999)	-	S. Douglas, pers. comm.

Code	General Location	Land manager	Tenure	LGA	Zoning	Last surveyed	Count	Flowers/fruit	Source[1]
HO10a-10d*	Berowra Valley RP (McKay Rd fire trail north, Hornsby Heights)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1998	7 (1995), 15 (1998), 25 (Coombes)	-	Steve M Douglas (duplicate of HO10b?); Coombes (1995) - Sites 7-8; A J Ford, pers.comm (duplicate?)
HO11	Berowra Valley RP (below Parklands Oval, Mt Colah)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1999	13 (1999)	-	James Molloy, pers. comm.
HO13a-13d*	Berowra Valley RP (Cabbage Tree Hollow 1, Galston)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	2005	6 (1995), 47 (1998), 36 (2005)	-	Jamie Slaven & R. Doig *et al*, Steve M Douglas, Coombes (1995) - Site 22
HO14a&b*	Berowra Valley RP (Tunks Ridge 1, Hornsby Heights)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1995	80 (1995)	-	Coombes (1995) - Sites 11a&b
HO15a-15c*	Berowra Valley RP (Tunks Ridge 3, Hornsby Heights)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1995	170 (1995),	-	Coombes (1995) - Sites 12-14
HO16	Berowra Valley RP (Tunks Ridge 5, Hornsby Heights)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1995	4 (1995)	-	Coombes (1995) - Site 15
HO17	Berowra Valley RP (Tunks Ridge 6, Hornsby Heights)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1995	8 (1995)	-	Coombes (1995) - Site 16
HO18a-18d*	Berowra Valley RP (Cabbage Tree Hollow 3, Galston)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1998	650+ (1995), 250 (1998)	-	S.Douglas, pers.comm, Coombes (1995) Sites 17, 19-21; Doig *et al*, pers.comm
HO19*	Berowra Valley RP (Carters Gully 3, Dural)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1995	30 (1995)	-	Coombes (1995) - Site 18
HO2	Marramarra NP (Layburys Creek)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	2005	2 (2005)	-	G Dowden, pers.comm
HO20a-20e	Berowra Valley RP (Benowie Trail 1, Hornsby)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1998	40 (1995), 2 (1998)	-	S. Douglas, R. Doig & J. Lewis, pers. comm.; Coombes (1995) Site 23
HO21	Berowra Valley RP (Carmen Crescent, Cherrybrook 1)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1995	5 (1995)	-	Coombes (1995) - Site 25
HO22	Berowra Valley RP (Patricia Place, Cherrybrook)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1995	6 (1995)	-	Coombes (1995) - Site 24
HO23	Berowra Valley RP (off Schofields Rd, Cherrybrook)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1998	2	-	R Doig, pers. comm.

Code	General Location	Land manager	Tenure	LGA	Zoning	Last surveyed	Count	Flowers/fruit	Source[1]
HO3a&b*	Ku-ring-gai Chase NP (Brooklyn)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1996	430 (1996), 1 (S. Bell)	Fruit present (S. Douglas pers. comm.)	M. Williams, R. Doig, & S. Bell, pers.comm
HO4	Ku-ring-gai Chase NP (Berowra)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1965	not recorded	-	E Lassak, pers.comm
HO7	Berowra Valley RP (Crosslands Rd, Galston)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1995	3 (1995)	-	Coombes (1995) - Site 2
HO8*	Berowra Valley RP (off Black Ash Place, Hornsby Heights)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1995	<20 (1995)	No flowers or fruit (2000)	Coombes (1995) - Site 4
HO9a&b*	Berowra Valley RP (Waninga Rd fire trail, Hornsby Heights)	DECCW (Lower Hawkesbury)	NPWS Estate	Hornsby	National Park and Nature Reserve	1993	14 ramets+ (1993); 50 (1995); 85 ramets (2006)	No flowers or fruit (1993)	Coombes (1995) - Sites 5&6; Felton (1993) – Sites W&X; M. Bremner, pers. comm.
KU1a, b*, c-e	Ku-ring-gai Chase NP (Murrua Track South 1)	DECCW (Lower Hawkesbury)	NPWS Estate	Ku-ring-gai	National Park and Nature Reserve	2006	many (1993); >992 ramets (2006)	No flowers or fruit (2006)	J. Foley & R. Doig, pers.comm; Felton (1993) Site AA, BB&Z, M. Bremner, pers. comm.,
KU2a&b*	Ku-ring-gai Chase NP (Murrua Track North 1)	DECCW (Lower Hawkesbury)	NPWS Estate	Ku-ring-gai	National Park and Nature Reserve	2006	20 ramets (1993); 15 ramets (2006)	No flowers or fruit (1993; 2006)	Felton (1993) - Site Y; M. Bremner, pers. comm.
HO18e	Berowra Valley RP (Mitchell Rd firetrail, Dural)	DECCW (Lower Hawkesbury)?	NPWS Estate	Hornsby	National Park and Nature Reserve	1995	10 (1995)	-	Coombes (1995) - Site 17, R. Doig *et al*, pers.comm
KU5	Garrigal NP (East Lindfield)	DECCW (Northern Beaches)	NPWS Estate	Ku-ring-gai	8(a) National Park	1962	2 (1962)	-	L A S Johnson, pers.comm
WA2	Garrigal NP (Belrose)	DECCW (Northern Beaches)	NPWS Estate	Warringah	7(b) Environmental Protection	-	not recorded	-	R. Coveny, pers. comm. in Felton (1993)
WA3	Garrigal NP (Davidson 1)	DECCW (Northern Beaches)	NPWS Estate	Warringah	8(a) National Park	1993	5 ramets (1993)	No flowers or fruit (1993)	Felton (1993) - Site J
WA4	Garrigal NP (Davidson 2)	DECCW (Northern Beaches)	NPWS Estate	Warringah	8(a) National Park	-	not recorded	-	J. Howell, pers. comm. in Felton (1993)
SH2	Colymea State Conservation Area	DECCW (Nowra)	NPWS Estate	Shoalhaven	8(a) National Park	1974	1 clump (1974)	-	D Black, pers.comm
SU11	Heathcote NP (Scouter Mnt)	DECCW (Royal)	NPWS Estate	Sutherland	8(a) National Park	2001	7 (2001)	No flowers or fruit (2001)	KMA 2001 (Site 18)
SU12a-12d*	Heathcote NP (Mirang Gully)	DECCW (Royal)	NPWS Estate	Sutherland	8(a) National Park	1993	51 ramets (1993), 2 (2001)	Fruit present (1993)	Felton 1993 (Sites D, K&I; KMA 2001 (Site 4))
SU13	Heathcote NP (Spion Kop)	DECCW (Royal)	NPWS Estate	Sutherland	8(a) National Park	1993	4 ramets (1993)	No flowers or fruit (1993)	Felton 1993 (Site C)

