## **Ecological history of Lachlan Nature Reserve, Centennial Park, Sydney, Australia: a palaeoecological approach to conservation**

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**APPENDIX 1**

# Technical underpinnings of microfossil assemblage interpretation

## *Pre-European Swamplands (pre-1788)*

The key arboreal taxa represented in pre-European microfossil zones is dominated by *Epacris* spp. and *Casuarina* sp. (probably *Casuarina cunninghamiana* [Miq.] or *C. glauca*). Herbaceous undergrowth consists of rushes (Restionaceae), sedges (Cyperaceae) and club mosses (*Lycopodium* spp.). There is minor representation from *Leptospermum* spp., other Myrtaceous taxa, *Hakea* and *Banksia* and, from depths above 30 cm (modelled at 1450 AD), *M. quinquenervia* and *Monotoca elliptica* (Sm.) R.Br*.* The dynamics of this assemblage indicate that, throughout this period, the site was to subject cyclical wetting and drying and, prior to the modelled date of 1216 AD, appears to have fluctuated in response to periodic burning.

Pollen from woody plant taxa within microfossil zones B and C are dominated by *Epacris* spp. and *Casuarina* sp. (tentatively classified as *Casuarina cunninghamiana* [Miq.] or *C. glauca* based on comparison with herbarium reference samples). Herbaceous undergrowth consists of rushes (Restionaceae), sedges (Cyperaceae) and club mosses (*Lycopodium* spp.). As rushes, sedges and *C. glauca/C. cumminghamiana* have a preference for wetland environments (Ladd 1989; Moore & Moran 1989; Benson & Howell 1994), and *Epacris* species are generally only well represented within microfossil records when encroaching upon mire surfaces (D'Costa & Kershaw 1997), the local vegetation of the time appears to have been growing on, or immediately proximal to the swamp.

Peaks in the absolute abundance of *Casuarina* pollen between 440 AD and 820 AD (most likely derived from the fire-sensitive *C. glauca/C. cunninghamiana* given the site conditions and their presence in the modern flora; (see Ladd 1989) appear to be negatively correlated with the absolute abundance of *Epacris* spp. (a fire-tolerant shrub) within the lower portion of the record. This suggests that the site may have been periodically subjected to fires, and this is consistent with the appearance of charcoal laminations within sediment unit IV. The correlation between *Epacris* and *Casuarina* pollen is replaced with the gradual increase of *Casuarina* pollen after the modelled date of 1216 AD towards the youngest pre-European sedimentary layer, which may be related to changing anthropogenic or natural fire patterns. A similar negative correlation pattern can be observed between the dominant wetland herbs, Restionaceae and Cyperaceae, and dryland herb, *Haloragis* sp.,which appears to be indicative of cyclical wetting and drying of the site.

Other arboreal pollen within zones B and C include *Leptospermum* spp. and other Myrtaceae taxa with *Hakea* and *Banksia*, and, from depths above 30 cm (modelled at 1450 AD), minor representation from *M. quinquenervia* and *Monotoca elliptica* (Sm.) R.Br*.* The combination of taxa from *Epacris* and *Hakea* genera is diagnostic of Sydney’s dune heathland communities (Hamilton 1928; Gilmour *et al.* 2000),which tend to grow on nutrient-poor acidic soils (McHugh *et al.* 1998), such as the unit IV sands present in this zone. The vegetation growing on the site at the time has therefore been classified as either a swamp-heath swampland or a sedge-swamp heathland mosaic.

## *Early European swamplands (c. 1770 AD–1887 AD)*

Microfossil zone D (*c*. 1770–1896 AD) is representative of the vegetation assemblage growing within the vicinity of the site during the use of the swampland as Sydney’s common ground (1811–1820) and water reserve (1820–1887). This microfossil zone is distinguished from zone C by an increased abundance of Myrtaceous taxa coinciding with a decline in *Casuarina* and *Epacris* pollen. The first occurrence of taxa known to be introduced to the site (*Ficus* and *Pinus*) is recorded in the upper 2 cm of this zone.

