Local Land Services
Greater Sydney

Wildlife of the Elizabeth Macarthur Agricultural Institute

Peter Ridgeway 2015

In collaboration with:

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Greening Australia

Peter Ridgeway
Greater Sydney Local Land Services
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Summary

The wildlife of Western Sydney - the 'Cumberland Plain' - is unique and remarkable.

This sunken shale basin is very different to the sandstone country which surrounds Sydney. This is a land of grassy woodlands and open spaces; a land of Emu, Kangaroo and Bettong, and of shallow lakes brimming with waterbirds.

The Elizabeth Macarthur Agricultural Institute – formerly part of the Camden Park estate – contains some of the best remaining wildlife in all of the Cumberland Plain. This wildlife has intrinsic value but it has also played its own part in the remarkable heritage of Camden Park.

This report details the first comprehensive survey of the wildlife of EMAI. The survey was conducted in October 2013 as a voluntary project with the assistance of Greening Australia, EMAI, the then Hawkesbury-Nepean Catchment Authority and over 40 professional volunteers.

The survey recorded 140 native wildlife species including many declining and endangered species. A few of these remarkable species are highlighted in this report. All previous wildlife survey and reports were also analyzed to complete the picture of the sites biodiversity.

Sadly the wildlife of the Cumberland Plain are disappearing at an alarming rate and without serious intervention little will remain for future generations to enjoy.

EMAI presents an opportunity to offer a future to our wildlife. As a working farm and research institute EMAI are well placed to showcase ecologically sustainable agriculture practice. The institute has already contributed to local biodiversity through a long-term program to eradicate the devastating weed African Olive.

The decline in wildlife in the Cumberland Plain is driven by decline of our landscapes rather than the loss of 'bushland' or 'remnants'. Few of our native species live their lives contained within the small patches of vegetation we think of as bushland. Rather they rely on the landscape - the scattered trees, farm dams and native pastures. The EMAI wildlife survey provides a fascinating example of how wildlife relies on the matrix of bushland and non-bushland habitats alike.

The future of our wildlife will be determined not only by the management of 'bushland' but by the management of our rural landscapes. The management of grazing, firewood collection, weed and fox control will determine what wildlife survives. I hope this survey proves a practical document for those who wish to restore this remarkable heritage for future generations to enjoy.

Peter Ridgeway
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Greater Sydney Local Land Services
17/3/2015

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The EMAI Landscape

The Elizabeth Macarthur Agricultural Institute (EMAI) is a 1,600 hectare property situated on the Nepean River southeast of Camden. An orientation map is provided.

The Institute incorporates most of the original 'Camden Park' estate settled by the Macarthur family in 1795 – the first settlement west of the river. As a consequence of this unique situation we know more about the wildlife of this property than any other in the Cumberland Plain – offering a glimpse into the wildlife of this region as it once was and how it has changed over time.

The property is presently owned and managed by the NSW Department of Agriculture as a premier agricultural research institute and farming enterprise. The site includes an Environmental Education Centre managed through Wooglemai Field Study Centre in conjunction with the Department of Education. There is also a collection of staff quarters just south of Sawyers reserve.

The regional landscape consists of gently undulating plains and hills on fine textured clay soils formed from the weathering of Wianamatta shales, and deep alluvial sands along the river and floodplain.

The EMAI property can be broadly summarized into six habitats. The diversity of habitats results from the diversity of underlying geology and also past land uses on the site.

Woodlands

Grassy woodlands once covered most of the western Sydney landscape; these are now the critically endangered Cumberland Plain Woodlands (CPW).

At EMAI the dominant CPW woodland is Shale Hills Woodland. This vegetation is dominated by Coastal Grey Box (*E. moluccana*), Forest Red Gum (*E. tereticornis*) and Narrow-leaved Ironbark (*E. crebra*) and is generally on elevated land.

Small areas of a similar vegetation – Shale Plains Woodland – are present in lower dryland areas. This vegetation is likewise dominated by Coastal Grey Box (*E. moluccana*), Forest Red Gum (*E. tereticornis*) and Narrow-leaved Ironbark (*E. crebra*) but with occasional Thin-leaved Stringybark (*E. eugenoides*).

In both communities the natural structure is of an open grassy woodland. Most of the flora diversity is in the groundlayer including hundreds of native flower and forb species. Dominant grasses vary between patches but two of the most common are Kangaroo Grass (*Themeda australis*) and the wire grasses (*Aristida ramosa*/*Aristida vagans*)

Native pastures

Where ringbarking has occurred and stock activity is higher the canopy trees have not recovered. Much of EMAI consists of these 'derived native grasslands'.

Far from sterile habitats these grasslands often have equal or greater flora diversity and wildlife diversity than the 'remnant' woodlands which are the typical focus of conservation.

These grasslands are afforded protection as a form of critically endangered Cumberland Plain Woodland. However the tendancy remains to separate western Sydneys landscapes into agricultural 'pasture' and 'natural' woodlands. In reality both are flora and wildlife habitat. Flora and fauna respond primarily to groundcover diversity, groundcover structure (interstitial spacing) and the presence of hollow trees rather than the density of tree canopy.

If attitudes can be changed grassland habitats across Western Sydney have the potential to be both productive agricultural landscapes and vital natural areas.

Figure 1 – A White-necked Heron in thick native pasture – Mark Fuller

Exotic pastures

The importance of land management is highlighted by the most modified landscape on EMAI – the 'improved' or fertilised exotic pastures.

Unlike the native pastures these areas are dominated by exotic grasses and in certain times & locations by cropping. These habitats support the lowest abundance and diversity of native flora & fauna.

While land clearing is an obvious threat to native wildlife the management of native grasslands is a considerably greater threat to wildlife. A single land manager can rapidly convert large areas of native pasture into 'improved' pasture causing greater loss of biodiversity than broad scale tree clearing.

Riverflat

The riverbanks are dominated by Riparian Forest. This is a rare vegetation type as the result of grazing and sandmining along the river.

Much of the riverbank vegetation in the region is young regrowth planted to stabilize banks after sandmining. These areas have young trees often including a very strange mix of non-local Australian 'native' trees. The southern and western sections of the EMAI riverbank are mostly sandmine rehabilitation vegetation and most are heavily impacted by exotic weeds.

In the northeast corner of EMAI is one of the last truly remnant patches of Riparian Forest. This riverbank was fenced by the second generation of the MacArthur family to protect the fragile riverbank – one of the earliest conservation projects in Australia.

Figure 2 – The Riverbank at EMAI showing extensive weed infestation

Dominant trees include River Apple (*Angophora subvelutina*), River Peppermint (*Eucalyptus elata*), Bangalay (*Eucalyptus botryoides x saligna*) and an understorey of Sally Wattle (*Acacia floribunda*), Bracken (*Pteridium esculentum*), Slender Bamboo Grass (*Austrostipa ramosissima*) and Weeping Meadow Grass (*Microlaena stipoides var. stipoides*)

Most of the Macarthur's legacy of riverbank forest retention was destroyed by sandmining in the mid to late 1900s. The remaining stand is in very poor health and severly infested with exotic weeds, many of them originating from the Camden Park nursery in the 1800s where some of the nation's worst environmental weeds were first introduced.

This stand had never been thoroughly surveyed. During the current wildlife survey volunteers discovered Sydney's largest remnant native trees hidden in the thick weeds of the EMAI riverbank. The largest – dubbed 'Mr Fat' – is a testament to the remarkable Riparian Forests which once stretched the length of the Nepean River.

Away from the Nepean there is fringing vegetation along some of the smaller creeks at EMAI. This is Alluvial Woodland, found on the richer soils and dominated by Swamp Oak (*Casuarina glauca*), Cabbage Gum (*Eucalyptus amplifolia*), Forest Red Gum (*E. tereticornis*), and Rough-barked Apple (Angophora floribunda). This vegetation is mostly more recent regrowth and lacks the magnificent old trees and hollows of the Riparian Forest

Farm Dams

Successive farm managers have created a considerable network of farm dams. These waterbodies vary considerably in their habitat value for native wildlife

The most important for wildlife are the larger, shallower dams as deeper dams have limited vegetation growth and the depth interferes with shallow-feeding birds. Cameron's Dam in the southwest is a large dam with considerable areas of flat and fringing marsh along the southern boundary, and is a haven for a wide diversity of wading birds and frogs. By comparison the Barragal Hills dam – although surrounded by woodland – is small with steep edges and has limited wildlife use.

The natural lagoons

While the numerous dams on the property are a comparatively recent addition to the farm, the series of wetlands on the eastern side of EMAI are remnant wetlands which feature heavily in the reports of explorers Macquarie, Caley and Barralier.

The Nepean River crosses beds of shale and sandstone in the reach alongside Camden Park. At Menangle Bridge this bedrock is nearly exposed and some more typically sandstone flora may be found including the river gum *Tristaniopsis laurina*. This geological boundary is responsible for the sharp right-angle bend in the River which defines Camden Park's northern border, and perhaps for the shallow levee along the western bank. It is this natural levee which acts to dam the flat portions of Camden Park and create a series of natural temporary wetlands or billabongs. Remarkably we still have the local Aboriginal names for these wetlands - 'Barragal' in the north and 'Menangle' in the south.

Barragal lagoon was once a major wildlife hub. Explorers reports abound with references to the excellent hunting here. As late as 1998 when Brian Trench undertook a bird survey of the property there were 'hundreds' of waterbirds on Menangle (southern Barragal).

Both lagoons are smaller than their original size due to overflow drains to the river, but offer the potential to be restored to their former glory.

The scale and isolation of EMAI are key to its wildlife

History of EMAI Wildlife

While many people are familiar with the heritage of Camden Park/EMAI, few are aware of the interactions between its early custodians and its wildlife.

From the first description of the *Cumberland Plain Land Snail* at Camden Park by explorer Ensign Francis Barrallier in 1802, to the collection of the *Brush-tailed Phascogale* by Captain Arthur Onslow at Camden Park in the 1820s, and the protection of riverflat forest by the Macarthur family, each generation has contributed to the understanding and protection of our native wildlife.

Later decades were less kind to the wildlife of EMAI with clearing, intensification of agriculture, sandmining and CSG. However the 1900s also saw a new era of voluntary environmental restoration at EMAI. Recent decades have seen similar promising moves toward sustainable whole-of-property management for EMAI in which native flora and fauna are respected.

Aboriginal heritage

The Menangle region was inhabited by Aboriginal peoples for tens of thousands of years prior to European settlement. Today the region is important to Aboriginal people of many heritages including local Dharag, Gundungurra and Tharrawal peoples and the land is located within the Tharrawal Local Aboriginal Land Council area.

In addition to the cultural and physical heritage the long history of Aboriginal occupation has left its mark on native wildlife. In particular the introduction of the Dingo around 4,000 years ago and the local extinction of the only native apex predator (Thylacine) and scavenger (Tasmanian Devil) have resulted in permenant changes in the environment and subsequent impacts to other native species.

Exploration & Settlement

The Cowpastures

In 1795 a herd of wild cattle – the progeny of escapees from the early colony seven years previous – were rediscovered grazing '*in a pleasant and apparently fertile pasturage*' west of the Nepean River.

> *'…a species of wild oat [Microlaena]… grows in great luxuriance, and in fields that are several acres in extent' (King, 1803)*

The Sydney colony was struggling in agricultural production, and these new lands appeared ideal for expansion. Settler David Collins later wrote:

> '*The country where they were grazing was remarkably pleasant to the eye; everywhere the foot trod on thick and luxuriant grass; the trees were thickly scattered, and free from underwood, except in particular spots; several beautiful flats presented large ponds, covered with ducks and the black swan, the margins of which were fringed with shrubs of the most delightful tints, and the ground rose from these levels into hills of easy ascent.*'

After the discovery of wild cattle the herd was protected by officially declaring the region west of the Nepean 'out of bounds'. Nonetheless by 1805 government surveyor James Meehan and settler John Macarthur followed a well-established track from Prospect, crossed the river and surveyed for Macarthur an attractive new land holding. Under some controversy western Sydney's first farm – Camden Park – was born.

King

Governor King (Sydney Gazette Dec 11th, 1803) records of his trip with Cayley:

> '*In the swamps of Manhangle, Carabeely and others enormous eels, fishes and various species of shell are found, which are sometimes used by the natives as food. They usually feed upon opossums and squirrels, which are abundant in that country, and also upon kangaroo rat and kangaroo, but they can only catch this last one with the greatest trouble*'

King also confirms the extent and condition of native grassland in the flats, noting:

'*there are several kinds of grass, the principal of which is a species of wild oat [Microlaena], which grows in great luxuriance, and in fields that are several acres in extent.*'

Cayley

In 1805 the naturalist George Caley explored the area – like many others being en-route to explore the Blue Mountains. Cayley noted the luxuriant grass and dispersed pools (wetlands) across the valley.

Governor Macquarie

Governor Macquarie undertook an expedition from Parramatta for the Cow-Pastures in 1810, and his diary gives another glimpse into this landscape and wildlife at the time.

The expedition was led by John Warby an illiterate convict. Warby had previously cut the Cow pastures Road from his farm at Prospect Creek to the Nepean and had good relations with local Aboriginal peoples. It is disappointing that this gentleman – responsible for much of our knowledge of these times - scarcely rates a footnote in Macquarie's diary or subsequent records.

Elizabeth and Lachlan Macquarie crossed the Nepean on Friday 16th November 1810 and spent five days exploring the region from the Cowpasture Bridge (near Camden) as far south as Stonequarrie Creek near Picton. Elizabeth records the numerous herds of wild cattle throughout this region, the isolated farms and Aboriginal place names.

Macquarie notes:

'We passed through Mr. McArthur's first Farm, called by the natives "Benkennie", and arrived at our Halting Place, called "Bundie"… our little Camp was formed on a beautiful Eminence near a Lagoon of fine fresh Water… in a very fine open Forest'

Ensign Francis Barrallier

The journals of Barrallier have only in recent years been translated from the French. Barrallier's journal began as a proposal to the governor to explore the inland '*trying to penetrate as far as the Blue Mountains as I should find it practicable*'

After crossing the Nepean in 1802 Barralier visited Camden Park and notes:

> '*at 8 o'clock I arrived near a swamp, which the natives called Baraggel, where I decided to spend the night, feeling rather indisposed. I explored the borders of this swamp, and I found a rare shell belonging to a species I had never seen before.*'

Barralier – like other reports from the time – notes the extensive wetlands and fertile riverflat grasslands in the region. He mapped and recorded three major wetlands running north to south: Barragal, Menangle and the largest Carabeely, and south of this a further chain of ponds.

Today Barrallier's reference to the snails may seem strange, however at the time biological exploration was extremely popular for the better educated settlers.

A thorough search of Museum and private collections has failed to find Barrallier's snail. Barralier was known to be a keen naturalist and collector – a fact which the governor take pain to congratulate him on. However it appears that all of Barrallier's botanical and fauna collections were lost or destroyed in the early 1800s.

It is tempting to speculate on Barrallier's snail. A number of acquatic species are present at EMAI however these species are similarly common around the harbor and other areas Barrallier collected. The mussel *Corbicula* is one such species, as is *Gastrocopta*. Another – a species of *Gabbia* – is restricted to areas from Parramatta westward, but again is likely to have come to attention in Parramatta well before Barrallier's journey to Camden Park.

What was the original vegetation like?

The vegetation of the Cumberland Plain features heavily in the records of early explorers and settlers. With so much documented there should be little doubt about the original structure of this vegetation. However the nature of the 'original' vegetation is a subject of considerable controversy, not assisted by selective summarisation of the historic records.

When reading early accounts it is important to consider that most exploration was undertaken to assess the grazing and cropping potential of the land. Farming success in the early Sydney colony was poor and authorities were desperate for favorable reports of grazing and cropping land. For this reason the objectivity of some early reports may be questionable.

A glimpse into just this problem is given by the explorer Caley. Caley criticized the naming of the 'Cowpasture Plains' south of EMAI as an example of this bias, criticizing the popular description 'Cow Pastures':

'*Nothing appears more vague than applying it to a hilly forest. I shall hereafter call it Cow or Vaccary Forest*.'

It is also important to note that by 1820 the landscape of the Cumberland Plain had changed irrevocably – and the accounts of vegetation from these dates should not be considered reflective of the vegetation at the time of settlement.

Nonetheless there is objective evidence of the nature of pre-European vegetation in the Cumberland Plain. This evidence is not in explorers or settlers journals but rather in the flora itself. While most animals can move into new areas as habitat changes many local flora have extremely limited dispersal capacity (<1 m/annum) and some have evolved *in situ* in the Cumberland Plain. Their habitat requirements give us an insight into the vegetation as it was over the last ten thousand years.

Naturally this is best undertaken where very early botanical records exist (such as at EMAI) before vegetation structure changed and species were potentially lost due to habitat change.