Code	General Location	Land manager	Tenure	LGA	Zoning	Last surveyed	Count	Flowers/fruit	Source[1]
SU14	Heathcote NP (Eckersley Ford)	DECCW (Royal)	NPWS Estate	Sutherland	8(a) National Park	1995	6 (2001)	No flowers or fruit (2001)	KMA 2001 (Site 4)
SU15	Heathcote NP (Eckerley Ford)	DECCW (Royal)	NPWS Estate	Sutherland	8(a) National Park	-	not recorded	-	P. Akkersdyk cited in Felton 1993
SU16	Heathcote NP (Baggary Gully)	DECCW (Royal)	NPWS Estate	Sutherland	8(a) National Park	-	not recorded	-	Felton 1993
SU17	Heathcote NP (Girronba Ridge)	DECCW (Royal)	NPWS Estate	Sutherland	8(a) National Park	1973	not recorded	-	J D Sommerlad, pers. comm, Felton 1993
SU18*	Heathcote NP (Girronba Ridge)	DECCW (Royal)	NPWS Estate	Sutherland	8(a) National Park	2006	26 ramets (2006)	-	S. Felton, pers. comm.
SU19	Heathcote NP (Girronba Ridge west)	DECCW (Royal)	NPWS Estate	Sutherland	8(a) National Park	1973	not recorded	-	J D Sommerlad, pers. comm, KMA 2001 (site 21)
SU20	Coutts Camp, Waterfall	DECCW (Royal)	NPWS Estate	Sutherland	5(a) Special Users (Recreation Camp)	1993	7 ramets (1993)	No flowers or fruit (1993)	KMA 2001 (site 20); Felton 1993 (site O)
SU21	Royal NP (Wises Track)	DECCW (Royal)	NPWS Estate	Sutherland	8(a) National Park	1993	1 'patch' (1990); 5 ramets (1993)	No fruit (1990); no flowers or fruit (1993)	Felton 1993 (site A); Travers Morgan 1990 (site 25)
SU22	Royal NP (Crystal Pool)	DECCW (Royal)	NPWS Estate	Sutherland	8(a) National Park	1993	9 ramets (1993)	No flowers or fruit (1993)	Felton 1993 (site B)
HA4*	Wollemi NP (Comleroy Rd)	DECCW C10	NPWS Estate	Hawkesbury	8(a) National Park	1998	50 (1998)	-	S. Douglas, pers. comm.
HO5*	Off Beaumont Rd, Mt Ku-ring-gai	Department of Defence	Crown Land	Hornsby	Rural	1995	<20 (1995)	-	Coombes (1995) - Site 3
CA1*	Holsworthy (Nat Bull)	Department of Defence	DEF Defence reserve	Campbelltown	Environmental Protection	2005	55 ramets (2005)	No flowers or fruit (1993); few plants with fruit (2005)	M. Bremner, pers. comm.
CA10*	Holsworthy (O'Hares Creek)	Department of Defence	DEF Defence reserve	Campbelltown	Environmental Protection	-	not recorded	-	Payne in Felton 1993
CA11*	Holsworthy (O'Hares Creek)	Department of Defence	DEF Defence reserve	Campbelltown	Environmental Protection	-	not recorded	-	Payne in Felton 1993
CA15*	Holsworthy (Eckersley Range)	Department of Defence	DEF Defence Reserve	Campbelltown	Environmental Protection	1994	not recorded	-	Payne in Felton 1993
CA2a&2b*	Holsworthy (Nat Bull)	Department of Defence	DEF Defence reserve	Campbelltown	Environmental Protection	1993	10 patches (1990); 30 ramets (1993); 37 ramets (2005)	No fruit (1990); no flowers or fruit (1993, 2005)	Felton 1993 (site T), Travers Morgan 1990 (site 11); M. Bremner, pers. comm.