There is no dramatic change in the dominant swampland assemblage (namely *Epacris, Casuarina,* Cyperaceae and Restionaceae) at the interface of zones C and D.The relative stability of the flora across this boundary indicates that, if there is a hiatus in sedimentation at this point, either the uppermost sediments of units C and D have been mixed, or there were limited changes to the vegetation across the putative discontinuity. Alternatively, there may be no hiatus at this point in the record, suggesting that the onset of European arrival increased rates of sediment delivery to and storage in the swamp (potentially associated with the tree felling and soil compaction which occurred after the establishment of the common in 1811). This is plausible given rapid soil loss is a common characteristic of early European disturbance to the landscape within south eastern Australia (Gale & Haworth 2002).

Several changes to the vegetation record during the first century of European settlement in Sydney indicate increasing levels of anthropogenic disturbances to the site. For instance, the marked decline in *Casuarina* pollen may reflect the timber collection described in written records of the site prior to the construction of the parkland (Richards & NSW Sydney Water Supply Commission 1869; Lynch & Larcombe 1959). Similarly, reduction in the abundance of *Epacris* pollen towards the top of this zone may be associated with trampling by livestock during the sites use as a water reserve (Richards & NSW Sydney Water Supply Commission 1869), in association with the clearance of the land in preparation for the park (State Records of NSW 1883–1889).

Evidence for landscape change associated with use of the site as the city common is provided by the marked rise in Poaceae and first appearance of Asteraceae fenestrate-type (Liguliflorae)(commonly a pasture weed) in the vegetation record. Such changes may also reflect the drying and reduced filtration of the swamp surface due to overextraction and compaction of the swamp sediments that occurred across the Lachlan Water Reserve (Richards & NSW Sydney Water Supply Commission 1869). This is supported in the vegetation record by an increase in other dryland herbs and a rise in abundance of *Melaleuca quinquenervia*, which has problems establishing seedlings within excessively long hydroperiods (Myers 1983). The rise in *M. quinquenervia* abundance may additionally be a product of soil nutrient loading from the dumping of residential waste products and industrial effluents at the site, as this tree is an opportunistic species in disturbed sites and able to tolerate elevated levels of P, N and K (Johnson *et al.* 2003).

## *The Centennial Park swamplands and Lachlan Nature Reserve (1887 to the present)*

The rise in *M. quinquenervia* abundance within microfossil zones E and F may have altered the site hydrology, as this species has the capacity to dry out wetlands (Morton 1966), enhance subsoil and metal acidification, and rapidly propagate and disperse, particularly within disturbed sites (Johnson *et al.* 2003). Such changes, in combination with the those related to increased sedimentation rates after *c*. 1979 (reflected in the core chronology), and the rise in pollutant runoff to the Park’s ponds in the 30 to 40 years preceding the study (McHugh *et al.* 1998), may also have contributed to the vegetation change in the upper layers of the record. This includes the near-complete demise of the original swamp heath species which are adapted to nutrient-poor soils (Lamont 1972), the depletion of Restionaceae, which are highly prone to competition-induced local extinction following the influx of nutrients (Meney & Pate 1999), and the colonization of the Lachlan Swamp Reserve with more-pollutant and nutrient-tolerant plants. Of particular significance is the rise in *Gleichenia dicarpa* throughout the latter half of the 20th century, which thrives in soils with elevated nutrient levels (Clarkson *et al.* 2004), and the more regular appearance of *Hypolepis* sp. over the past 20 years, which is very tolerant of heavy metal uptake (Kachenko *et al.* 2007). The expansion of Cyperaceae (sedges) within the Reserve during the existence of the parkland is probably linked to the expansion of *Gahnia sieberiana,* which also has been found to flourish in areas subjected to soil disturbance (Coates 2003).

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