For example the endangered woodland & grassland flower *Pimelea spicata* which is present on Barragal Hills cannot tolerate closed canopy or closed shrub cover for extended generations. This species has very limited dispersal capacity and is endemic to the Cumberland Plain and Illawarra. It's presence at EMAI demonstrates that extensive areas of open woodland or grassland have been present in the region since before settlement.

The flora in early collections at Camden Park can give us firm answers to a hotly debated question – just what was the vegetation like at the time of settlement?

Conversely species of dense, moist woodland or dry rainforest such as the vine *Cynanchum elegans* (present in early collections from Camden Park) are not tolerant of open woodland habitats. This species former presence at EMAI testifies to the presence of denser patches of forest vegetation during the same period. Indeed its apparent extinction at EMAI is likely due to the opening up of this denser vegetation by ringbarking.

Along the river are to be found a considerable number of moist forest specialist plants including the vulnerable shrub *Pomaderris brunnea*. These species demonstrate that the small patches of tall moist forests we see today once dominated this stretch of the Nepean River. It is most likely that the open 'park-like' riverside vegetation reported and sketched at Camden Park after 1820 was the result of early grazing and clearing and that at least portions of the river were in fact shrubby forest.

In summary it is very clear from botanical evidence that the landscape of EMAI was quite varied prior to European arrival. It included grassy open woodlands on flats, closed-canopy shrubby forest on the hilltops,

tall moist forests along the river and large wetlands along the river benches.

When the Macquaries settled this property these diverse habitats were the home for a remarkable fauna which was to have a profound impact on the lives of those who settled here.

1806 – 1900

In 1806 the estate to become 'Camden Park' was granted to John Macarthur by Lord Camden. For the first decades this was a struggling enterprise at the edge of the colony. However the farm quickly grew into one of Australias most significant agricultural facilities.

Captain Arthur Onslow

Captain Arthur Onslow married Elizabeth Macarthur in 1867. Onslow was a keen naturalist and contributed many observations on native wildlife.

Regrettably most of these are lost, however one is of great significance. In 1820 Onslow shot an unusual and cryptic animal in the Barragal Hills and sent the skin & skeleton to the Australian Museum. This animal was the Brush-tailed Phascogale. This remarkable discovery is explored in detail later in this report.

In 1830 there was a severe fire on the property. From 1840 onwards agriculture on site and regionally expanded considerably. During this period the Phascogale and another susceptible species – the Brush-tailed Bettong – were wiped out. It is remarkable to realise how quickly these species disappeared after settlement.

The Macarthur's sustainable legacy

The Macarthur family left a legacy of innovative agriculture and a progressive vision of sustainable land management.

Waterbird protection

In an unusual move the early Macarthur generations protected the waterbirds on Barragal and Menangle lagoons from hunting (a popular sport at the time). An early Royal Agricultural Society Annual report records the property as having:

> '*...wooded hills... and many varieties of water fowl....enjoying life on the lagoons where they are strictly preserved by the management.*' (anon. 1922)

The Nursery

The Macarthur family operated a nursery during the early 1800's to encourage landscaping and botanical interest in the growing colony.

Regrettably the nursery was responsible for the introduction of many of the region's most devastating weeds. Amongst the plants advertised for sale in 1857 are privet (*Ligustrum spp*), African Olive (*Olea europaea ssp cuspidata*) and Thorn Tree (*Gleditsia tricanthos*). Each are now ecosystem-transforming weeds of devastating impact and vast economic consequence, not only at Camden Park but across the Sydney region.

Sadly Olive continued to be promoted in the region after its impact was all too clear. The 1976 Forestry Commission catalogue lists *Olea africana* as '*a useful small tree'* but warns '*it can become a very bad weed in some areas e.g. Cobbitty*'.

However the intentions of the nursery were sound. In addition to horticultural use the plants were promoted for use in restoring the damage of early land clearing, especially along the river.

Riverbank Fencing

Another of the Macarthur's sustainable visions was to fence the riverbank. Thorp (1987) identifies this fencing as being installed in the years 1828 to 1829.

The speed of early landclearing along the Hawkesbury Nepean River is difficult to comprehend. The Windsor and Richmond settlements had been established to provide cheap river access for produce to the Sydney settlement, however within a single generation sedimentation of the river threatened and ultimately destroyed this transport route. This sedimentation was largely the result of riparian land clearing.

The Macarthurs recognized the value of riparian vegetation and protected this land from clearing and from stock. Sadly most of this remarkable treasure was subsequently destroyed in the 1980s for sandmining.

One area of original Riparian Forest – 'Macarthurs Forest' remains at EMAI. As it happens the Macarthurs actions protected one of the most remarkable forests in Western Sydney, including what is now the largest remnant tree in the Cumberland plain – 'Mr Fat'.

Figure 3 – The Macarthur's sustainable vision protected the Riverflat at EMAI from grazing. This area protects Sydney's largest remnant tree - 'Mr Fat' (above) with a diameter of over 2.5 m

1900 to 1970

This period saw increasing industrialization of the farming enterprise at Camden Park and collapse of the commercial farm. This ultimately led to the sale of the site in 1973 to the State Government and the birth of the (then) John Macarthur Agricultural Institute.

The Navigation Woods

Between 1960 and 1980 a large area of woodland in western Camden Park was cleared and pasture improved. This woodland bordering navigation creek was once the largest area of woodland at Camden Park. The accompanying air photo was taken in 1961 and demonstrates just how quickly woodland can be destroyed under intensification of agricultural production.

Sandmining

In the early 1980s Menangle River Soil & Sand Supplies Ltd were given approval to strip much of the EMAI riverbank which the Macarthur family had so carefully protected. Eventually all but one small section of the Riparian Forest was removed. A mix of non-local Australian native trees were replanted in some of the areas after extraction concluded.

Figure 4 – The Navigation Wood as it was in 1961

Moloney – witness to decline

In 1929 the local historian J Moloney compiled memories of early menangle which cover the period 1850 – 1929. These memoirs contain some fascinating insights into the wildlife of the region and the tragedy of the early 1900s. This is sobering reading which tells firsthand of the loss of Menangle's native treasures.

Moloney explains the destruction of the Swamps and their wildlife:

'*I have always understood that the name Menangle means in the aboriginal dialect 'the place of swamps... the installation of the Sydney water supply scheme was responsible in the main for the dissapearance of the lagoons on the eastern side of the river and for the decrease in size of those on the Camden Park estate. The storage of water in the Cataract and Prospect dams has minimised the flood waters, and the flat land at Menangle has not been so frequently inundated as was the case...*'

By his early years many of the native species were already uncommon or gone:

'*The native animals with the exception of bears [koalas], cats [quolls] and opossums [brushtail possums] were almost extinct in my boyhood days, and I can remember the last wombat being killed near the railway bridge on the southern side of the river. The platypus was plentiful in the river and creeks but I'understand that this most interesting specimen of Australian fauna has finally disappeared from its old haunts.*

Fish of several varieties were obtainable from the river, creeks and lagoons - mullet, perch, black-fish, sprats and eels.

Birds were plentiful - cockatoos, parrots, magpies, larks, finches, robins, owls, hawks, ducks, cranes, swans, pelicans and brolgas.

Reptiles were in complete array - lizards of every type - snakes, brown, black, lead, whip, tiger, green, diamond and carpet, together will all varieties of goannas, indigenous to the sandstone belt.

Native dogs were gradually being exterminated where in earlier times they were very numerous.'

The majesty of EMAI's wildlife was rapidly declining.

1970 to 2010

The 1970 to 2010 period saw increasing concern and action for the biodiversity of Camden Park.

Macarthur Regional Environmental Study

In 1986 mounting community concern over sandmining and urbanization resulted in the Macarthur Regional Environmental Study conducted in conjunction with the National Parks & Wildlife Service. Appendix D of Working Paper 4 outlines the 'Areas with identified conservation value' for protection. This accurately describes the Riparian Forest vegetation then remaining, noting two types: alluvial flats with *Eucalyptus botryoides-saligna* and *Casuarina cunninghamia*, and rocky [sandstone exposed] areas with *Tristaniopsis laurina* and/or *Leptospermum*.

It concludes '*The alluvial flats should not be mined*'. It also raises concern on the lack of long-term community focussed planning for the Macarthur region, with planning instead dictated on a case-by-case basis at the request of developers. It notes the distinction between regions of Sydney planned in earlier years - with bulk public open space and bushland - and the decline rather than progress in planning standards in western Sydney. It concludes:

> '*Every opportunity should be taken within the planning process to enhance the native vegetation remnants on this land. Their long term viability is under threat*'.

Regrettably the report lacked political support and its recommendations were not implemented.

Revegetation

The period between 1970 and 1990 saw the emergence of planting and weed control operations at EMAI. It is important to document these activities

to assist in future works and understanding of the vegetation on site. All known plantings are summarized in Figure 5 and include the following:

Barragal Lagoon - fenced and planted in March 1986 with Eucalypts and Casuarinas.

Menangle Lagoon - fenced from stock in 1986 and approximately 40 Eucalyptus benthamii seedlings were planted (Bents Basin provenance). In 1988 a supplementary planting of approximately 420 seedlings; in 1991 a further 1200 seedlings planted around the lagoon.

Institute Dam - fenced and planted in spring 1991 with Casuarina cunninghamiana, Lomandra longifolia, Callistemon salignus, Leptospermum flavescens, Melaleuca stypheloides and Acacia floribunda.

Ridgetops - A two-hectare area to the east of the access road to the institute buildings was fenced and planted with 2000 tubestock seedlings in autumn 1992. Canopy and shrub species planted included Eucalyptus crebra, E. tereticornis, E. amplifolia, Acacia floribunda, A. decurrens, Casuarina glauca, Bursaria spinosa, Dodonaea triquetra, Melaleuca stypheloides.

Another ridgetop to the west was fenced and planted with 4100 tubestock seedlings in spring 1997 – species as per the 1992 ridgetop planting.

Figure 5- Barragal Landcare replanting - HNCMA

The western boundary of EMAI was similarly fenced in 1997 and planted with 4000 tubestock seedlings – species as per 1992 ridgetop planting.

Wildlife was a priority during this period also. Anchored, floating "islands" were added to some of the larger dams on the property in this period order to provide nest sites for waterbirds. In the early 1990s each platform was occupied by nesting Black Swans.

Sue Rose

Sue Rose was a botanist at the John Macarthur Agricultural Institute during this period, and responsible for much of the replanting work. She was also instrumental in the development of the EMAI Herbarium and protection of Sawyers Reserve – the first grazing-free area since the Macarthurs ownership.

Sue Rose did many of these plantings herself - many by hand and watered by bucket.

In recognition of Sue's contributions a track was constructed in the 1990s within the Riverine Forest, near the Orchard Packing Shed. Natural regeneration in this spot has been remarkable, and an obvious place to begin restoration of the Riparian Forest.

Sadly Sue never got to see her plantings established. After many painfull years opposing sandmining and other developments she moved to Albury in the early 1990s.

Creation of Sawyers Reserve

Sue Rose authored a report in July 1986 entitled: *Recommendation for retaining and fencing of a corridor of native vegetation in Sawyers Paddock, John Macarthur Agricultural Institute*

This report concerned a paddock of 13 hectares and '*recommended that the area be fenced off permanently from stock and that the area be managed as a natural area*'.

A glimpse into the bushland condition at this time is provided in the note: '*this will necessitate some bushland weeding to remove potential problem weeds such as Privet, Wild Olive, Willow Trees, African Boxthorn, thistles and noxious weed species*'

After considerable efforts the recommendation was adopted. A succession of managers at EMAI have honored the Reserve and excluded stock from this area. This was the first stock-free area established at EMAI since the second generation of Macarthurs.

A short winding trail including '*educational small signs naming individual shrub and tree species*' was recommended for Sawyers reserve but was never completed.

Figure 6 – Sue's Track shows that even the degraded riverbanks can be recovered to much of their former glory

Proposed Barragal Wildlife Refuge

In 1987 a proposal was lodged to dedicate the catchment of Barragal Lagoon as a wildlife refuge.

The proposal was given serious weight and incorporated in the institutes Draft Development Program. It was to incorporate 100 hectares on EMAI and 21.5 hectares on Camden Park Estate, protected with official wildlife refuge status. The proposal included removal of all grazing from the refuge area, with restoration works to be funded through the 1988 Bicentenary Community Employment Program.

The knowledge of wildlife on the site at this time (and the species lists included in the proposal) are very limited.

The proposal considered undertaking a small mammal trapping program. At the time Wyn Rohan-Jones (later Blue Mountains National Parks & Wildlife Service) who was advising the wildlife refuge proposal expected that only Black Rat and House Mouse were present. This suggests that native small mammals had already disappeared at this time.

The report recommended that '*A program of reintroduction of native mammals accompanied by a revegetation program would be required to establish a viable population of small native mammals*'. This recommendation was progressive for its time.

At the time of the proposal the environs of Barragal Lagoon were reported to have a lack of shoreline vegetation and reedbeds and heavy erosion due to stock access.

The report proposed construction of '*a waterbird hide equipped with a photographic display and information on the waterbird species*' accompanied with detailed designs.

Lastly the report proposed that '*the farm worker 'stick picking' gang not operate within the area proposed as a refuge as fallen timber provides habitat for many native species*'. This continues to be a key struggle for wildlife recovery in the region.

Figure 7 – An Australian Owlet-Nighjar in Barragal – Brendon Levot

The 1989 Wildife Survey

In 1986-89 Sue Rose coordinated the first wildlife survey of EMAI, with a report written in January 1990 entitled '*Native Fauna on the Elizabeth Macarthur Agricultural Institute (Camden Park)*'. The report focused on practical conservation opportunities to restore the wildlife on EMAI.

The survey was largely undertaken by botanists and contains a number of clear misidentifications, however the survey was remarkable for its time. It also incorporated the novel idea of a species list incorporating blank lines '*for future observations to be added*'. Later readers did exactly that, and the additional observations record the last bandicoots at EMAI.

In Autum 1986 a student also recorded the birdlife on the site's dams and lagoons as part of this wildlife survey.

First bush regeneration

The wildlife survey and growing community interest resulted in the first bush regeneration on site in 1995. The first wildlife-oriented programs began about this time also.

A corridor planting in 1997 became the first local wildlife corridor, linking the riparian forest with Sawyers Reserve.

The 1996 Survey

In 1996 Brian Trench – an educator at the environmental education center - conducted a flora and fauna assessment of the EMAI property as part of a Masters degree.

As with the 1989 survey this survey included some errors of identification; nonetheless it provides an important benchmark of the biodiversity at this time. Most importantly it applied a strategic approach of separately sampling each habitat on the site for comparison. The relevant sections in this report compare Trench's data to the current wildlife.

Trench followed in the steps of the 1989 survey in attempting to find small ground mamals at the site. Mammals were surveyed using parallel trap lines spaced every 100m in each habitat type. The trap line consisted of 10 Elliott traps set 2 m to 5 m apart plus a larger 'bandicoot' trap and 'possum' trap. The traps were inspected for 4 nights. No small ground mammals were found.

Birds were surveyed more successfully, again stratified into habitat types. The length of observation varied from site to site using accumulation curves to determine when all species were likely to have been observed and survey could conclude. This is unfortunate as it does not allow us to compare bird abundance from 1996, however comparisons on diversity can be made. All habitats were surveyed in the first week in November, 1994.

The study included a detailed outline of practical actions to restore the wild areas of the property, although most were not subsequently pursued.

Figure 8 – The tiny Shining Bronze Cuckoo at Sawyers Reserve – Mark Fuller

Barragal Landcare

The most recent and hopeful development for wildlife at EMAI has been the formation of Barragal Landcare.

Barragal Landcare formed in 2006 as a mechanism for staff and locals to assist in the restoration of EMAIs natural values. A key focus of the group has been the eradication of African Olive and bush regeneration in the Barragal and Navigation Creek areas.

Roger Giles

Roger Giles was a former Research Scientist at EMAI and instrumental in the formation of Barragal Landcare.

Roger had a particular passion for the historic heritage of EMAI and in particular the Barragal and Menangle lagoons. He had been instrumental in previous attempts to protect the catchment of Barragal as a Wildlife Refuge.

Through Roger and others efforts Barragal Landcare developed a Memorandum of Understanding between DPI management and the then HNCMA which has removed grazing animals from a 50 ha portion of the Barragal lagoon catchment including the lagoon itself and surrounding woodland. This has resulted in considerable improvements to the health of Barragal Lagoon and the return of some waterbird species.

Roger was also (and remains) integral in the fight to eradicate African Olive at EMAI. This is a monumental task but one which Barragal Landcare and EMAI management are on track to achieve with consistent and patient effort.

Mick Starr

Mick Starr was a carpenter at EMAI until his retirement in 2008, and also instrumental in the development of Barragal Landcare. Mick developed a passion for the site's birds of prey and has been recording their behavior since 1996. In addition to surveying these birds he was passionate in their conservation, installing possum rings around nesting trees to protect eggs and chicks and successfully advocating for 'Raptor Protection Areas' when CSG wells were installed.