Code	General Location	Land manager	Tenure	LGA	Zoning	Last surveyed	Count	Flowers/fruit	Source[1]
CA3*	Holsworthy (Engineers Bridge)	Department of Defence	DEF Defence reserve	Campbelltown	Environmental Protection	2005	50 'patches' (1990); 144 ramets (1993); >500 ramets (2005)	2% of individuals fruiting (1990); fruiting (1993); 26 ramets fruiting (2006)	Felton 1993 (site P); Travers Morgan 1990 (site 7); M. Bremner, pers. comm.
CA4*	Holsworthy (Mackel Landing Ground)	Department of Defence	DEF Defence reserve	Campbelltown	Environmental Protection	2005	10 'patches' (1990); 37 ramets (1993); 131 ramets (2005)	no fruit (1990); fruit (1993); light fruit (2005)	Felton 1993 (site Q); Travers Morgan 1990 (site 8); M. Bremner , pers. comm.
CA5*	Holsworthy (Woolwash Rd west)	Department of Defence	DEF Defence reserve	Campbelltown	Environmental Protection	1993	48 ramets (1993)	No flowers or fruit (1993)	Felton 1993 (site U)
CA6a-6c*	Holsworthy (Coach Rd south)	Department of Defence	DEF Defence reserve	Campbelltown	Environmental Protection	2005	21 ramets (1993); 30 ramets (2005)	No flowers or fruit (1993; 2005)	Felton 1993 (site R); Travers Morgan 1990 (site 6); M. Bremner, pers. comm.
CA7*	Holsworthy (Aberfoyle Rd mid)	Department of Defence	DEF Defence reserve	Campbelltown	Environmental Protection	2005	74 ramets (2005)	2 ramets fruiting (2005)	AMBS. 1996 (site 1H); M. Bremner, pers. comm.
CA8*	Holsworthy (Aberfoyle Rd mid)	Department of Defence	DEF Defence reserve	Campbelltown	Environmental Protection	1993	3 'patches (1990); many (1993); not located (2005)	No fruit (1990); fruit present (1993)	Felton 1993 (site N); Travers Morgan 1990 (site 4)
CA9*	Holsworthy (Aberfolye Rd east)	Department of Defence	DEF Defence reserve	Campbelltown	Environmental Protection	2005	55 'patches' (1990); 149 ramets (1993); >500 ramets (2005)	<1% of individuals fruiting (1990); flowering and fruiting (1993); lightly fruiting (2005)	Felton 1993 (site S); Travers Morgan 1990 (site 5); AMBS 1996 (site 3H); M. Bremner, pers. comm.
LI1*	Holsworthy (north)	Department of Defence	DEF Defence reserve	Liverpool	7(b) Environmental Protection (Bushland)	2005	93 ramets (2005)	3 ramets fruiting (2 fruiting heavily) (2006)	M. Bremner, pers. comm., AMBS 1996 (site 8B)
LI2*	Holsworthy (National Park Rd south)	Department of Defence	DEF Defence reserve	Liverpool	7(b) Environmental Protection (Bushland)	2005	37 ramets (2005)	2 ramets fruiting (2006)	M. Bremner,pers. comm.
LI3*	Holsworthy (National Park Rd north)	Department of Defence	DEF Defence reserve	Liverpool	7(b) Environmental Protection (Bushland)	2005	44 ramets (2005)	No flowers or fruit (2006)	M. Bremner,pers. comm.
SU7g*	Holsworthy (Heathcote Rd)	Department of Defence	DEF Defence reserve	Sutherland	5(a) Special Users (Military Purpose)	2005	8 ramets (2005)	No flowers or fruit (2005)	M. Bremner, pers. comm.
SU9c*	Wild Cat Ridge Firetrail (north), Holsworthy	Department of Defence	DEF Defence reserve	Sutherland	5(a) Special Users (Military Purpose)	2005	14 ramets (2005)	No flowers or fruit (1993)	J Virtue in Felton 1993; AMBS 1996 (site 8D); M. Bremner pers. comm.