Mick wrote a number of research papers and reports on the raptors of EMAI and logged over 300 days of observation. Mick's findings are summarized later in this report.

Figure 9 – Barragal Landcare – Lowan Turton

Figure 10 – The extent of planting (green) and weed control (purple) activities at EMAI

The 2013 Survey

Although a number of biodiversity studies have been undertaken at EMAI the property's wildlife had never been comprehensively surveyed and previous surveys included many errors and gaps.

Between 2010 and 2013 the need for a broader biodiversity survey became apparent. A key priority for this survey was to follow-up previous reports of Bandicoot and Bush Rat at EMAI. Survey in 2010 to 2013 had alarmingly indicated these 'common' species were at the brink of extinction in the Cumberland Plain.

In October 2013 the then Hawkesbury-Nepean Catchment Management Authority (now Greater Sydney Local Land Service) and Greening Australia partnered with EMAI management to undertake a comprehensive wildlife survey.

As there was no government funding for biodiversity audits at the time the survey was undertaken on a cost-neutral basis using expert volunteers and donations of survey equipment and labor. The survey also provided the opportunity to involve site staff, local community and schools with the EMAI property and its wildlife.

Figure 11 – Volunteers install microbat traps ('harp nets') – Alison Towerton

The survey was conducted across one intensive week of camping in October 2013. Over 40 local volunteers (and a number of professional ecologists) helped to survey native birds, reptiles, mammals and plants.

The results highlighted just how much wildlife calls the property home - with hundreds of species recorded.

The survey recorded one of Australia's smallest animals, a mature Little Forest Bat (*Vespedelus vulturnus*) weighting in at just 5 grams. At the other extreme the survey discovered what may be Sydney's largest remnant tree, 'Mr Fat' a *Eucalyptus saligna* - *Eucalyptus botryoides* hybrid measuring a staggering 2.5 m diameter and 22 m in height.

The remarkable wildlife on the property is a testament to the vision of successive land managers in managing the site as a sustainable operation. This vision continues today to ensure a healthy landscape is passed on for future generations to enjoy.

Review of previous studies

As a historic property EMAI has been a site of interest for over 150 years. Early settlers – especially the wealthy and educated - were acutely interested in the local wildlife. Early visitors to Camden Farm recorded in their diaries not only the large impressive species but even notes on unusual snails and rare plants. This provides an excellent insight into the original wildlife of the property.

Early generations observed wildlife keenly, and unusual or uncommon wildlife was often shot to be sent to museums and other scientific collections.

As wildlife became rarer in the 1900s interest gradually shifted from the purely academic to considerations of conservation management. The 1960s to 1990s saw the development of a local Herbarium and a range of wildlife surveys at EMAI. During the same period proposals for agricultural and coal seam gas developments resulted in professional biodiversity assessments of the property.

Unfortunately while this has resulted in a considerable library of reports and anecdotes much of the information was not publicly accessible. On closer inspection much of it also included errors of identification or reporting.

For the present project we collected and reviewed all previous reports about the site. The staff at the then

EMAI Library and Herbarium were particularly helpful in finding many forgotten reports and providing fascinating insights into the property and its history.

Equally as important for the present study were the reports provided of staff working and living at EMAI. We interviewed all staff past and present we could find who had an interest in wildlife on the site. A number of interesting and reliable reports were collected from these volunteers and contributed significantly to our understanding of the wildlife.

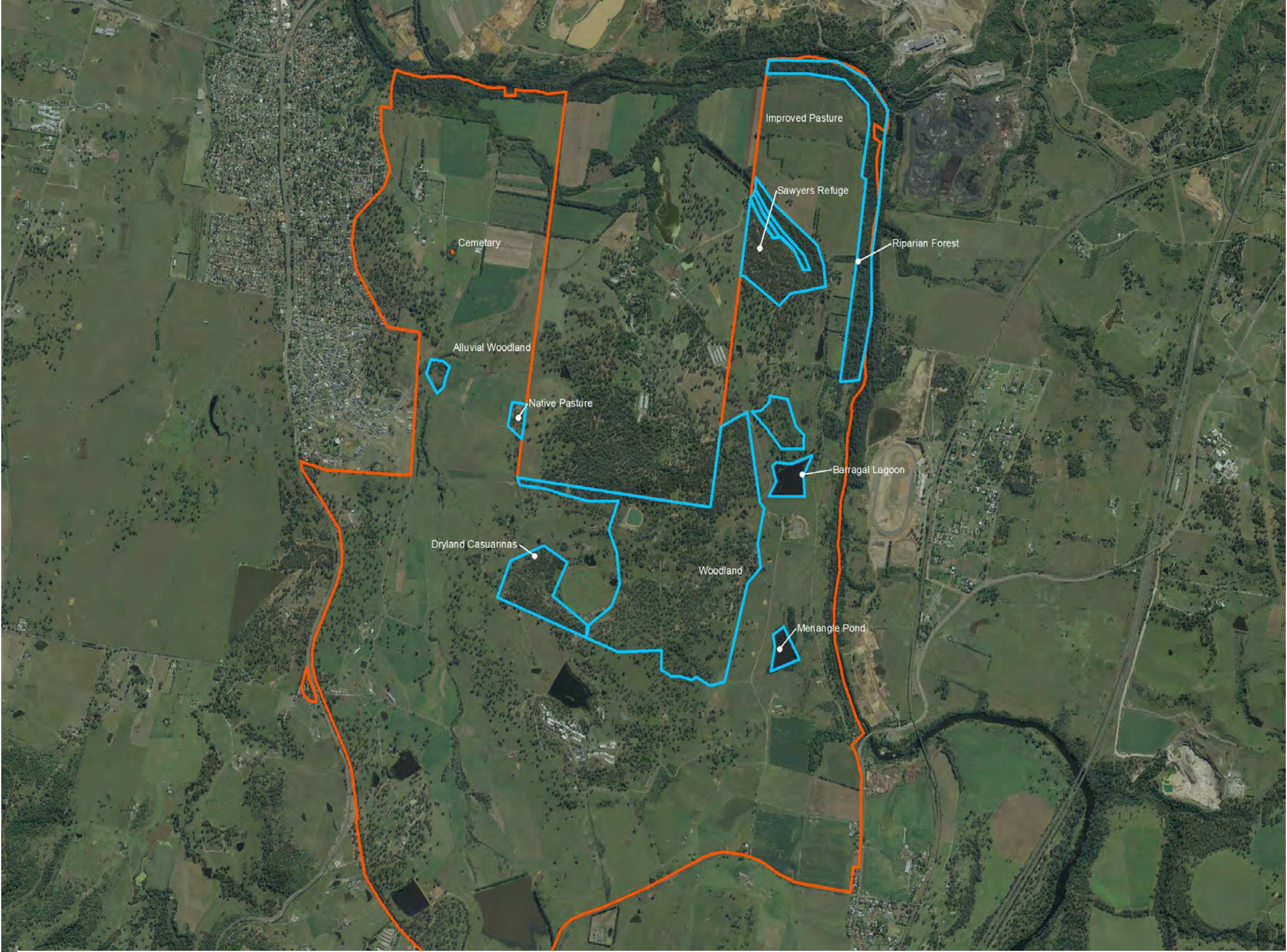


Figure 12 –Habitats surveyed at EMAI 2013

Survey Methods

Habitat Types Mapping

The site was divided into habitat types through field mapping. Useful trails and other relevant features were also mapped. The field mapping was conducted on 9th September 2013 with assistance from EMAI staff and Barragal Landcare. The habitat map is shown in Figure 12.

Survey season & conditions

The survey was undertaken over five days being 14 – 18th October, 2013. Conditions during survey were dry and warm. A temporary evacuation was required on 17th October due to nearby bushfires and resulted in one lost trap night.

Survey Techniques

Mammals

Mammals have suffered the most of all wildlife in Western Sydney. The worst affected are the small ground mammals of which every species is either extinct or close to regional extinction.

Due to their rarity and nocturnal habits the mammals were also the most difficult group to detect. Consequently the priority for mammal surveys was to maximise the chances of detecting any mammals present, rather than comparison between habitat types. This meant unequal sampling effort between habitats – we targeted those areas we considered most likely to give results.

For ground mammals **Cage Traps** (large) and **Elliott Traps** (small) were used. Cage traps were baited with sardines to attract Quolls or oat-mix balls for Bandicoots. Elliott Traps were baited with balls of mixed oats, honey, peanut butter and oil to attract small ground mammals.

Trap locations were:

- Bamboo next to the Packing Shed (10 Cages) targeting former Bandicoot sightings
- Sawyers drain (20 Elliotts, 5 Cages)
- Sawyers Reserve (10 Elliotts, 5 Cages)
- Barragal Gully (20 Elliotts, 5 Cages)

By comparison the relatively common Microbats (small insect-eating bats) were surveyed by equal effort in each habitat type. Microbat call detectors called '**ANABATs**' were left at 7 locations for 3 nights (14th – 16th). There recorded ultrasonic bat calls for later identification.

Unfortunately due to technical failures only three sites returned valid calls. These were Barragal Ridge and two sites on the river – the old Piggery and the Riverbank. Further bat survey would be helpful at a later date to allow better comparison between habitats and generate a better baseline for detecting changes over time.

Microbat Harp Traps were used to identify those bats which could not be differentiated by call analysis on ANABAT, including the Long-eared Bats *Nyctophilus gouldi* and *Nyctophilus geoffroyi*.

Harp traps were set up in four locations along 'flyways' – narrow corridors along disused trails and similar areas where bats were likely to be caught. The locations were:

- A string of three traps placed across Sawyers drain Monday 14th and retrieved Thursday 17th (3 nights)
- One trap at Dryland Casuarinas from 15th (2 nights);
- One trap at Barragal fork dam from 15th (2 nights); and
- One trap at Barragal fork hill from 15th (2 nights)

Camera Traps (wildlife cameras) were used to detect larger mammals as well as any 'incidental' wildlife. They also provide vital data on the activity rates (or abundance) of the more common species on site. Cameras were installed in suitable locations and baited with an oat-mix ball secured in front of the camera in a tea strainer. Traps were installed at:

- Barragal Fork (x2)
- Barragal Gully (x3)
- Barragal Hill
- Dryland Casuarinas
- Duckponds
- Barragal Lookout

- River (x4)
- Sawyers Grassland (x4)

Spotlighting targeted nocturnal birds (e.g. Owls) and arboreal wildlife too difficult to trap (e.g. gliding possums). **Call Playback** was used to increase the chance of detecting Owls and Squirrel Glider responding to territorial calls. Sites surveyed included:

- Barragal Fork (x3)
- Barragal Gully
- Dryland Casuarinas
- Duckponds
- South of Camden Park Chicken Sheds
- Old Trees
- River (x3)
- Sawyers (x3); and
- Sawyers Creek

Nightly counts were used to estimate population size in kangaroo species. A fixed stretch of the Lodge Gate trail afforded good views of grazing kangaroos and was surveyed each night.

Birds

Western Sydney's birds are diverse and comparatively easy to survey. In response we made our bird surveys rigorous and structured. This allowed us to analyse how birds were using different habitats & management zones across EMAI, as well as detecting rare and threatened species. It will also allow others to repeat the same surveys in the future, to investigate any change to birds on the site.

Twelve representative habitat types were selected. Each habitat was surveyed by two independent birding teams on two independent days wherever possible. The order in which sites were surveyed (between sunrise and 10 am) was reversed to avoid any bias.

The surveys were done using the Birdlife Australia Atlas 2 hectare - 20 minute search method. Birds were recorded within plots of approximately 100 x 200 m (2 ha). Each species observed within 20 minutes was recorded. Some groups also tallied the abundance (individuals) for each species – this additional data should be collected in any future surveys.

Birding teams were experienced volunteers from the Cumberland Bird Observers Club and the Blue Mountains Bird Observers.

Frogs & Reptiles

No targeted survey was undertaken for frogs due to poor weather. Reptiles have not suffered as much as mammals and frogs in western Sydney, and given the intensity of work required were not a priority for survey.

Instead incidental sightings of frogs and reptiles were collected, and provided a good background of the species present. Further survey would be worthwhile.

Invertebrates

Invertebrates make up the overwhelming diversity of life on the planet. They are typically overlooked in survey, resulting in their description as '*the other 99%*'of wildlife.

Few species of invertebrate are unique to western Sydney and survey requires extensive time and expertise. So the invertebrates were not a priority for this survey. However Western Sydney does have a unique species of land snail – the Cumberland Plain Land Snail –which is present at EMAI.

Incidental sightings of invertebrates were recorded and encouraged, particularly for land snails.

Water Quality

Water quality can play an important role in the health of wetland wildlife, not only aquatic wildlife but also wading birds. The key waterbodies at EMAI are the natural wetlands of Barragal and Menangle 'ponds'. There is concern about the declining waterbirds of these sites, and possibly salinity.

The electrical conductivity (i.e. salinity) of both wetlands was tested on the same afternoon. Conductivity was tested using conventional detectors at six independent sites on both lagoons.

Flora

No targeted flora survey was undertaken, however the survey team also collected records of rare species observed, and a review of existing records has been included to assist future management.

Summary of survey results

The survey made a total of 567 wildlife observations over 5 days. The site is home to a remarkable diversity of wildlife: a total of 140 species of wildlife were recorded, including many declining and endangered species. A few of these remarkable animals are highlighted in this report.

One way to summarise this overwhelming diversity is to consider the most abundant wildlife at the site (as recorded by passive monitoring cameras) which is presented in Table 1 below.

Common Name	Total
Common Wallaroo	19
Fox	9
Swamp Wallaby	9
White-faced Heron	6
Australian Raven	4
Brown Hare	4
Common Brushtail Possum	2

Table 1 – Most abundant terrestrial wildlife at EMAI as detected by unbaited remote cameras

The survey also collected information on the habitats and flora of the site – since it is impossible to recover the wildlife without also recovering and understanding the flora.

An unexpected finding of the habitat survey was the discovery of a stand of very old remnant trees within dense woody riverside weeds. This included the largest remnant tree ever recorded in the Cumberland Plain, at over 2.5 meters diameter single bole. This highlights the habitat value and previous commitment to sustainable land management by the Macarthur family who fenced this riverbank from stock.

The survey used a technique of 'repeated representative sampling' to allow the comparison of different habitat types on the property. For example this revealed the remarkable importance of native pasture for wildlife – equally as important as woodland 'remnants'.

The future of wildlife on EMAI depends on the management of the rural landscape as a whole rather than intensive management of only the thicker habitat 'remnants'. This is a greater challenge than allocating land to 'wildlife' or 'industry'. Managing grazing regimes, fertiliser, woody-weed control, foxes and firewood collection to recover native wildlife while also maintaining a viable farming enterprise is a complicated endeavour.

Community Outcomes

The 2013 survey also provided the opportunity to engage site staff, local community and schools with the EMAI site and its wildlife. This engagement and education was considered a key outcome for the survey so it is worth mentioning the results here.

Over 35 volunteers assisted professional ecologists over five days of survey. A total of over 375 volunteer hours were contributed to the project.

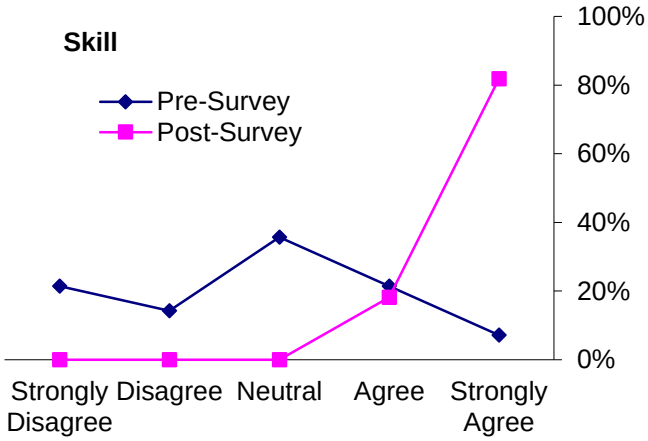
Participants included a diverse mix of local landowners, high school children, Landcare volunteers, bush regenerators and ecologists. Many volunteers noted that a key outcome of the training was the chance to connect with experts and with locals from other backgrounds and experience.

Volunteers also highlighted the importance of learning hands-on as part of a serious research project rather than through a mock-up or classroom exercise.