Code	General Location	Land manager	Tenure	LGA	Zoning	Last surveyed	Count	Flowers/fruit	Source[1]
KU4	Browns Waterhole, South Turramurra	Ku-ring-gai Council	Council Reserve	Ku-ring-gai	Open Space - Existing Recreation 6(a)	2006	1 ramet (1993); 9 ramets (2006)	No flowers or fruit (1993; 2006)	Ku-ring-gai Council; Felton (1993) - Site V; M. Bremner, pers. comm.
KU3	Ku-ring-gai Wildflower Garden	Ku-ring-gai council	Crown Land	Ku-ring-gai	Open Space - Existing Recreation 6(a)	1997	1 (1997)	No flowers or fruit (1997)	R. Doig, pers.comm
WO2*	Condell Park, Wilton	Private (Bradcorp)	Freehold	Wollondilly	2e Special residential zone	2000	40 to 50 (2000)	-	Travers Morgan (1990)
WA1	Duffys Forest	Private (Provent Pty Ltd)	Freehold	Warringah	7(b) Environmental Protection (Bushland)	1997	16	-	P Smith, pers. comm.
SU7h&l*	Lucas Heights Shooting Club	Private (Sydney International Clay Target Association)	Freehold	Sutherland	5(a) Special Users	1990	2 'patches' (1990), 17 ramets (2005)	No fruit present (1990)	Brockhoff in Felton 1993, Travers Morgan 1990 (site 13), M. Bremner,pers. comm.
BM1	Faulconbridge (Daley Rd)	Private Land	Freehold	Blue Mountains	Bushland Conservation (LEP1991)	1998	none provided	-	J. Smith, pers. comm.
BM2	Winmalee (Tall Timbers Rd)	Private Land	Freehold	Blue Mountains	Living - Bushland Conservation (LEP2005)	1990	1 (1990)	No flowers or fruit (1990)	T. James, pers. comm.
BM3a*	Springwood (Lalor Dr)	Private Land	Freehold	Blue Mountains	Bushland Conservation (LEP1991)	1991	16 (1991)	5 stems flowering; 1 stem with fruit (1991)	M. Thompson, pers. comm.
CA13	Katanna Ave, Wedderburn	Private Land	Freehold	Campbelltown	Rural	1989	3 ramets (1993)	No flowering or fruiting (1989; 1993)	Payne in Felton 1993 (site M)
CA14	Victoria Rd, Wedderburn	Private Land	Freehold	Campbelltown	Rural	1989	4	Fruit present (1993)	Payne in Felton 1993 (site L)
HO12	Galston Gorge, Galston	Hornsby Council	Freehold	Hornsby	Rural	1995	12 (1995)	-	Coombes (1995) - Site 10
HO6	Crosslands Field Study Centre, Galston	Private Land	Freehold	Hornsby	Special users	1995	7 (1995)	-	Coombes (1995) - Site 1
SU2a	Monash Road, Menai	Private Land	Freehold	Sutherland	2(a1) Residential	2001	7 (2001)	No flowers or fruit (2001); fruit present (2005)	KMA 2001 (site 9)
BH1	Yoothamurra Trail, Baulkham Hills	Private Land (Deerubbin LALC)	Freehold	Baulkham Hills	1(b) Rural	2001	14 (2001)	-	S. Douglas, pers. comm.
BH2	Schwebel Lane, Glenorie	Private Land (Deerubbin LALC)	Freehold	Baulkham Hills	1(b) Rural	1994	1 (1994)	-	S. Douglas, pers. comm.
SU1	South of White Rock Quarry, West Menai	Private Land (Gandangarra LALC)	Freehold	Sutherland	1(a) rural	2005	1 clump (2005)	-	I. Drinnan pers. comm.