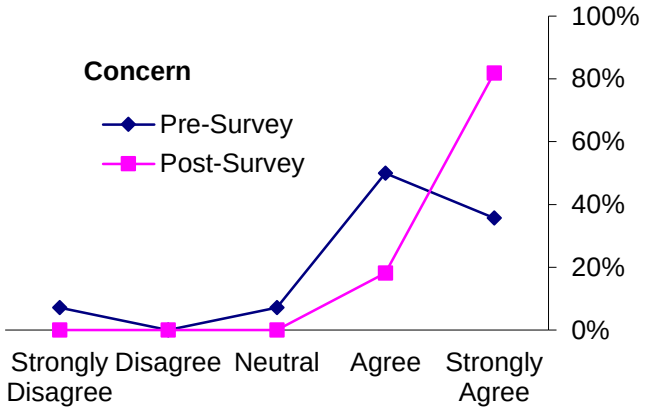
As well as receiving training in wildlife survey and identification techniques participants learnt about the complexities of wildlife conservation management. Landcare and bush regeneration volunteers were particularly interested in applying this knowledge to ensure that their operations assisted in wildlife recovery.

Volunteers were asked to complete pre- and post-survey questionnaires to monitor how the experience contributed to their skills and attitudes.

Volunteers reported a substantial increase in skills & ability after participation. This improvement was even reported in otherwise experienced participants such as Landcare volunteers and professional bush regenerators.



Volunteers also reported a significant increase in concern for wildlife conservation which has been great to share.



The Macarthur's sustainable riverbank legacy is disappearing – along with its wildlife

The wildlife of EMAI

Mammals

Monotremes

Short-beaked Echidna *Tachyglossus aculeatus* (uncommon)

The echidna remains moderately common in the region and on the site but requires very large areas of habitat and coarse woody debris. This species can be heavily impacted by stick picking and firewood collection and the encroachment of urban areas and roadkill.

Platypus *Ornithorhynchus anatinus* (unknown)

The logo of Camden Council the Platypus is a rare species in the Nepean. It is the subject of occasional community reports (latest for EMAI is 2003) however these remain unconfirmed. Most observers are not aware of the native Water Rat which looks remarkably similar while swimming to the Platypus. It is possible that the Water Rat persists in Camden and is the source of some platypus observations.

Marsupials (General)

Common Brushtail Possum *Trichosurus vulpecula* (common)

The Brushtail Possum is moderately common in woodland across EMAI and especially near dwellings and old sheds.

Common Ringtail Possum *Pseudocheirus peregrinus* (common)

The Common Ringtail is common in the riverbank (its preferred habitat) but uncommon elsewhere at EMAI. This species feeds, roosts in and eats flowers, foliage & berries of the weed Small-leaf Privet which supports much of the EMAI population. The nest is a sphere or ball of twigs about the size of a small soccer ball, hidden in dense shrubbery or vines.

Feathertail Glider *Acrobates pygmaeus* (unknown)

The Feathertail Glider is a remarkable and tiny gliding possum. The species is very rarely seen and is difficult to survey. Until recently it had not been confirmed from the Cumberland Plain for some time. In 2012 the National Parks Service began a widespread microbat nest box program in the northern Cumberland Plain. To everyone's surprise a considerable number of Feathertail Gliders have been found in these 'bat' nest boxes. It appears the species is still present in reasonable abundance in the larger woodlands of western Sydney. Feathertail Gliders were shot by the late Charles Starr (undated) at Menangle and may still be present at EMAI, but were not confirmed by our survey. A nest box program would be the most practical means to confirm their presence.

Figure 13 – The tiny Feathertail Glider may survive at EMAI – Narrawan Williams

Sugar Glider *Petaurus breviceps* (common)

The hand-sized Sugar Glider remains common in woodland and in the River at EMAI. This is a gliding possum, using a skin membrane between its front and rear legs to glide between trees where it feeds on insects and plant sap. The species presence is generally given away by the horizontal bites left on trees where it feeds on sap in Winter (when animal food is scarce). However at EMAI the species appears common despite an obvious lack of these 'feed trees'. The gliders probably feed on Acacia (wattle) sap and these shrubs may be critical to their survival on site.

Sugar Gliders den in large family groups in hollow trees. Dens were identified in large old trees along the river.

Figure 14 – A den of Sugar Gliders - Akos Lumnitzer

Squirrel Glider *Petaurus norfolcensis* (Regionally extinct)

This slightly larger relative of the Sugar Glider is a grassy woodland specialists. Formerly common in the Cumberland Plain it is now believed to be regionally extinct. Its woodland habitat has now been recolonized by the smaller Sugar Glider.

In the 1980s a Squirrel Glider was injured on the barbed wire surrounding the Managers Cottage (Rose 1990). This was taken into care and identified by Helen George, who later went on to establish the wildlife care organization WIRES, for which she was subsequently given the Order of Australia Medal.

Sue Rose records the finding with a footnote: 'supposedly rare'. Indeed this is one of just three verified records of this species which once was dominant in the Cumberland Plain. The area surrounding the Managers Cottage is very open, fertile woodland and classic habitat for this species. This was the last confirmed record of the species for the Cumberland Plain.

Greater Glider *Petauroides volans* (Regionally extinct)

The Greater Glider was once common in the majestic Riparian Forest at EMAI. True to its name this is an enormous gliding possum (about the size of a small dog). It lives in family groups in tall moist forest and dens in hollow trees. Greater Gliders are exclusively foliage eaters and rely on healthy vegetation. The nearest remaining population is at Gulguer/Bents Basin. If the Riparian Forest at EMAI is restored this majestic animal could be considered for reintroduction in the future.

Yellow-bellied Glider *Petaurus australis* (Regionally extinct)

The Yellow-bellied glider is a medium-sized glider of Ironbark woodlands including EMAI. It requires large areas of habitat with healthy understorey. The species disappeared from EMAI in the 1800s and the last regional population (at Castlereagh) was wiped out by fire around 2001.

Koala *Phascolarctos cinereus* (Regionally extinct)

The koala was once a common sight in the region and likely to have occurred at EMAI visiting both riparian forest and grassy woodland habitats. The last regional sighting around Menangle was in the late 1800s (Moloney 1929).

Common Wombat *Vombatus ursinus* (Declining)

Despite both name and reputation the wombat is a declining species in the region. EMAI staff continue to see occasional animals, however only scats were detected during the current survey. Sightings have subsequently confirmed a very small population persists on site.

As the wombat has declined in western Sydney it has contracted to riparian habitats, however it was originally also common in grassy woodland. The key threats appear to be the disease Sarcoptic Mange (spread by foxes) and the replacement of rich grasslands by pasture and by woody weeds along the river.

The control of woody weeds in the riparian forest will be critical to this species future at EMAI. The Camden Airport and Bents Basin have both undertaken successful control programs for sarcoptic mange which would also benefit the EMAI population.

Figure 15 – A healthy wombat – B Levot

Figure 16 – A mange affected wombat – B. Levot

Figure 17 - Every wild life is precious. This headstone for a wombat which died in care was erected by Sue Rose in Sawyers Reserve. Shown with Roger Giles, 2008

Dasyurids

Thylacine *Thylacinus cynocephalus* (Extinct)

The Thylacine or 'Tasmanian tiger' was the keystone predator of the Cumberland Plain and a grassy woodland specialist. This pouched marsupial denned in thick riverflat or gully vegetation from where it emerged to open habitats to hunt larger prey - particularly kangaroos and wallabies.

Thylacines (and later dingoes) ensured a balanced grazing pressure on native woodlands – a balance which is now difficult to maintain. They were probably also responsible for maintaining the health of macropod populations by targeting sick and weak individuals.

Aboriginal hunting and the introduction of the dingo coincided with the regional extinction of this key predator in relatively recent times (up to 4,000 years ago). European hunters and disease wiped out the remaining Tasmanian animals from their Tasmanian grassy woodlands in the 1930s resulting in global extinction of the species.

Figure 18 – Thylacine at Hobart Zoo in 1921 - Public Domain.

Brush-tailed Phascogale *Phascogale tapoatafa* (Regionally extinct)

Captain Arthur Onslow married Elizabeth Macarthur in 1867 and was a keen naturalist and contributed many observations on native wildlife (now mostly lost). In 1820 he shot an unusual and cryptic animal in the Barragal Hills and sent the skin & skeleton to the Australian Museum. This animal was the Brush-tailed Phascogale.

The record of this species in Western Sydney was lost for over 100 years until the present survey uncovered the skull of the Phascogale shot by Onslow in the collections of the Smithsonian Institute, along with Mr Onslows original collection details.

Sadly this is the only evidence we have that Phascogales once frolicked in trees of the Cumberland Plain. This species requires very large areas of habitat to survive and was most likely a victim of early land clearing.

Figure 19 - This skull collected by Ct Arthur Onslow at EMAI is the only remaining evidence that Brush-tailed Phascogales once roamed Western Sydney's woodlands. - Smithsonian Institute Collections

Figure 20 – Brush-tailed Phascogale – Ern Mainka

Spotted-tailed Quoll *Dasyurus maculatus* (Rare visitor)

The Spotted-tailed Quoll is the largest remaining native predator in the region. It is a rare visitor to EMAI. It was last seen by Dairy manager Kristine Riley at EMAI who reported a 'spotted possum' bailed up by dogs at the woodpile by houses south of Sawyers Reserve (the animal escaped unharmed). It is believed that Quolls are no longer 'resident' or breeding in the Cumberland Plain, however animals regularly arrive possibly traveling east out of the Burrogarang Region.

Figure 21 – Spotted-tailed Quoll

Eastern Quoll *Dasyurus viverrinus* (Regionally extinct)

The small Eastern Quoll is now extinct in NSW. It was a small, agile hunter of small mammals, birds and insects and proved an excellent hunter of chickens in the early colony. The Eastern Quoll suffered from persecution, poison and land clearing and later by the introduction of the European Red Fox. The last animals in NSW died at Vaucluse when weed control removed their refuge habitat.

Figure 22- Eastern Quolls as painted by early settler – Public Domain

Antechinus *Antechinus sp* (Regionally extinct)

This small marsupial 'mouse' was one of the most remarkable animals of the Cumberland Plain. Antechinus are small and agile and feed on a wide range of invertebrates.

Antechinus have one of the most remarkable life histories of any animal. The males become mature in their first year and expend all their resources on mating after which the male population dies *en masse* from stress-related causes. This leaves the females without competition for food as they raise the young.

It is unclear which Antechinus species was native to the Cumberland Plain. Staff at the Sydney University Farm at Cobbitty reported Yellow-footed Antechinus in the 1970s. This is the most common species in grassy woodland, however the potential of other Antechinus species cannot be ruled out.

The last Antechinus population in the Cumberland Plain was deliberately destroyed at Camden Lakeside in 2010.

Figure 23 – the remarkable native Antechinus

Dunnart *Sminthopsis murina* (Regionally extinct)

The Dunnart is a close relative of the Antechinus and has not been seen in the region for many decades. Dunnart populations appear to operate on a 'boom and bust' model in response to certain fire regimes.

Macropods

The Macropods (Kangaroos, Wallabies and 'rat kangaroos') have changed considerably over time at EMAI.

In 1989 only the Swamp Wallaby (a riverbank species) was common at EMAI. It is listed in Sue Rose's wildlife survey under the Riverbank species list. By comparison it appears that Wallaroos were limited at that time to occasional individuals. Rose lists 'Eastern Grey Kangaroo' (probably misidentification of a female Wallaroo) in the section on occasional wildlife sightings with a note '*sighted Sheep Paddock, Stanhams Land and dead on Old Hume Hwy*'. This suggests that kangaroos were rarely observed in 1989.

Today one species the Common Wallaroo (often mistaken for Eastern Grey Kangaroos) has naturally colonized the site and is believed to be at carrying capacity. The remnant population of Swamp Wallabies appears to be small but healthy. The once dominant Eastern Grey Kangaroo has not re-established a healthy population to date.

Common Wallaroo *Macropus robustus* (Common)

Figure 24 – Common Wallaroo at Turkeys Nest – Michael Streatfield

Table 2 shows the results of wallaroo counts undertaken at EMAI in 2013. The counts surveyed animals in the 85 hectare area visible from the entrance drive between the Caretaker Gates and Barragal Lagoon, where it is estimated between 25 – 50% of the total population feeds. Surveys were conducted at 7 pm (twilight). The total population is therefore estimated at between 0.3 and 0.6 animals per hectare.

Date	Male	Female	Total
16/10/2013	11	12	23
15/10/2013	21	29	50

Table 2 – Standardised Wallaroo count results

Eastern Grey Kangaroo *Macropus giganteus* (Rare/Unconfirmed)

A single reputable sighting of Eastern Grey Kangaroo was made during the present survey. It appears that this species is uncommon or a vagrant in the region. Eastern Grey Kangaroos were shot out of the region by the early 1920s. Unlike the Wallaroo they have failed to recolonize the area now that hunting has ceased.

The Eastern Grey Kangaroo prefers the richer soils and flats of the Cumberland Plain. If the species recovers or is reintroduced it would likely replace Wallaroo in much of the native pasture at EMAI rather than resulting in a net increase in grazing pressure.

Swamp Wallaby *Wallabia bicolor* (Common)

The Swamp Wallaby is a darker more 'robust' wallaby largely confined to the riverbank areas at EMAI. It prefers dense, moist vegetation. Unlike the grazing wallaroo, the swamp wallaby is generally a browser feeding on native and exotic shrubbery.

Brush-tailed Bettong *Bettongia penicillata* (Regionally extinct)

The Brush-tailed Bettong or 'kangaroo rat' was reported from EMAI by Barrallier in 1802. This species disappeared early from the Cumberland Plain, well before foxes were introduced. Its regional extinction may have been due to the change in fire regimes and grazing pressure which arrived with European settlers when the Nepean was crossed. Brush-tailed Bettong require lush native grasslands and woodlands with lots of hollow logs; the arrival of cows and later settlers and removal of Aboriginal and dingo control of kangaroo populations all combined to remove this lush feeding habitat.

Long-nosed Bandicoot *Perameles nasuta* (Regionally extinct)

The only record of Bandicoot at EMAI is a handwritten note in the final pages of Sue Rose's wildlife survey of 1990:

The native species in the Cumberland Plain is in fact the similar Long-nosed Bandicoot. It is not surprising that the last individual was recorded from dense weeds. Weed patches offer shelter from predators and have been the last refuge for a number of species in the Cumberland Plain; while also being responsible for the loss of many species through structural change.

The black bamboo from which Bandicoot was recorded was ringed with traps during the present survey however no bandicoot were found. The last population in the Cumberland Plain at Agnes Banks died out in 2012-13 after the introduction of pigs for bow hunting. This species is now regionally extinct.

Monotremes

Bush Rat *Rattus fuscipes* (Regionally extinct)

The Bush Rat is a native species of woodland areas which rarely enters houses or suburban areas. It plays a key role in recycling nutrients and 'cleaning up' the bushland, feeding on a very wide range of foods.

The Bush Rat has suffered considerably by firewood harvesting, stick collecting and foxes, and is now regionally extinct. A 'bush rat' reported in 2008 from EMAI but was almost certainly a misidentification of the similar but introduced Black Rat which is itself uncommon in bushland due to the pressures noted above. Intense efforts to locate bush rats & bandicoots at EMAI in the 2013 survey failed to find any evidence of these species.

Rakali (Water Rat) *Hydromys chrysogaster* (Unknown)

The Rakali or 'Water Rat' is a very large aquatic animal frequently mistaken for a Platypus. It was once common along the Nepean and in local creeks and common at Spring Farm until the 1980s. Rakali construct long complex burrow networks in clay creekbanks. At night they emerge to feed on yabbies' and mussels – often building up considerable 'midden' piles of discarded shells. There are unconfirmed reports of Rakali from the Nepean and these animals may be the source of Platypus reports. However it remains possible that the Rakali may be regionally extinct. No evidence of Rakali was found in the current survey.

Grey-headed Flying-Fox *Pteropus poliocephalus* (Uncommon)

The Grey-headed Flying Fox is a regular visitor to EMAI when Eucalyptus are in flower. It is considered a 'keystone' species for its role as pollinator for our woodlands.

The Flying Fox is a frequent visitor to orchards and the few roosts remaining are in agricultural or urban areas. As a result is often mistakenly considered 'common'. In reality numbers have plummeted in recent decades and it is rightly considered vulnerable to extinction within the medium future.

Microbats

Microbats are small insectivorous bats which use sonar echolocation to find their prey. Microbats are rarely seen however they make up much of the diversity of wildlife in western Sydney.

Figure 25 – This mature Little Forest Bat captured in the Sheep Paddocks lived up to its name, weighing in at less than 5 grams

The microbats diversity is maintained by each species targeting different parts of the habitat. The following table is a helpful introduction to this diversity:

Above-canopy feeders
Miniopterus schreibersii
Mormopterus loriae
Mormopterus norfolkensis
Tadarida australis
Hunts in canopy gaps
Chalinolobus morio
Saccolaimus flaviventris
Scoteanax rueppellii
Scotorepens orion
Hunts close to vegetation
Falsistrellus tasmaniensis
Rhinolophus megaphyllus
Vespadelus vulturnus
Gleans from structures

Nyctophilus geoffroyi
Nyctophilus gouldi
Vespadelus darlingtoni
Chalinolobus gouldii
Specialists/Unknown
Myotis macropus (over open water)
Scotorepens orion (often over water)

Table 3 – The structural preferences of microbats in Sydney region

A more comprehensive outline of the microbats of EMAI is given in Table 4 below.

Species	Piggery	Riverbank	Barragal Ridge	Total Calls	Species Comments
Chalinolobus dwyeri	7	1	0	8	Vulnerable (NSW) A beautiful species with jet black fur with a fringe of white around the body. A highly manoeuvrable species with short, stout wings designed for feeding just below the tree canopy. Habitat: Dry and open forest; Roosts in sandstone caves. A key species, likely to decline as Camden becomes suburban
Chalinolobus gouldii	21	81	25	127	Sydney's most abundant bat, this is the only species to tolerate streetlights and most common bat in nest boxes (which may disadvantage competing species). The species is fast flying and generally feeds of flying beetles and moths below and around the tree canopy, selecting open gaps. Roosts in tree fissures and hollows, nest boxes but not under loose bark, prefers holes with entrance diameter ~10cm, about 15m above ground. Abundant in all habitat types at EMAI
Chalinolobus morio	8	0	24	32	A species of bushland areas (over 6 ha) and the suburban fringe. A truly chocolate-coloured small bat, with distinctive rounded ears. A fast, direct and agile hunter – catches flying insects only (no gleaning) feeding mostly on moths. Prefers areas of low shrub density - clearly favouring the fairly shrub-free Barragal Ridge at EMAI. Has slightly different habitat requirements to the otherwise similar *Vespadelus darlingtoni* which prefers low tree density and old-growth. Roosts in trees, entrances ~3cm diameter, prefers spouts, hollow trunks and fissures

Falsistrellus tasmaniensis	1	0	0	1	A Vulnerable species. A large chocolate-brown species with characteristic nose. Similar to Greater Broad-nosed Bat but with two pairs of upper incisors and larger ears. Not a species of suburbs. A fast flying species feeding near the canopy with a preference for beetles. Prefers wet, denser forests than most bats but generally on shale and in greater Sydney mostly restricted to Cumberland Plain. Roosts in older smooth-barked trees using numerous roosts in rotation spread ~800m apart.
Miniopterus australis	12	10	10	32	Possibly a misidentification? This species is moving south each year and in recent years establishing in Sydney. Needs confirmation
Miniopterus schreibersii oceanensis	0	0	1	1	Vulnerable (NSW). A small brown snub-nosed bat. Feeds above the canopy. This species has a remarkably high metabolism, and typically consumes 1/3 of its body weight in insects each night. Uses most habitats. Roosts in limestone caves during the Spring, migrates to Sydney where common in suburban bushland. Roosts in any suitable structures (especially stormwater culverts and bridges).
Mormopterus norfolkensis	1	15	7	23	Vulnerable (NSW) A fast-flying species with poor manoeuvrability, wide ranging. Feeds above the canopy, favouring open paddock with old trees. At EMAI appears to favour the 'Old Paddock Trees' area. Requires fertile soils - largely restricted in Sydney region to the Cumberland Plain. Roosts in tall isolated or emergent trees

Nyctophilus sp.	14	132	8	154	It is impossible to miss those enormous ears! Trapped animals have the lovely habitat of folding these down and hiding their faces in them, presumably to conserve body heat. These are 'gleaning' species using their unusually good sight (for a bat) and amazing ears to detect and pick insects off foliage. Lesser Long-eared bat (*geoffroyii*) seems to prefer low density of ground cover as opposed to larger Gould's Long-eared bat which is restricted to larger bushland remnants. Both roost under bark and in tree fissures and remarkably close to the ground (often 3m or less). Generally spends <2 days per roost, with roosts spaced an average 200m apart. Lesser Long-eared Bats are common throughout EMAI; no confirmation of Gould's long-eared bat to date
Saccolaimus flaviventris	0	7	0	7	Vulnerable (NSW). A large and distinctive black-and-white bat. A high-flying and fast species. Found at low densities, believed territorial (males have distinct throat pouch), roosts in tree hollows, large (20cm) roost entrances
Scoteanax rueppellii	0	0	2	2	A large brown bat with broad square jaw – much larger than other broad-nosed bats. Suspected to be carnivorous on other bat species. A slow, direct flying species. Favours ecotones, such as creeks and the edges of forest clearings for hunting beneath the canopy. Will travel across clearings to reach suitable patches of habitat, but does not feed in such areas. Often flies low (<5m) above creeks. Roosts in tree hollows, and occasionally in old buildings
Scotorepens orion	3	0	0	3	A moderately sized brown bat with distinctive pointed ears. Prefers fertile soils and creeklines. Roosts in tree hollows and buildings. Often seen over open water.

Tadarida australis	68	8	20	96	A large species with distinctive white stripe down side. Above-canopy feeder. A large bat with characteristic deep call audible to humans. Roosts in mature trees, particularly with large central hollows and surrounded by groups of trees and undergrowth. Frequently roosts in urban remnants, even when intact forest is available nearby
Vespadelus spp	2	3	0	5	A remarkably small bat (smaller than a human thumb at 5 grams). Very agile, feeding at the top of the shrub layer. No evidence of gleaning. Prefers open woodland, but almost all habitats used. Will not roost under bark - some roosts have surprisingly wide entrances (15cm) for such a tiny species. Not recorded heavily on ANABAT but trapped repeatedly during survey
Total Calls by Habitat	137	257	97		

Table 4 – Microbat species detected by call (ANABAT) at EMAI

Introduced Species

*Black Rat *Rattus rattus* (Rare)

The introduced Black Rat is present around houses and in bushland areas at EMAI. It is uncommon to rare in bushland with very few animals trapped. While Black Rats are unwelcome their very low numbers are a stark reflection of the impact of foxes, stick picking and firewood collection.

*Cat *Felis catus* (Occasional)

A small population of feral cats were observed by camera trap during the present survey. Unlike western NSW the feral cat does not appear to be particularly common in the Cumberland Plain. There are also a number of domestic cats associated with the staff houses located south of Sawyers reserve.

*Fox *Vulpes vulpes* (Highly abundant)

The fox is one of the most abundant animals at EMAI and one of the most serious threats to native wildlife.

Unbaited wildlife cameras detected an average of 0.26 foxes per camera-night – a very high activity rate. This sets an important benchmark for any future fox control program.

A coordinated biannual Menangle Fox Campaign is currently underway and includes EMAI and some neighbouring properties. The campaign includes robust monitoring and it is hoped will prove a successful and long-term solution to this very important issue.

Figure 26 – Fox hunting in riverflat forest – Akos Lumnitzer

*Rabbit *Oryctolagus cuniculus* (Occasional)

Rabbits were reasonably uncommon in bushland areas surveyed. EMAI management regularly use Pindone baiting for rabbits on the property.

*Brown Hare *Lepus capensis* (Abundant)

The Brown Hare was abundant in bushland areas and especially Sawyers Reserve. It is possible that some staff confuse this species with Rabbit. Hare's are more solitary than Rabbits and do not burrow, making them more difficult to control then Rabbits. They are unlikely to be heavily affected by the rabbit baiting at EMAI.

*Pig *Sus scrofa* (Rare visitor)

Feral pig have been occasionally reported from EMAI but are quickly removed. A feral population recently established at Brownlow Hill however eradication works are progressing well.

*Goat *Capra hirsus* (Rare visitor)

Feral goat have been occasionally reported from EMAI but are quickly removed. A large feral population has recently established at Camden Airport and is proving difficult to eradicate. This is a priority species to monitor for potential incursion at EMAI.

*Fallow Deer *Dama dama* (Rare visitor)

Fallow Deer are occasionally reported from EMAI but quickly eradicated. As with Goats there is a large population on the river near Camden Airport which is proving difficult to control in the thick habitat. These deer originate from the various abandoned deer farming enterprises e.g. Theresa Park.

Frogs

EMAI is home to a diversity of frog species. Contrary to popular assumption native frogs spend most of their lives away from water and the best habitats for native frogs at EMAI are Sawyers Reserve and Barragal Floor – two large areas of more sheltered woodland.

A key problem for local frogs is the introduced fungal disease Chitrid. This disease was introduced with African Clawed Frogs which were used for pregnancy testing in Sydney up to circa 1940. While the frogs did not establish in the wild the fungal disease they carried did. Chitrid has now spread into most habitats across Australia.

Our native frog species have varied tolerances to Chitrid. The most susceptible local species is the once ubiquitous Green and Golden Bell Frog. It was once very common at EMAI. It is now restricted to industrial or other damaged wetland habitats where mild water toxicity and/or salinity controls the fungus activity without killing the frogs – a compromise which has this species from extinction.

By comparison two species the Common Eastern Froglet and the Striped Marsh Frog are highly resistant to Chitrid. These species have increased in abundance as other frog populations decline; however they also act as carriers and spread Chitrid to susceptible frogs.

Common Eastern Froglet *Crinia signifera* (Abundant)

This very small frog is the most common species on EMAI. It breeds in any water from temporary puddles to larger wetlands, and may compete with other native frog species.

Figure 27 – Common Froglet – Edwin Vella

Green & golden Bell Frog *Litoria aurea* (locally extinct)

This species is highly susceptible to chitrid infection. It was once common at EMAI and throughout the region especially in open-water ponds with fringing bullrush.

This species is now restricted to industrial or other habitats with mild water toxicity and/or salinity which limit the impact of Chitrid.

Figure 28 – Green & Golden Bell Frog

Green Tree Frog *Litoria caerulea* (Rare)

This very large frog is moderately tolerant to Chitrid. It has a particular preference for grasslands and open grassy woodland and is often found in houses near these areas. For this reason it is often considered common.

Nonetheless that this frog is in decline in the Cumberland Plain and is now quite uncommon in bushland areas.

Figure 29 - Green Tree Frog at Navigation Creek – Rebecca Mooy

Figure 30 – Dwarf Tree Frog

Eastern Dwarf Tree Frog *Litoria fallax* (Abundant)

This small frog is found in thick reed beds and can be found in good numbers in any of the larger natural or artificial waterbodies at EMAI.

Lesueur's Frog *Litoria lesueuri* (Rare)

This is an uncommon tree frog at EMAI and should be a priority for further survey.

Peron's Tree Frog *Litoria peronii* (Abundant)

This frog has fared well from agriculture and is a common species in 'improved' pasture as well as in woodland areas.

It is readily identified by the small emerald spots on the back and yellow mottling in the groin.

Figure 31 – Perons Tree Frog – Mark Fuller

Tyler's Tree Frog *Litoria tyleri* (Rare)

An uncommon frog in woodland at EMAI.

Verreaux's Frog *Litoria verreauxii* (Rare)

An uncommon frog in woodland and wetlands at EMAI.

Smooth Toadlet *Uperoleia laevigata* (Rare)

An uncommon small frog in woodland at EMAI.

Reptiles

Eastern Snake-necked Turtle *Chelodina longicollis* (Common)

Despite heavy losses to roadkill and foxes the eastern snake-necked turtle continues to be common throughout the Menangle and Camden regions.

Figure 32 – Snake-necked turtle – Paul Randall

Bearded Dragon *Pogona barbata* (Common)

The bearded dragon is often misidentified for a frill-necked lizard due to the spiny frill around its neck.

EMAI is one of the few locations in the Cumberland Plain where the Bearded Dragon continues to be common. This species prefers open woodland where it feeds on a wide range of invertebrates. It requires large undisturbed areas of fertile woodland away from roads.

Figure 33 – A bearded dragon in the northern pasture at EMAI – Michael Steatfield

Lace Monitor *Varanus varius* (Common)

The Lace Monitor or 'goanna' is the largest reptile of the Cumberland Plain. It preys on birds nests, insects small reptiles and small mammals. Females dig a nest in live termite nests to lay eggs. The termites repair the hole and provide an air conditioned habitat for the eggs. When the eggs hatch the female generally returns and opens the nest again so the young can escape.

While Lace Monitor remain widespread EMAI is one of the few locations in the Cumberland Plain with a large healthy population of Lace Monitor.

Figure 34 – Lace Monitor at Barragal – Michael Streatfield

Dark-flecked Garden Sunskink *Lampropholis delicata* (Common)

One of two species of the common 'garden' skink. This species is very common in all habitats on site

Pale-flecked Garden sunskink *Lampropholis guichenoti* (Common)

One of two species of the common 'garden' skink. This species is very common in all habitats on site

Water Dragon *Physignathus lesueurii* (Common)

The water dragon is still relatively common along the river at EMAI. This animal is well adapted to water and an excellent swimmer. It can survive considerable periods underwater where is dives for protection.

Scaly-foot (Legless Lisard) *Pygopus lepidopodus* (Unknown)

The scaly-foot is a species of legless lizard frequently mistaken for a snake. It is one of the most remarkable of the Cumberland Plain wildlife. It can be readily distinguished from a snake by its clear ear hole behind the eye. It feeds on small lisards and similar prey which it hunts in the leaf litter.

This species is rare and declining in the Cumberland Plain region. The last record of a scaly-foot at EMAI was by Sue Rose in 1989 when it was uncovered during earthworks. The species is difficult to find and most sightings occur during earthworks or by coincidence. It is possible that it survives at EMAI, however firewood collection and stick-picking are major risks to the species.

Figure 35 – the remarkable Scaly-Foot lisard is threatened by firewood collection and stick picking

Red-bellied Black Snake *Pseudechis porphyriacus* (Common)

The Red-bellied black snake is a common snake across EMAI. This species prefers frogs and is frequently found in riparian, dam or wetland areas. While poisonous it is not an aggressive species. Sadly traditional fear of snakes still see many of these animals needlessly killed.

Figure 36 - The common Red-bellied Black Snake, a non-aggressive frog hunter, at Sawyers Pond

Eastern Brown Snake *Pseudonaja textilis* (uncommon)

The Eastern Brown Snake is uncommon but still regularly seen in most dry habitats at EMAI. This species feeds on mice and rats and is important in managing these agricultural pests.

Brown snakes are venomous and can be aggressive. Contrary to common practice it is always safer to leave these animals alone rather than attempt to kill the snake: almost all snake bite deaths in Australia occur as a result of attempts to kill the snake.

Red-naped Snake *Furnia diadema* (Rare)

This is a small nocturnal snake which feeds on small lisards and similar prey. Its habits make it difficult to detect; however it appears to be genuinely rare in the Cumberland Plain.

A beautiful individual was discovered in March 2015 during earthworks near the institute at EMAI. This is the first record for the region.

Figure 37- A beautiful Red-naped snake rescued during earthworks – Kris Riley

Whip Snake *Demansia psammophis* (Unknown)

This inoffensive snake is extremely fast and rarely seen. It was last confirmed in the early 1900s but may possibly survive at EMAI.

Green Tree Snake *Dendrelaphis punctulatus* (Regionally extinct)

The Green Tree Snake is colorful python-like species found in intact riparian areas. It has not been confirmed in the Cumberland Plain for some decades.

Tiger Snake *Notechis scutatus* (Regionally extinct)

The Tiger Snake has not been confirmed in the Cumberland Plain since the last known habitat at Edmondson Park was developed in 2013. Locally it appears to have been common in flooplains and wetlands and would have been a common animal in the extensive Barragal –Menangle lagoons. 'Tiger' snake reports are often found to be young Brown Snakes which have a similar striped pattern.

Diamond Python *Morelia spilota* (Unknown)

The Diamond Python is generally restricted to healthy riparian areas in the Cumberland Plain. It is declining in the region and has not been seen for some time at EMAI. However it is possible that a small population survives in the Riparian Forest.

Birds

Over 100 bird species are regularly present at EMAI. It is impossible to introduce them all in this guide, instead a few species of concern are introduced.

There are good historic records of birds at EMAI including two previous surveys using repeatable techniques. For this reason we are able to investigate the changes to birds at EMAI over time and differences in the birdlife between different habitat types. By better understanding our bird life we can then suggest ways to improve their wellbeing into the future.

The most widespread and abundant birds in 2013 are outlined in the tables below. The current birdlife is dominated by the carnivorous Corvids (Ravens, Crows, Butcherbirds and Cuckoo-shrikes). This indicates a lack of woody debris, tall grass and scattered shrubs necessary for other species needs.

Common Name	Scientific Name	Observations*
Australian Raven	*Corvus coronoides*	13
Grey Butcherbird	*Cracticus torquatus*	11
Sulphur-crested Cockatoo	*Cacatua galerita*	9
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	8
Eastern Rosella	*Platycercus eximius*	8
Magpie-Lark	*Grallina cyanoleuca*	8
Olive-backed Oriole	*Oriolus sagittatus*	8
Rufous whistler	*Pachycephala rufiventris*	8
Grey Fantail	*Rhipidura albiscapa*	7
Sacred Kingfisher	*Todiramphus sanctus*	7
Striated pardalote	*Pardalotus striatus*	7
Bar-shouldered Dove	*Geopelia humeralis*	6
Galah	*Eolophus roseicapillus*	6
Noisy Miner	*Manorina melanocephala*	6
Superb Fairy-wren	*Malurus cyaneus*	6
Willie Wagtail	*Rhipidura leucophrys*	6
Bell Miner	*Manorina melanophrys*	5
White-throated Gerygone	*Gerygone albogularis*	5

Table 5 – Most ***widespread*** birds at EMAI. *Results show the number of site surveys in which the species was observed out of a total 15 surveys.