Code	General Location	Land manager	Tenure	LGA	Zoning	Last surveyed	Count	Flowers/fruit	Source[1]
SU5a-d*	Bardens Trig, Menai	Private Land (Gandangarra LALC)	Freehold	Sutherland	1(a) rural	1990	numerous (1993)	No flowers or fruit (1990)	Travers Morgan 1990 (site 21) , Felton 1993 (sitesG&H) (duplicate of SU5A?), KMA (1992) in Connell Wagner (2002)
SU6	NE of Little Forest, Menai	Private Land (Gandangarra LALC)	Freehold	Sutherland	1(a) rural	1992	not recorded	-	KMA (1992) cited in Connell Wagner (2002)
SU10	Forum Drive, Heathcote	Private Land (Landcom)	Freehold	Sutherland	7(b) Environment Protection (Bushland)	2001	20 (2001)	Flowers and fruit present (2001)	KMA 2001 (Site 2)
SU4	Akuna Ave, Bangor	RTA	Road reserve	Sutherland	2(a1) Residential	2001	31 (92 prior to construction of Bangor By-pass)	No flowers or fruit (2001); 1 clump flowering (2002)	KMA 2001 (Site 13), Connell Wagner 2002
SU9a&b	Heathcote Rd, Lucas Heights	RTA	Road reserve	Sutherland	6(d) Future Recreation	2005	12 (1991); >72 ramets (2005)	One ramet flowering lightly and holding a few old fruit (2005)	G d'Aubert, pers. comm.; KMA 1991 (site 22); M. Bremner pers. comm.
RY2	Lucknow Park, North Ryde	Ryde Council	Council Reserve	Ryde	7(b) Environmental Protection (Bushland)	2004	not recorded	-	City of Ryde 2004
SU2b	Old Illawarra Road, Menai	Sutherland Council	Council Reserve	Sutherland	7(b) Environmental Protection (Bushland)	2001	4 (2001)	No flowers or fruit (2001)	KMA 2001 (Site 3)
SU3	Alison Crescent, Menai	Sutherland Council	Council Reserve	Sutherland	7(b) Environmental Protection (Bushland)	2005	116 (2001)	Flowering and fruiting (2001); fruit present (2005)	KMA 2001 (Site 1)
SU7a-7f	Lucas Heights Conservation Area	Sutherland Council	Council reserve	Sutherland	7(b) Environmental Protection (Bushland)	1990	20 (1990), 6 ramets (1993), 21 (1996)	,	NECS 2001, G d'Auber & H O'Brie, pers. comm., Akkersdyk in Felton 1993
WI1*	Nepean Dam	Sydney Catchment Authority	SCA Freehold	Wingecarribee	5c1 Water Catchment zone	2005	400 (2005)	40 stems fruiting, many fruiting heavily (2005)	Paul Burcher, pers. comm.
WO3a-3d*	Avon Dam Catchment	Sydney Catchment Authority	SCA Freehold	Wollondilly	5c1 Water Catchment zone	1999	>500 (1999)	46 ramets fruiting (including 7 fruiting heavily) (2006)	S. Douglas; M. Bremner, pers. comm.
SU8	Soil Conservation Depot, Lucas Heights	Waste Services NSW	Crown Land?	Sutherland	6(d) Future Recreation	-	not recorded	No flowers or fruit (1990)	J Virtue cited in Felton (1993)

[1] for details see References section of this recovery plan.

Appendix 4: Species profile and environmental impact assessment guidelines

THREATENED SPECIES INFORMATION

Melaleuca deanei

F. Muell.

Common Name: Deane's Paperbark

Conservation Status

Melaleuca deanei is listed as a vulnerable species on Schedule 1 of the NSW *Threatened Species Conservation Act 1995* and as a vulnerable species under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*.

Figure 1. ***Melaleuca deanei*** **©M. Bremner**

Description

Melaleuca deanei F. Muell. is a paperbark with a shrub habit, up to 5 m high, with flaky bark. Leaves are alternate, narrow-elliptic to lance-shaped in outline and 12-25 mm long and 3-6 mm wide. The leaves are moderately dark green in colour and twisted so the edges turn towards the stem, while the leaf tip ends in a sharp point. The mature plant is hairless, however new shoots are covered in white hairs. Flowers are creamy-yellow and arranged in a typical bottle-brush spike, up to 6 cm long (Figure 1). Within each flower, groups of stamens (17-28) are fused together at the base. Fruit is barrel-shaped, 3-5 mm in diameter, and the opening to the fruit is 3 mm in diameter.

Distribution

Melaleuca deanei is endemic to the Sydney Basin Bioregion (Figure 2). The main distribution of the species extends from St. Albans (Hawkesbury LGA) in the north, to Nepean Dam (Wingecarribee LGA) in the south, and west to Faulconbridge (Blue Mountains LGA).

The main distribution of the species can be divided into a northern and a southern range. The northern range extends north from Ryde LGA, including the Blue Mountains (48 populations), whereas the southern range extends south from Sutherland LGA (46 populations). The two ranges are separated by a distance of approximately 28 km. This is partly a consequence of unsuitable habitat for the species occurring on the Cumberland Plain in Western Sydney, but is also the result of the loss of habitat in northern, southern, and inner western Sydney to urban development.

Another two disjunct sites have been recorded in Morton NP and Colymea SCA, west of Nowra (Shoalhaven LGA). This is over 60 km south of the main distribution of the species.

Recorded occurrences in conservation reserves

More than 50% of all populations occur in DECCW estate and are zoned as National Park or Nature Reserve. Holsworthy Military Reserve contains 17 % of the known *M. deanei* population, and this thus represents an important population outside a formal conservation reserve. Two large populations occur on land managed by the Sydney Catchment Authority, within the Nepean and Avon Dam catchments.

Habitat

Melaleuca deanei mostly occupies broad flat ridgetops, dry ridges and slopes (Benson & McDougall 1998). In southern Sydney, the species is most often found on flat broad ridge tops more than 100 metres wide (Travers Morgan 1990). The altitudinal range of *M. deanei* is between 20 and 410 metres above sea level, and annual rainfall in the species' distribution ranges from 1,000 to 1,400 mm (Benson & McDougall 1998).