Common Name	Scientific Name	Count*
Eurasian coot	*Fulica atra*	26
Welcome Swallow	*Hirundo neoxena*	26
Australian Raven	*Corvus coronoides*	21

Silvereye	*Zosterops lateralis*	17
Bar-shouldered Dove	*Geopelia humeralis*	13
Red-browed Finch	*Neochmia temporalis*	13
Grey Fantail	*Rhipidura albiscapa*	10
Sulphur-crested Cockatoo	*Cacatua galerita*	9
Galah	*Eolophus roseicapillus*	8
Eastern Rosella	*Platycercus eximius*	7
Bell Miner	*Manorina melanophrys*	7
Hardhead	*Aythya australis*	7
Straw-necked Ibis	*Threskiornis spinicollis*	7
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	6
Noisy Miner	*Manorina melanocephala*	6
Peaceful Dove	*Geopelia striata*	6
Rufous whistler	*Pachycephala rufiventris*	5
White-necked Heron	*Ardea pacifica*	5
Black-winged Stilt	*Himantopus himantopus*	5
Fairy Martin	*Petrochelidon ariel*	5

Table 6 – Most ***abundant*** birds at EMAI. *Records the total number of individuals observed across the 15 site surveys

Comparison between habitat types

The birdlife allows us to compare the wildlife diversity of the different habitats at EMAI. The bird diversity of each habitat type is indicated in the table below.

Site	Native Diversity	Rare	Exotics	Sightings	Unique Species*
Dryland Casuarinas	9	1			0
Riverflat Forest	11	1		26	1
Riverflat Forest	15	2	1		
Fertilised Pasture	14	2		47	1^
Old Paddock Trees	15	2	2		0
Barragal Ridge	17				2
Barragal Gully Woodland	18	2			3
Menangle Lagoon	18	1			2
Duckponds	18	2			3
Barragal Lagoon	19			73	3
Barragal Lagoon	20				
Sawyers Creek	20	1		48	1
Sawyers Forest	21	1	1		4
Unfertilised Pasture	22	2		53	2
Unfertilised Pasture	20	2		31	

Table 7 – Comparison of bird diversity & abundance across EMAI habitats. *Adjusted for number of sites surveyed. ^Little Corrella – a pest of pastures

A previous study by Brian Trench in 1996 also measured the diversity of birds at EMAI by habitat type. Trench used the Shannon-Weiner index as an indicator of wildlife diversity. Instead of just counting how many species of wildlife are observed ('species diversity' - Table 7) it calculates the degree to which the wildlife observed is dominated by a small number of common species. SWI is calculated as SWI = $\sum p \log p$ where p is the number of individuals observed for a given species as a proportion of the total number of individuals observed at the site. High values of SWI indicate diverse wildlife that is not overly dominated by a small number of species.

The SWI results for 1996 and 2013 are compared in Table 8. At first glance this suggest that the bird diversity at EMAI has increased spectacularly. However this is likely an artifact of survey technique. Brian Trench was an amateur birdwatcher working alone, while the 2013 surveys were undertaken by pairs or highly experienced birders. It's not that bird diversity has increased at EMAI but that the 2013 observers were simply better placed to find all the birds present. The protocol used for the 2013 survey (and selection of observers) follows the Birdlife Australia standard and will avoid these problems for any future comparative survey.

Site	SWI (2013)	SWI (1996)
Riparian Forest	0.82 - 1.20	**0.61 - 0.86**
Alluvial Woodland	0.95 - 1.26	0.32
Fertilised Pasture	1.00	

Unfertilised Pasture	1.14 - 1.23	0.32
Barragal Woodland	1.23 - 1.25	
Sawyers Reserve	1.24 - 1.34	0.54
Barragal Lagoon	1.04 - 1.19	
Menangle Lagoon	1.23	

Table 8 – Comparison of Shannon-Weiner Index for habitat types between 1996 (Trench) and 2013

Decline in riparian forest birds

The Shannon-Weiner Index does reveal one startling change highlighted in red – a dramatic relative decline in the diversity of birds in the Riparian Forest. A comparison of Trench and 2013 species list show few differences. However the abundance of birds in the Riparian Forest has become dominated by the privet-feeding Silvereye. In 1996 the Robins and Fantails (insectivorous species) were equally common as the silvereye, however these birds were observed just once in the 2013 surveys.

The decline of bird diversity in the Riparian Forest is a serious concern and can be attributed to the dominance of privet in this habitat – a weed which favors the Silvereye but few other native birds. Restoration by Sue Rose in the 1980s was still present in 1990s but had almost completely been retaken by weeds by the time of 2013 survey. The restoration of the Riparian Forest is achievable and would help bring the Riparian birds back. It is good to note that while the riparian birds have declined in number there has been no loss of species since 1996.

Value of native vs. fertilised pasture

Both surveys (1996 and 2013) and both indicators (Table 7 and Table 8) show that native pasture has substantially more wildlife than 'improved' (fertilised) pasture. Native pasture has on average 50% more native wildlife than fertilised pasture. Native pasture with mature trees has greater wildlife diversity than any other habitat at EMAI including Sawyers Reserve. The biodiversity value of native pasture at EMAI should not be overlooked.

It is interesting to note that the native pasture paddocks were also free of pasture-damaging birds such as Corellas, which were common on the fertilised paddocks.

The role of shrubs

The significance of native pasture could suggest that shrubs are not an important element in woodland areas.

However the bird results clearly show that woodlands with shrubbery (e.g. Sawyers Reserve) provide significantly more diverse bird habitat than woodland areas with little to no shrub cover (e.g. Barragal Ridge and Barragal Gully). Uncommon birds in particular were more likely to be found in Sawyers forest where the patches of shrubbery provide cover.

Native pasture with mature trees has greater wildlife diversity than any other habitat at EMAI – even Sawyers Reserve. The biodiversity of native pasture has been undervalued at EMAI. Sustainable native pasture management should be priority for restoring native biodiversity

Many parts of EMAI including Barragal have very little woody ground cover or shrub cover due to past and current management. Significant improvements could be made for native wildlife without compromising agricultural land use. Nonetheless it will also be important to monitor and manage recovery of the native shrub *Bursaria spinosa*. This species has a propensity for becoming overabundant in recovering woodlands, forming a dense monoculture and reducing flora and fauna diversity. It is the diverse mix of habitats that protect such remarkable diversity at EMAI

Changes in species abundance over time

The relative abundance of each bird species was compared between 1996 and 2013. In general bird abundance at EMAI has not significantly changed. However a few bird species have seen major changes to abundance over the last decade. These changes are summarized in Table 9 below.

Species		River	Sawyers	Native Grassland	Comments
Red-whiskered Bulbul	**Pycnonotus jocosus*	-3%	0%	0%	This introduced bird has disappeared from EMAI and is in regional decline; cause unknown (but positive)
Common Starling	**Sturnus vulgaris*	0%	0%	-81%	This introduced bird has disappeared from EMAI and is in regional decline; cause unknown (but positive)
Australian White Ibis	*Threskiornis molucca*	0%	0%	-10%	The population reduction of this self-introduced native species is due to improvements in the management of the nearby Jacks Gully Landfill
Australian Magpie	*Cracticus tibicen*	0%	-10%	-2%	There has been a reduction in Magpie abundance in Sawyers balanced by an increase in Raven numbers. Magpie prefer open habitats while Ravens are better adapted to closed forest. This change appears to be a response to the vegetation structure at Sawyers thickening over time.
Brown Gerygone	*Gerygone mouki*	12%	0%	0%	The increase of this species along the river is a puzzle.
Silvereye	*Zosterops lateralis*	27%	0%	10%	Substantial increase in Silvereye in both River & Pasture corresponds with regional population increases, possibly due to expansion of Privet (a riparian weed and key Silvereye food).
Noisy Miner	*Manorina melanocephala*	0%	-15%	3%	The Noisy Miner was once rare in the Cumberland Plain but has adapted to suburbs to become a pest native species. The reduction in this species at Sawyers despite increased suburban development nearby is unexpected: possibly a response to increasing shrub density under stock exclusion and a very good sign
Grey Fantail	*Rhipidura albiscapa*	-19%	8%	0%	The significant reduction in Fantail and Wagtail along the river is of concern
Willie Wagtail	*Rhipidura leucophrys*	-26%	4%	-2%	The significant reduction in Fantail and Wagtail along the river is of concern
Sulphur-crested Cockatoo	*Cacatua galerita*	0%	4%	10%	This species is adapted to suburban environments and continues to increase regionally; this is a serious problem for bushland areas where this species competes for food and nesting hollows
Welcome Swallow	*Hirundo neoxena*	0%	-41%	3%	The apparent decline in Welcome Swallow numbers may simply reflect their highly nomadic behavior

Table 9 – Bird species showing >10% change in abundance at EMAI over last 18 years (based on Trench 1996 & Ridgeway 2013)

A common thread in these figures is the decline of birds in Riparian Forest which has been considered above.

It is also interesting to see a reduction in Noisy Miners at Sawyers Reserve. Noisy Miners are an aggressive native bird responsible for widespread biodiversity declines. Between 1996 and 2013 their numbers substantially declined at Sawyers Reserve as native cover increased – demonstrating that improved native groundcovers and shrubs can help control this species.

Noisy Miners are an aggressive native bird responsible for widespread biodiversity declines. Between 1996 and 2013 their numbers substantially declined at Sawyers Reserve as native cover increased. Improving groundcover elsewhere at EMAI could similarly help control this pest.

Finches

The only finch common enough to be detected in our methodological bird surveys was Red-browed Finch, with 6 and 7 birds recorded in native and exotic grasslands respectively. The double-barred finch (*Taeniopygia bichenovii*) is still present but was not observed, while the Zebra Finch (*Taeniopygia guttata*) may be regionally extinct.

While Trench observed all three species in 1996 only the red-browed was recorded in his methodological surveys, making it difficult to quantify these declines. However in response to interview he noted:

> *'Finches of all sorts seem much less common than they used to be. The zebras, double bars and firetails were often seen in large flocks.'*

Waterbirds

Brian Trench and other locals also reported declines in waterbirds – particularly on Barragal Lagoon. Trench did not count waterbirds on Barragal Lagoon, however an earlier study in 1989 includes four waterbird counts. The waterbird counts from Barragal Lagoon in 1989 and 2013 are compared in Table 10. The late 1980s received average rainfall for Sydney but followed an extensive drought. Without longer term monitoring it is difficult to discern if waterbirds are declining on Barragal or not.

	8/04/1989	24/04/1989	9/05/1989	26/05/1989	14/10/2013	17/10/2013
Australasian grebe	2	2	1	3	1	3
Australian White Ibis					1	
Black Swan	2					
Black-fronted Dotterel		1	1			
Black-winged Stilt					5	5
Cattle Egret			54	6		
Chestnut Teal	2		5			
Eastern Great Egret					1	
Eurasian coot					1	26
Great (Black) Cormorant	2	2	6			
Great Egret						1
Grey Teal		12	2			
Hardhead					1	7
Hoary-headed Grebe					1	1
Little Black Cormorant	1		1			
Little Pied Cormorant	1		1	1		
Masked Plover	14	2				
Pacific Black Duck	2		16	34		1
Pelican			4	1		
Pied Stilt			1			
Straw-necked Ibis			2			7
White Egret		1				
White-faced Heron	2	1	1		1	2
White-necked Heron					1	1
Wood Duck	14		14	9		
Yellow-billed Spoonbill					4	4
Total waterbirds	42	21	109	54	17	58
Number of species	9	6	13	5	9	10

Table 10 – Comparison of waterbirds on Barragal Lagoon – 1989 and 2013

Raptors

Mick Starr was a passionate observer of the birds of prey at EMAI between 1998 and 2001, recording over 322 days of observation.

Figure 38 – A nest of Nankeen Kestrel near the laboratories – Mick Starr

In 2002-2003 Mick made particular study of the Nankeen Kestrel nest located southwest of the laboratories – a nest still in use during our survey in 2013. The nest hollow is located 6m from ground in a Forest Red Gum amongst native grassland/pasture. The prey was mostly small skinks (*Lampropholis* sp. - 87%) and House Mouse (*Mus domesticus* - 10%).

Between 1998 and 2001 Mick recorded 15 of the 24 Australian birds of prey at EMAI. Successful breeding species occurred in five species: Whistling Kite (*Haliastur sphenurus*), White-bellied Sea-Eagle (*Haliaeetus leucogaster*), Wedge-tailed Eagle (*Aquila audax*), Brown Falcon (*Falco berigora* - two pairs), and Nankeen Kestrel (*Falco cenchroides*).

The Wedge-tailed Eagles became new breeding residents midway through the study, siting their nest 1 km from the Sea-Eagles' nest. Both Eagle species nesting in woodland gullies, whereas Kite's, Falcons and Kestrels nested in open pasture.

The Whistling Kites at EMAI abandoned their nest-site after one year due to high rates of human activity – a reminder that the seclusion of EMAI is just as important for its wildlife as the physical habitat

The Whistling Kites at EMAI abandoned their nest-site after one year due to high rates of human activity – a reminder that the relative solitude of EMAI is just as important for its wildlife as the physical habitat of forests, grasslands and wetlands.

The abundance of each raptor at EMAI is summarized in Table 11 below. Further details for each raptor species are given in Table 12.

Species	*1998 (100)*	*1999 (72)*	*2000 (97)*	*2001 (53)*
Pacific Baza *Aviceda subcristata*	0	0.01	0	0
Black-shouldered Kite *Elanus axillaris*	0.03	0.22	0.03	0
*Whistling Kite *Haliastur sphenurus*	0.29	0.63	0.03	0.04
*White-bellied Sea-Eagle *Haliaeetus leucogaster*	0.46	0.53	0.18	0.13
Spotted Harrier *Circus assimilis*	0.01	0	0	0
Swamp Harrier *Circus approximans*	0.01	0	0	0
Brown Goshawk *Accipiter fasciatus*	0.03	0.24	0.14	0.04
Grey Goshawk *Accipiter novaehollandiae*	0.04	0.18	0.03	0.02
Collared Sparrowhawk *Accipiter cirrhocephalus*	0.04	0	0	0
*Wedge-tailed Eagle *Aquila audax*	0.32	0.60	0.45	1.51
Little Eagle *Hieraaetus morphnoides*	0.22	0.15	0.36	0.23
*Brown Falcon *Falco berigora*	0.64	1.06	0.89	0.66
Australian Hobby *Falco longipennis*[a]	0	0	0	0
Peregrine Falcon *Falco peregrinus*	0.05	0.21	0.04	0.02
*Nankeen Kestrel *Falco cenchroides*	0.28	0.90	0.66	1.11
Total	2.42	4.73	2.81	3.76

[a]One casual sighting outside survey times

Table 11 – Raptors observed at a 1600-ha agricultural site near Camden, N.S.W., 1998-2001. Figures given are number of sightings per observation day. For each year the number of observation days are given in parentheses. Species prefixed by * successfully bred during period. From Starr et al 2004.

In 2005 Mick Starr wrote a detailed report entitled 'Raptors on Camden Park' which comprises a daily journal rather than a summary of findings. Two entries are reproduced below as particular relevance to the wildlife of EMAI:

30-8-05.

I went in the afternoon with Kevin Rofe, the land manager for the Sydney Gas Company over some of the areas that they wish to establish wells in on the property that would infringe on the critical Raptor zones... we saw Kestrels, Black shouldered kites, Brown falcons & a Wedge-tailed Eagle & I pointed out numerous Raptor nest sites from previous years to him.