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In its northern range, the species mainly occurs on Hawkesbury Sandstone (quartz sandstone with shale and laminite lenses), whereas in the southern range, it is found on the Lucas Height soil landscape unit (shale and fine-grained sandstone) (Chapman & Murphy 1989).

Ecology

Melaleuca deanei is a clonal species and has the ability to re-sprout from a swollen rootstock (lignotuber) to produce coppiced growth. It can also sucker from its rootstock (Felton 1993). Observations so far indicate that recruitment of *M. deanei* is more likely to result from vegetative reproduction rather than from seedlings.

The exact age at which *M. deanei* starts to produce flowers and seed is unknown, but this may take as long as 20 years. *M. deanei* produces flowers and seed infrequently and at irregular periods, with intervals of several years between flowering. It is not known which factors trigger flowering, but some observations indicate that population size affects flowering. Larger populations flower more often than smaller ones, possibly because there is a need for crossbreeding between different individuals.

It is not known how *M. deanei* is pollinated, though insects are the most likely group of pollinators (Turnbull & Doran 1997 cited in Virtue 1991). Native bees (family Colletideae) are generally the most common pollinators of Australian Myrtaceae (Beardsell *et al* 1993). Seed is wind dispersed and light winds seem sufficient to empty the seed capsules (Virtue 1991).

Fire plays a role in providing the right conditions for germination and seedling growth, and seedlings usually only establish after fire (Felton 1993). The species grows most commonly in sites exposed to direct sunlight, or in places where light penetration has been increased by disturbance, such as at the edge of fire trails (Travers Morgan 1990). The species' preference for light may explain its habitat preference for open ridgetop vegetation (Felton 1993). It is therefore likely that fire, and possibly other physical disturbances that increase light levels without impacting upon the soil, play a role in providing for the recruitment and long term persistence of the species.

Fire can also lead to local extinctions of *M. deanei* if it occurs too frequently over long periods. Such frequent fires are a threat because juveniles have a slow growth rate and therefore take a longer period of time to become fire resistant (Felton 1993). The critical fire frequencies for survival have not yet been determined, although the Draft Threatened species Hazard Reduction List for the Bush Fire Environmental Assessment Code states that fire should not occur more than once every ten years.

Threats

The main threats to the survival of *M. deanei* are its low fecundity combined with habitat loss and fragmentation (especially along ridgetop locations and within the urban Sydney region), and inappropriate fire regimes, particularly frequent fire. The species is also threatened by mechanical methods of bushfire fuel hazard reduction, the construction and maintenance of tracks and easements, unrestricted access and rubbish dumping, as well as weed invasion. Hybridisation with other species of *Melaleuca* and *Callistemon* may also pose a risk to the species.

Management

The recovery plan for *M. deanei* (DECCW 2010) identifies a range of actions required to effectively conserve the species. Management should be aimed at minimising habitat loss and fragmentation; reducing fire frequency in areas prone to frequent fire; and preventing the loss of populations along easements, walking tracks and fire trails. Other management initiatives should include: survey and monitoring; community education and awareness; and conducting research that will assist future management decisions.

Recovery Plans

A recovery plan has been prepared for *Melaleuca deanei* (DECCW 2010).