29-6-06

Whilst I was in the Turkey Dam area I noticed a disturbance amongst the noisy miner birds and on further observation I saw a Barking Owl being harassed by the miners, this was at 3-30pm in the afternoon on a sunny day so it may have been out to hunt very early, as I approached it flew from tree to tree until the noisy miners became to much for it & it flew off into the Barragal hills

Pacific Baza *(Aviceda subcristata)*	A single observation, possibly a vagrant. Bazas are rarely sighted though increasingly so in recent years. (Starr). No observations (Ridgeway)
Black-shouldered Kite *(Elanus axillaris)*	Infrequently sighted (Starr). One observation (Ridgeway)
Whistling Kite *(Haliastur sphenurus)*	Successful breeding activity was observed at a site that featured episodic periods of intense human activity in 1998 and 1999. In 2000 and 200 I, a pair was observed hunting over the same area. (Starr). Not observed (Ridgeway) - a concerning change
White-bellied Sea-Eagle *(Haliacetus leucogaster)*	One pair bred at the site in every year. Breeding occurred between July and December, with one or two young raised per year. The nest-site was in a secluded location near a large river. (Starr). One observation (Ridgeway), believed to be from same pair; breeding reported.
Spotted Harrier *(Circus assimilis)*	One sighting during the study period (Starr). Not observed (Ridgeway)
Swamp Harrier *(Circus approximans)*	One sighting during the study period (Starr). Not observed (Ridgeway)
Brown Goshawk *(Accipiter jasciatus)*	The most frequently seen accipiter, usually observed hunting or flying. (Starr). Not observed (Ridgeway) - possibly declining
Grey Goshawk *(Accipiter novaehollandicae)*	Sighted regularly in low numbers. Although no breeding activity was seen, it is noteworthy that a Brown Goshawk and a white-morph Grey Goshawk were observed in what appeared to be a courtship flight, behaviour seldom recorded between two species that rarely interbreed. (Starr). Not observed (Ridgeway) - possibly declining
Collared Sparrowhawk *(Accipiter cirrhocephalus)*	Sighted infrequently (Starr). Not observed (Ridgeway)
Wedge-tailed Eagle *(Aquila audax)*	Hunting behaviour was observed at the site throughout the observation period; Rabbits were the main prey item observed. In 2000 and 2001, successful breeding was observed for one pair. The nest-site was in a secluded location 1 km from the Sea-Eagles' nest. Breeding activity occurred between July and November of both years, with one or two young raised. (Starr). One observation; reported breeding (Ridgeway)
Little Eagle *(Hieraaetus morphnoides)*	One pair regularly sighted either hunting or flying/perching. Although nesting activity was not recorded, copulatory behaviour was observed once; mating took place on a fence post. (Starr). Not observed (Ridgeway)
Brown Falcon *(Falco berigora)*	Two established breeding pairs were observed, with nests approximately 2 km apart in areas of low human disturbance. Breeding occurred between October and January, with one or two young raised by each pair in each year. Hunting of reptiles, small mammals and insects was observed during the breeding period (Starr). Not observed (Ridgeway)
Australian Hobby *(Falco longipennis)*	Not seen during survey transects; one casual sighting (Starr). Not observed (Ridgeway)
Peregrine Falcon *(Falco peregrinus)*	Sighted infrequently (Starr). Not observed (Ridgeway)

Nankeen Kestrel (*Falco cenchroides)*	Sighted regularly, and one pair of birds nested in an area of low human disturbance. Breeding occurred between September and January, with three or four young raised each year (Starr). Not observed (Ridgeway)

Table 12 – Summary of raptors at EMAI. The findings from Starr (2004) are the result of 322 days over 4 years; the current survey featured just four days of observation and is very limited.

Birds of conservation concern

Australisian Pipit

The Australasian or 'Richards' Pipit is an inconspicuous bird of native grasslands and pasture. It is a regular migrant to Australia from breeding grounds in northern Asia.

Pipit numbers have severely declined in western Sydney due to increased housing development and the intensification of native pasture use (e.g. fertiliser addition or seeding). The small population at EMAI is of considerable value. It is one of the few populations near Sydney and of considerable interest to local and international birders

Figure 39 – Australasian Pipit – Akos Lumnitzer

Jacky Winter

The Jacky Winter was once a common bird throughout Sydney. It is a bird of rural grasslands and open woodlands. During preparation for the 2013 survey at least 4 individuals were observed during a drive-by at EMAI.

Previously common on farms the Jacky Winter was called 'Farmers Friend' due to its inquisitive nature and diet of insect and snails in cropping areas. It has two white bands beneath the tail which is 'wags' to startle its prey – a habit which make identification easy.

This is another bird disappearing from Sydney which takes refuge in EMAI as a large area of rural grasslands free from disturbance.

Figure 40 – Jacky Winter – Mark Fuller

The most significant and rare birds at EMAI are birds of native grassland and pasture. These birds rely on large areas of undisturbed habitat. Sustainable farm management considering the needs of native wildlife is just as vital for EMAIs wildlife as the restoration of bushland habitats

Peaceful Dove

The Peaceful Dove is a bird of fertile open woodland and heathy woodland. Like the previous species it is declining across the Sydney region. The only local record of Peaceful Dove in recent years was made during the 2013 survey at EMAI. This species should be monitored closely at the site.

Figure 41 – Peaceful Dove – Edwin Vella

Molluscs

The terrestrial snails are a key group of invertebrates in Cumberland Plain Woodland, responsible for decomposition and nutrient cycling as well as a key food source for other wildlife. Unfortunately all species are uncommon due to the lack of course woody debris. Structural woody debris is one of the most serious problems for EMAI wildlife. Stick picking is still undertaken by some ground staff and unauthorized firewood collection by staff on weekends is a recurrent concern. These activities should be phased out to allow the wildlife of EMAI to recover.

*Brown gardensnail *Helix aspersa* (Common)

The introduced garden snail is common across the site. This is a foliage-eating species, most prevalent in exotic pasture and crops but also found in Barragal Gully and other natural areas.

Figure 42 – Garden Snail – John Stanisic

Native Carnivorous Snail *Austrorhytida capillacea* (Uncommon)

As its name suggests this remarkable native snail preys exclusively on other snail species. It is easily identified by its remarkably flattened shell. It is only present where good woody debris and litter are present and suffers greatly from the activities of stick picking and firewood collection. Given a chance it does a great job controlling populations of the Gardensnail.

Figure 43 – Southern Carnivorous Snail

Cumberland Plain Land Snail *Meridolum corneovirens* (Rare)

This is probably not the 'rare shell' reported by Barrallier beside the lagoons on his passing through Camden Park in 1802. However early recorders fascination with native molluscs is remarkable.

Cumberland Plain Land Snails feed on rotting wood and fungi – they are key decomposers and do not take live foliage. The species is very uncommon on EMAI due mostly to stick picking and firewood collection.

Figure 44- Cumberland Plain Land Snail – Daryl McKay

Macgillivray's Ambersnail *Austrosuccinea macgillivrayi* (Uncommon)

A dark morph of Macgillivray's Ambersnail was recorded at Barragal Floor. This is a medium sized snail (to 15 m), short-lived (1 year) and typically found in ditches or swampy sites but occasionally in dry country.

Figure 45 - Macgillivray's Ambersnail – Greg Steenbeeke

Aquatic molluscs

Little is known of the aquatic snails of EMAI. Three species have been recorded in the past however a thorough survey of Barragal by an expert would be useful.

Weakly Toothed Pupasnail *Gastrocopta pediculus*

Recorded by the Australian Museum in 1941; probably common

Freshwater Snail *Gabbia vertiginosa*

Recorded by the Australian Museum in 1912; probably common

Freshwater Clam *Corbicula australis*

Recorded by the Australian Museum in 1958; probably common

Gordian Knot Worm *Gordius sp.*

This fascinating aquatic worm is known from an undated record at EMAI. Congregations of the worm often form dense 'knots' with many animals intertwined. This is a remarkable species worth reporting if found.

Flora of EMAI

It is impossible to separate the flora and fauna of EMAI and both rely on each other for their survival.

For this reason the survey dedicated some time to collecting available information on the general and the threatened flora of the site.

In particular we reviewed the Herbarium and anecdotal records of threatened flora. An excellent Accession Register is held at the Education Centre to accompany the physical herbarium.

Old records were chased down in the field to see if plants had survived – considerable time in particular was given to finding previous records of *Pommaderris brunnea* in the Riparian Forest. Sadly none of these plants could be found and it appears these sub-populations are now extinct (although a healthy population survives at Sawyers Reserve).

The result was for the first time comprehensive maps of the threatened flora at EMAI as shown inFigure 46and Figure 47.

General detail on the flora communities has been included in the EMAI Landscapes section at the beginning of this report.

An excellent but outdated summary of the vegetation of Sawyers Reserve and the Riparian Forest is provided in '*Elizabeth Macarthur Agricultural Institute, Camden Park - Nepean River remnant native vegetation management plan, Sawyers Reserve and Riverine Forest*' written by Peter Cuneo of Mt Annan Botanic Gardens.

The endangered population *Marsdenia viridiflora* has been historically collected at EMAI. However vines discovered in 2013 were subsequently found to be a native Parsonsia species.

Further survey for any surviving *Marsdenia viridiflora* on site would be warrented.

Figure 46 – Threatened flora map 1

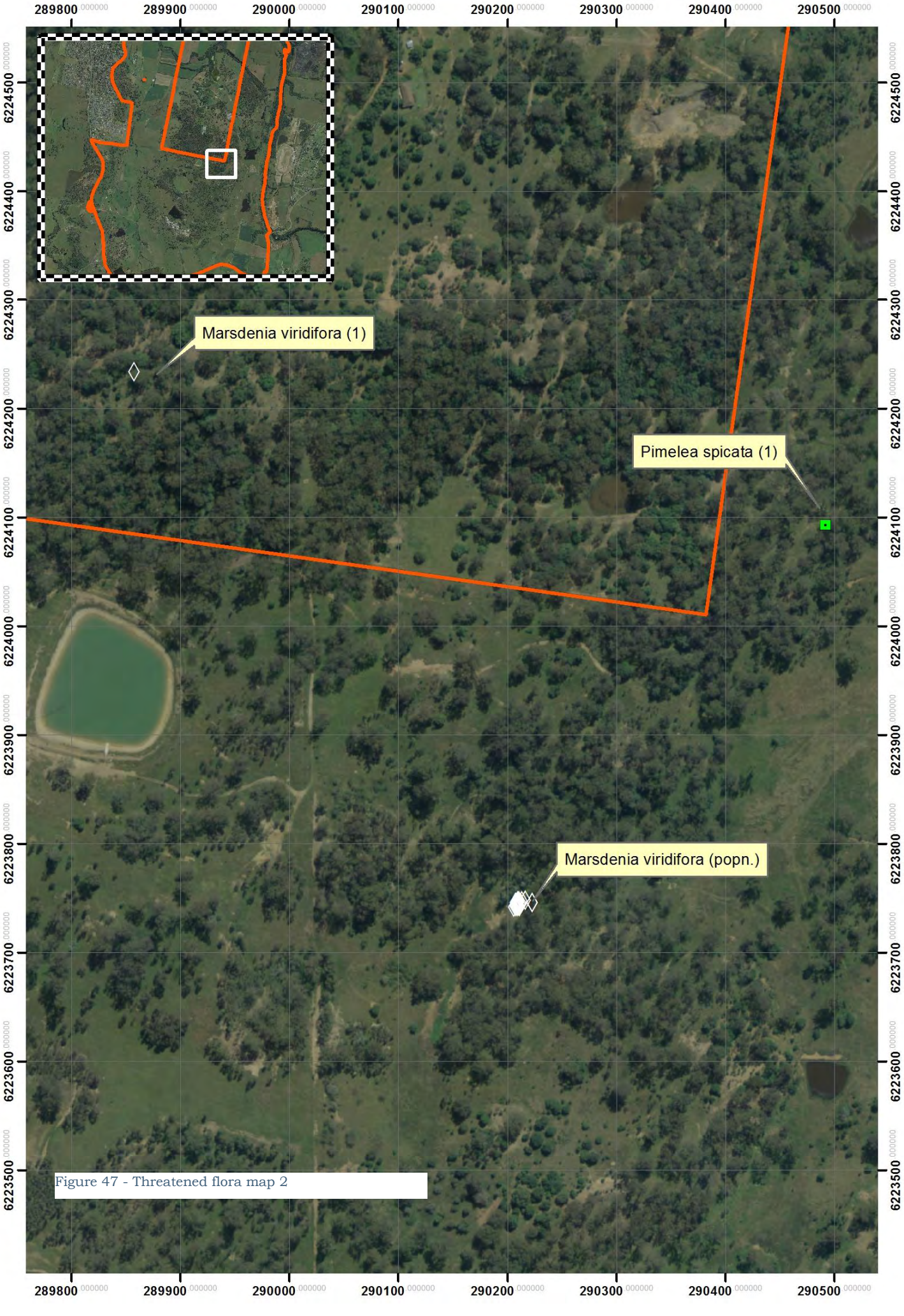


Figure 47 - Threatened flora map 2

Pimelea spicata

The Spiked rice-flower *Pimelea spicata* is a small endangered flower of grasslands and grassy woodlands. It is restricted to the Cumberland Plain and Illawarra.

This was once a common flower and common in early botanical collections but is now rare and most populations are very small (less than 5 individuals). Only two large (>5,000 plants) populations remain, one at Prospect Resevoir and the other at Camden Golf Club. The cause of this species decline is unclear, however woody thickening and fire exclusion may be key factors.

Figure 48 – The Spiked Rice Flower – a delicate part of our heritage

In 2013 a single plant was found at EMAI by bush regeneration contractors working above Barragal Floor. Despite their petite form *Pimelea spicata* are very long lived plants surviving underground as tubers for decades until favorable conditions return. The single plant appeared after grazing pressure was reduced and African Olive removed bringing light back to the groundcovers. The plant was fenced to exclude wallaroo and rabbit/hare grazing. Within months additional *Pimelea* plants had also appeared in the fenced area. This small enclosure will be monitored and hopefully expanded as additional plants are found.

Pommaderis brunnea

The Rufous Pommaderris *Pommaderis brunnea* is a medium shrub locally found in remnant Riparian Forest of the Nepean River and listed as Endangered in NSW.

The Herbarium at EMAI included specimens and collection notes from three populations at EMAI:

- Sawyers Reserve
- Nepean riverbank near riverbend paddock
- Bank of the Nepean River near Barragal

The Sawyers Reserve population is located opposite the Packing Shed. It has been mapped and appears in good health.

Extensive searches were undertaken of the Riverbend paddock surrounds in an attempt to relocate the population reported here. Unfortunately these plants appear to be extinct.

The Barragal riverside population was removed by sandmining in the 1970s.

Opportunities for wildlife recovery

As evidenced through this survey bushland regeneration alone is not sufficient to restore our native wildlife; neither can they survive by management of the 'woodland' remants alone. Existing government procecces and priorities do not support native wildlife. So what can be done?

This section outlines the challenges faced by EMAIs wildlife and some of the practical actions which offer potential to assist.

A common theme is managing agricultural activity for the benefit of wildlife - sustainable agriculture applied to the landscape as a whole. It is the management of EMAI as a property which will dictate the future of our wildlife heritage.

Firewood & stick picking

The Cumberland Woodlands are a grassy woodland environment, and more native species rely on the ground than on the trees. It is here that our efforts are most needed.

Fallen logs are critical for both food and shelter for the majority of native species. It should not be surprising that the greatest challenge for our wildlife is stick-picking and firewood collection.

At its peak there were 12 families living on EMAI in addition to staff living on Stanham's Camden Park estate. This has left a heavy legacy of firewood collection. However firewood collection continues today.

Stick-picking similarly remains a key behavioral problem. Through the early 1900s fallen timber was (incorrectly) considered to reduce pasture quality, harbor 'vermin' and pose a threat to stock, and government encouraged farmers to 'clean up' the pasture. Today we still struggle with this legacyWe now know that fallen timber is critical not only to native wildlife but also ***improves*** soil health. However staff continue to zeleously remove this important habitat. Changing this habit and re-spreading those habitat piles which remain will be a key challenge for EMAI if native wildlife is to recover.

Figure 49 - Stick picking and firewood collection are the single greatest threats to native wildlife

The importance of fallen timber for native wildlife is highlighted by recent work by Mulgoa Landcare.

> *'stick-picking and firewood collection destroys native wildlife… volunteers at Mulgoa have gone so far as helicoptering logs back into their reserve in a desperate bid to save their local wildlife from extinction'*

Mulgoa Nature Reserve has like EMAI been subject to historic firewood collection and stick-picking. As a result its native wildlife are declining and a number of key species have gone extinct.

In response local volunteers from the Cumberland Land Conservancy sought support from Sydney Helicopters Ltd in a bold plan to '*put the firewood back*'.

Monitoring by wildlife cameras suggests that the wildlife is already returning to Mulgoa as a result.

If firewood harvesting and stick-picking can be eliminated it would be suitable to consider similar

habitat log addition at EMAI. Hollow logs can be readily 'rescued' from the chippers of local tree surgeons, council collection depots, or local development sites. Programs are already underway in Mulgoa, Campbelltown, Edmondson Park, Wianamatta, and Cobbitty.

However before this will be of any benefit the current practices of firewood collection and stick-picking will need to be successfully reversed, and existing stick piles respread. It may also require sourcing commercial firewood sources to service staff cottages located on site.

Only after these practices are reversed can the damage of past years be addressed.

Figure 50 – Community volunteers helicopter logs into Mulgoa Nature Reserve in a desparate bid to save their local wildlife – Cumberland Land Conservancy

Pasture & grazing management

It is remarkable to read the early accounts of Camden Park with its luscious pastures of Weeping Grass brimming with wildlife (see History of EMAI Wildlife). However across much of EMAI the native pastures still remain.