For Further Information contact

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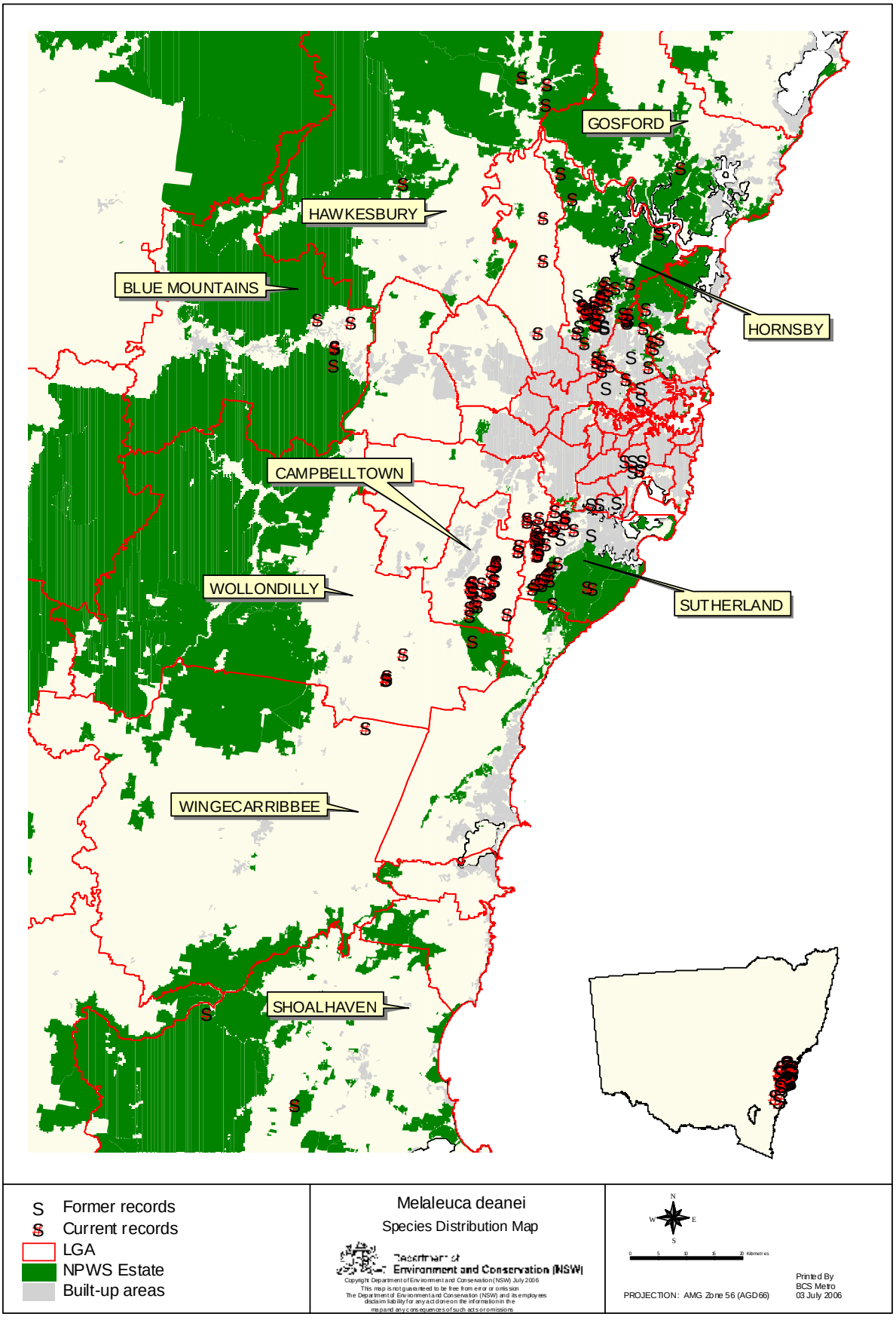

Figure 2. The known distribution of *Melaleuca deanei* within the Sydney region.

ENVIRONMENTAL IMPACT ASSESSMENT GUIDELINES

Melaleuca deanei F. Muell.

Deane's Paperbark

The following information is provided to assist authors of Species Impact Statements, development and activity proponents, and determining and consent authorities, who are required to prepare or review assessments of likely impacts on threatened species pursuant to the provisions of the *Environmental Planning and Assessment Act* (EP&A Act) 1979. These guidelines should be read in conjunction with the accompanying 'Threatened Species Information' profile and guidelines for the '7 Part Test of Significance', which must be carried out in accordance with Section 5A of the EP&A Act 1979.

Survey

Melaleuca deanei produces flowers or seed at infrequent intervals of up to several years only. Identification of the plant should thus primarily be based on its habit (shrub up to 5 m high, fibrous flaky bark), the alternate position of leaves, and the shape of the leaves (narrow-elliptic to lance shaped, 12-25 mm long, 3-6 mm wide, twisted so the edges turn towards the stem, while the leaf tip ends in a sharp point). New shoots are covered in white hair, while mature plants are hairless.

Melaleuca deanei often re-sprouts from a swollen rootstock or produces suckers from its rootstock. Counting the number of individuals can thus be difficult. Alternative survey methods include counting the number of stems or clumps of stems, or estimating the extent of the population.

Life cycle of the species

The life cycle of the species is not well understood. One factor that is likely to impact on the life cycle is fire. If a proposal is likely to result in frequent fires, then this may lead to declines in the population, since juvenile plants will not be able to become fire resistant between fire events.

Proposals which are likely to impact on the life cycle of the species, such that a local population is put at risk of extinction, would include proposals that:

- result in total destruction of habitat;
- result in a partial destruction or modification of habitat (including changes to hydrology and nutrification of the soil substrate) which may result in changes to vegetation community structure;
- result in increased fragmentation of *M. deanei* habitat;
- result in a requirement for frequent (<10 year) hazard reduction activities (fire or slashing), preventing establishment of juvenile plants;
- result in mechanical damage during maintenance or widening of fire trails or powerline easements;
- increase vehicular, bike, pedestrian, or other access to habitat; or
- increase rubbish dumping and associated weed invasion or likelihood of arson (for example, through adjacent residential development).

Threatening processes

Four key threatening processes listed under the *TSC Act 1995* (as of March 2007) are likely to, or potentially, threaten *M. deanei*.

- *'Clearing of native vegetation'*, has reduced and fragmented the habitat of *M. deanei.*
- *'Ecological consequences of high frequency fires'* is highly likely to threaten the persistence of *M. deanei* populations.
- '*Invasion of native plant communities by exotic perennial grasses*' as well as '*Invasion, establishment and spread of*

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Lantana camara' is also likely to threaten *M. deanei* given that at some sites, *Lantana camara*, *Eragrostis cruvula* and *Ehrharta erecta* have been recorded as a threat to *M. deanei.*

Threatening processes that have been identified as being relevant to this species should also be considered (see recovery plan; DECCW 2010). These include habitat loss, habitat degradation through weed invasion, unrestricted access and rubbish dumping, mechanical methods of bushfire fuel hazard reduction, and possibly hybridisation with other *Melaleuca* or *Callistemon* species.

Viable local population

Little information is available as to the viability of known populations of *M. deanei.* In the absence of such information, DECCW considers that all populations should be considered viable. It appears the species does not produce much seed in small populations, which may indicate that there is a need for cross-breeding between individuals. On the other hand, small population sizes may not be a relevant factor in viability assessments, as most recruitment is from vegetative reproduction. Therefore, populations should be considered viable unless there is evidence to the contrary.

A significant area of habitat

Given that *M. deanei* is a clonal species, numerous plants over a larger area may all be of one individual. Therefore, the significance of sites cannot be based on numbers of plants or stems without genetic testing. Other factors that can be used to determine the significance of a site include whether the population is setting seed, the size and connectivity of the habitat, the security of the site, the quality of the habitat (i.e. level of weed infestation) in comparison to other sites in the locality, the number of other sites in the locality, and whether the site is at the edge of the range of the species.

Habitat fragmentation

Habitat fragmentation may be a significant issue for the species, as the current distribution is highly fragmented. Management of *M. deanei* habitat and any proposals should aim to maintain the continuity of habitat between individuals within sub-populations, and avoid artificially creating new sub-populations.

Regional distribution of the habitat

Melaleuca deanei occurs within the Sydney Basin Bioregion. The species has a disjunct distribution, with 48 known populations occurring in the northern range and 46 populations in the southern range. The two ranges are separated by a distance of approximately 28 km.

Limit of known distribution

The current known distribution of *M. deanei* extends from St. Albans (Hawkesbury LGA) in the north to Nowra (Shoalhaven LGA) in the south, and Faulconbridge (Blue Mountains LGA) in the west. Further surveys may identify additional sites outside these areas.

Adequacy of representation in conservation reserves or other similar protected areas

Approximately 50 % of all *M. deanei* populations occur in national parks or nature reserves. A significant part of the known population (17 %) occurs within Holsworthy Military Reserve. Presently, most of this land is zoned as land for Environmental Protection, but it is not yet known whether this will be rezoned for development in the future.

Critical habitat

Critical habitat has not been declared for *Melaleuca deanei. .*

For Further Information contact Biodiversity Conservation Section, Metropolitan Branch, NSW DECCW, PO Box 1967, Hurstville NSW 2220. Phone 02 9585 6678. www.environment.nsw.gov.au

Appendix 5: Site Management Statement Proforma

Site Management Statement for *Melaleuca deanei*

Prepared by: ……..

Date: ……..

Site details:

Site Name: ……

Site Code: ……..

Location: ……..……..

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……...

Easting: ……..…..…..Northing: ……...……..AMG Zone: ……..…...……...

1:25 000 Mapsheet: ……...

Landowner/Landmanager contact details

Name: ……....

Phone number: ……..….

Postal address: ……..

……..…..

Parcel details:

LGA: …….

Portion/Lot: ……...

Street address: ……...

……...

Zoning: ……..

Tenure: …….

Current landuse:…….

Population details:

No. of ramets: Count: [ ] Estimate: [ ]
Lowest estimate =…….…...….Best estimate =…….…….Upper estimate =…….…….….

No. seedlings: Count: [ ] Estimate: [ ]
Lowest estimate =…….…...….Best estimate =…….…….Upper estimate ……..

Area of Occupancy: …….…….Accurate: [ ] Estimate: [ ]

Detailed site map attached: Yes/No Photographs taken: Yes/No

Reproduction: Buds: [ ] Flowers: [ ] Fruit: [ ]

Plant height(s):

Extent of Survey: complete/incomplete/unknown

Habitat (consider aspect, slope, altitude, geology)**:**

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…….…..

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Dominant Associated species (consider canopy, understorey, groundcover, vines/climbers)**:**

……..……...…..

……...….....

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……...

Soil texture: sand/loam/clay **Soil depth**: skeletal/shallow/deep

Drainage: waterlogged/damp/well drained dry/well drained moist

Fire history for the site: ……..

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……...…...

Existing and potential threats (consider trampling/grazing, isolation/fragmentation, erosion, inappropriate fire regimes, inappropriate access, rubbish dumping, weed invasion)**:**

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Predominant weed species and abundance:..…….……..……...

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Previous management actions (describe apparent success): ……

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Recommended threat abatement actions:

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Recommended monitoring and evaluation program: ……

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Timetable for implementation of actions and monitoring: ……

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