The recovery of EMAI wildlife depends as much on these pastures as it does on the woodland areas, as so graphically demonstrated by the survey results. Paddocks of native pasture with scattered mature trees and hollow logs are home to almost as much native wildlife as Sawyers Reserve. And just as some species rely on the thicker habitat of Sawyers, there are remarkable and rare species found only in the open areas of the paddocks. If we are to recover wildlife at EMAI we must escape the mindset of dividing the site between 'bushland' and 'non-bushland' areas.

Thankfully with sustainable agricultural management there is no reason why much of the original wildlife – and virtually all the bird life – cannot be returned. The key to the recovery of the native grasslands lies not in bush regeneration but in agricultural management.

We have already seen the sobering story of the destruction of Navigation Woods by overstocking and ringbarking. There will always be pressure to increase production at EMAI and therefore pressure for overstocking. This is a key challenge for achieving sustainable agriculture at the site and saving the native wildlife.

Equally damaging is nitrification and seeding of exotic pasture. As shown graphically in the survey results, 'improved' pasture has ***less than half*** the biodiversity value of native pastures.

Native grasslands are also under threat from introduced grasses such as Rhodes Grass and Chilean Needle Grass. These weeds pose equal risk to both grazing and to wildlife.

The excellent condition of the native grasslands at EMAI is in most part due to the sympathetic low stocking rates under DPI management and professional farm hands with a concern for detecting and eradicating pest grasses. It is critical that these efforts continue to be supported to maintain healthy native pastures for both agriculture and wildlife.

Healthy pasture for wildlife:

- *Native pasture – not seeded and not nitrified*
- *Old trees & opportunity for seedlings*
- *Hollow logs and litter*
- *Patches of long grass – not overgrazed*
- *Weed grasses excluded and removed*
- *Maintain a large quiet rural landscape*

Figure 51 - The heritage flock grazing in remnant woodland

It would considerably benefit grazing management on EMAI to install a number of permanent vegetation monitoring quadrats. This will allows grazing pressure to be managed on a scientific basis in response to the conditions.

Healthy pasture managed by these principles is not only ideal for our native wildlife. It also describes a sustainable agricultural practice which maintains and enhances the cultural heritage of EMAI.

Fox control

Another key threat to wildlife is the European Red Fox. The fox has been responsible for a very large proportion of the wildlife species lost from western Sydney and without fox control our native wildlife has little hope.

Foxes are presently the second most abundant animal on EMAI. They comprised a staggering 12% of all animals observed by remote cameras. In 2013 there were an average 0.2 foxes observed per camera per night – a useful statistic for future reference.

Until recently foxes have been baited at EMAI each spring to coincide with the lambing season, with followup occasional shooting. While this was a great initiative its limited season means it offered little hope for native wildlife.

Today EMAI is a participant in the Menangle Fox Campaign coordinated by the Menangle Fox Control Group. This program assists landowners across the region with twice-yearly control options over a 1200 hectare control area. This program offers the best opportunities for effective fox control in the region.

Foxes and Olive

Contrary to popular belief foxes are not carnivores but omnivores. This adaptability has been key to their success in western Sydney. It also makes them all the greater threat to wildlife by allowing foxes to build up high densities even in times where animal food is short.

For most predators nature does not allow for the complete extermination of their prey. Instead as prey declines so do the predators, ensuring both predator and prey species survive. However omnivores can persist through lean times through vegetable foods, allowing them to eat the very last individual of prey species. This ability is called 'hyperpredation' and is seen to devastating effect with foxes in Western Sydney.

A particular complication with foxes is the impact of African Olive. Olive plants seed irregularly and generally in the summer months. Depending on conditions it can skip one or two years without significant 'mast' (fruit drop). In a key 'mast' year African Olive fruits cover the ground, often forming a dense layer 4 – 6 mm thick.

'Foxes not only destroy wildlife and stock. They also appear to be the principle distributor of African Olive seed – another reason for prioritizing year-round control'

Foxes are one of the few species to eat these berries and they gorge on Olive berries. Studies in Western Sydney Parklands are indicating that fox densities can be as much as 80% greater in areas with Olive than without. This vegetable food source allows 'hyperpredation' – and means that foxes can kill even more native wildlife than they would in the absence of Olive.

Foxes are also key in spreading African Olive, and are one of the primary distributors of Olive seed. These are all further reasons for the priority control of the fox.

Figure 52 - The adaptable fox. This remarkable animal was photographed in the upper branches of gum tree at Barragal Floor

At EMAI a large proportion of the fox diet is African Olive fruit. By contrast fruit-eating birds are relatively uncommon. They comprised (in respective habitats) 6% (improved pasture), 10% (Sawyers), 17% (native pasture) and 50% (Riverflat Forest) of the total bird fauna. It is likely that foxes are key to the distribution of this key weed.

The continuing presence of vast areas of African Olive at Camden Park is therefore a challenge for the effective control of foxes at EMAI.

Foxes and rabbits

The current management realizes that the fox can be a valuable controller of rabbit numbers. For this reason rabbit baiting is usually timed to coincide with fox control.

The wildlife survey has demonstrated that rabbits are relatively uncommon at EMAI thanks to this work. However their close relative the Hare is quite common. This is likely to be due in part to the rabbit baiting efforts.

Future fox baiting should continue to be coordinated with both rabbit and hare control

Woody Weeds

This introduction of African Olive in the Cumberland Plain has been detailed in the history section of this report.

Impact of woody weeds on wildlife

Weed species are not created equal and most introduced plants have neglibable impact on the environment and wildlife. However a small number of weed species have devastating impact at a landscape scale. The impact of woody weeds in the Cumberland Plain falls into this category. These devastating species are commonly termed 'ecosystem transforming weeds'.

The key impact from these weeds is not their competition with native species but the change in vegetation structure they create. In western Sydney large areas have been transformed from open grassy woodlands to dense rainforest by these weeds. This has staggering consequences for wildlife.

Native plants and animals are strongly adapted to habitat structure. Western Sydney's unique species are almost all grassy woodland specialists (although there are also species specializing in Riparian Forest). As Olive invades grassy woodlands these species simply cannot cope. For example the Scarlet Robin and Jacky Winter both feed on the ground – and disappear entirely as grassy woodland transitions into shrubby forest.

Olive's 'woodland-to-rainforest' transition has also allowed new opportunistic wildlife to move in. This change is almost entirely restricted to the birds – as mammals, reptiles and frogs do not have the ability to recolonize from further afield. In the Cumberland Plain the Bowerbird is a classic example of this effect, having quickly established in many areas of Olive which mimick its rainforest home.

It is important to note that these changes to wildlife are not simply adaptation but rather a net loss. Woodland birds rely on woodlands and the march of Olive is resulting in heavy losses in the *uniqueness* and *diversity* of our wildlife. While in theory the the *abundance* of wildlife may be maintained studies have shown that very few native species use Olive habitat.

Climate, CO_2 and Woody Thickening

An obvious question which is rarely voice is why the Cumberland Plain's most aggressive weeds are all shrubs – Olive, Gleditsia and Privet in particular. This is not coincidental.

The conversion of grasslands and grassy woodland into shrubland communities is an emerging global phenomenon. This 'Woody Thickening' is well studied overseas but has been given surprisingly little attention in Western Sydney to date.

The principle cause of woody thickening overseas is atmospheric carbon. This is not the result of climate change *per sec* (i.e. temperature) but a *direct* response to the vastly increasing proportion of carbon in the atmosphere. In nature grasses and shrubs are in constant competition for the dominance. However these plant groups' process carbon dioxide using quite different biochemical processes. As it happens shrubs are more efficient in photosynthesizing at elevated carbon levels compared to grasses. As a result the more carbon is present in the atmosphere the more shrubs can dominate ecosystems – independent of any changes to climate which may additionally result.

This is bad news for grassy woodlands. It is especially bad news in the Cumberland Plain where a temperature inversion traps Sydney's pollution resulting in far greater local increases to atmospheric carbon than background (global) increases.

Unfortunatly there is nothing that property managers can do to combat woody thickening directly. However by recognizing the process and targeting woody weed control we can maintain a healthy landscape into the future.

Woody thickening applies to both native and exotic plants. At present EMAI is working to remove exotic woody weeds which will remain a key focus into the future. For now most habitats at EMAI have too few rather than too many native shrubs (as a result of past grazing practice). However it is possible that in the future intervention will be required to 'open up' formerly grassy areas which become overly dominated by shrubs. This is especially relevant with the native shrub *Bursaria spinosa* which can form inpenetrable thickets and result in biodiversity decline.

Fire

The Cumberland Plain Woodland community has evolved under a natural fire regime and persisted under relatively similar cultural fire regimes over recent times. The first tens-of-thousands of years of human management of the Cumberland Plain provided relatively amenible fire regimes. This allowed wildlife to continue to live much as it always had. However like most agricultural properties fire has been generally excluded from EMAI over the last 200 years.

For many wildlife species fire is key in providing a flush of new growth and in managing vegetation structure and woody thickening. The absence of fire can be just as devastating as it's overuse.

Establishing fire at EMAI and ensuring the best fire regime will be a key challenge for future management, especially with encroaching urban areas.

How frequent?

Cumberland Plain Woodland has evolved to require a fairly frequent (10-12 year) fire interval. More frequent fire does not allow sufficient time for some plants and animals to breed and recolonize burnt areas; less frequent fire allows a small number of species to dominate the community and reduces biodiversity of flora (e.g. orchids & lilies) and fauna (e.g. many woodland birds).

Burns also need to be patchy to provide flora and fauna refuge and provide a 'mosaic' pattern. This means that achieving a 10-12 year fire interval at EMAI requires small burns (in different spots) on at least an annual basis.

Wombats & Mange

The 2013 survey highlighted the heavy decline of wombats at EMAI over recent decades. Typically considered a common or pest species the wombat is in serious trouble in Western Sydney.

Wombats were common throughout the Cumberland Plain until quite recent times. Old burrows can stil be seen in both Cumberland Plain Woodland and Riparian Forest. However over recent years wombats have retreated to the more favoured habitat of Riparian Forests.

A key factor in these declines appears to be the disease Sarcoptic Mange, introduced to Australia by dogs and now spread by foxes. Sarcoptic mange is a mite bourne bacterial disease which causes a loss of fur, reduced health and reproduction and ultimately death. At EMAI it has been observed in foxes, wallabies and in wombats.

The disease is readily treated by the application of Cyvectin administered automatically from 'burrow flaps' installed outside dens. There is currently a treatment program operating at Camden Airport a few kilometers downstream of EMAI. Treatment appears to be effective for some years where undertaken thoroughly by targeting each burrow over a period of 6 months.

Consideration should be given to a potential mange control program at EMAI in the future.

A second problem for wombats is the increasingly scarce native vegetation along the river. Woody weeds have choked the river for decades however over the last two decades the remaining native patches have reduced substantially. Wombats cannot survive in this last refuge unless woody weed control is undertaken to maintain the grassy riverflat habitats.

Figure 53 – A mange affected wombat – B. Levot

Figure 54 – A healthy wombat – B Levot

Restoring Riparian Forest

Both the flora and the fauna survey highlighted that the Riparian Forest ('Macarthur Forest') has remarkable biodiversity value. With recovery it has the potential to be one of the most important wildlife habitats in western Sydney

Sadly the comparison with past surveys revealed that despite the forest being in poor condition for some decades it can and indeed has declined. Over the last 20 years this site has experienced the most biodiversity decline of any habitat at EMAI. Key species of concern are riparian birds, wombats and *Pommaderris brunnea* – the latter two species being close to extinction at EMAI.

To date restoration at EMAI has focused on the woodland and grassland habitats and is progressing well. It is critical to not compromise the success of these programs; nonetheless the restoration of the riverflat should be a key future priority.

The riverbank has been largely abandoned since the restoration work at Sues Track in the 1980s to 1990s. A restoration plan was commissioned with the Royal Botanic Gardens in the 1990s however its recommendations were never implemented

Despite the high proportion of weeds in the understorey layer, there is significant native species diversity remaining in Macarthur Forest, particularly around Sue's track where previous weed control has taken place. There are also several species of flora which are very uncommon and could soon be lost permanently, including *Commersonia fraseri*, *Backhousia myrtifolia*, *Duboisia myoporoides* and *Goodenia ovata*. These plants should be located and form the centre of any restoration work before this diversity is lost forever.

Of particular concern in this context is the wombat. Wombats have already disappeared from other habitats on site and the Riparian Woodland is their last stand. As the last native flora die out under a canopy of woody weeds there is progressively less food available for wombats.

> *'...despite the Macarthur Forest being in poor condition for generations the last 20 years have seen the riverflat experience the greatest biodiversity decline of any habitat at EMAI… some action to at least halt the loss of key species here should be a priority.'*

Figure 55 – Native Hymenanthera dentata and Passiflora herbertiana at the Sue's Track

It would not be advisable to draw effort away from the excellent volunteer and contractor work targeting woody weeds at EMAI. For this reason it is recommended that options be investigated for bush regeneration contractors to operate independently in the Riverflat on a small scale as part of a long-term restoration vision.

Recovering the heritage wetlands

The wetlands of Barragal and Menangle are a remarkable part of EMAIs heritage. The early reports of these wetlands describe vast beautiful, lush grasslands and sedgelands filled with waterbirds and wildlife (refer the history section of this report).

There is no doubt these were amongst the most beautiful aspects of Camden Park's heritage; and as previously discussed the Macarthur family responded by protecting these wetlands and prohibiting the shooting of waterbirds.

The wetlands have been the subject of considerable restoration effort since the 1970s some well-guided and some less so. Nonetheless they remain far from their former glory. The wetlands which supported hundreds of waterbirds and once filled the sky today support only dozens at best.

Restoring these wetlands to their former glory would be a remarkable achievement for the heritage of EMAI. In order to do so we need to understand the nature of Cumberland wetlands and what went wrong to Barrigal.

Temporary wetlands

Historic reports are very clear that Barragal and Menangle were not single, permanent ponds but series of wetlands which expanded and contracted on a regular basis in response to rainfall.

These descriptions agree with our current understanding of wetland requirements for waterbirds – especially for migratory waterbirds. Many of these species have a strong preference for very large extensive shallows which temporarily collect during suitable conditions.

The remarkable wetlands which so inspired early settlers are ***not*** the present outlines of Barragal and Menangle 'ponds'. These ponds are all that remains of much larger wetlands in what is now the extensive grazing areas which surround them. Understanding this is critical to any attempt to return the waterbirds to EMAI.

It is only by restoring temporary flooding these shallow flats that the magnificence and heritage of these wetlands can be restored.

Key actions for recovering the wetlands:
- containing silt from the borrow pit
- plugging the Menangle and Barragal drains
- removing waterside tree plantings so waterbirds can return
- enforcing stock exclusion

Draining

At an unknown date both 'Barragal' and 'Menangle' wetlands were partially drained to the river. While these drains are now overgrown when inspected in 2013 they were still functional.

As long as these drains remain the lagoons will remain small and permanent – rather than large and temporary as wildlife requires. Plugging the drains is not expensive, and flooding of the wetlands would not necessarily exclude cattle grazing. Replugging the drains would be necessary if these wetlands are to be restored.

Sedimentation

A secondary problem for the wetlands has been sedimentation. Brian Trench (1996) provides a detailed account of this problem:

> '*Barragal lagoon collects run-off from a relatively small catchment within the property boundary. This catchment has suffered from many years of overgrazing causing soil structural decline and consequent loss of topsoil. This soil has collected in the lagoon, silting it up so that a once extensive wetland habitat consisting of around 4 ha of sedgeland and shallows and 2 ha of deeper water now consists of 0.1 ha of shallow water surrounded by silted, compacted and completely bare banks, a small area of sedge and approximately 5 ha of very poor grazing land dominated by scotch thistle and couch grass. Only 1 km of fencing is required to fence off the whole lagoon, including the flats which are awash for a short time each year (three sides are already fenced). Silt removal will be necessary to restore depths to the original variety*'

Figure 56 - Barragal Lagoon during grazing circa 1987

Reshaping the lagoon by removal of the accumulated silt is a potential future action and has been successfully undertaken elsewhere in Sydney by National Parks and Local Land Services. This is a considerable enterprise and would require good planning and grant investment. Nonetheless this opportunity should not be overlooked.

Grazing

Subsequent to Brian Trench's report the immediate surrounds of Barragal lagoon were fenced. This has assisted in controlling cattle-induced erosion however the practice has not ceased. During the 2013 survey stock were observed feeding on and in the water in the fenced area. Improved enforcement of this as a stock exclusion area would greatly assist the wetlands recovery.

Containing the borrow pit

As previously mentioned the borrow pit is a major source of salinity and sediment to Barragal lagoon. This is an obvious area for potential improvement. Salinity is unlikely to be as great a threat to waterbirds as sedimentation.

The simplest way to contain the burrow pit will be to plug the walls similar to commercial dam containment works (e.g. by bentonite). This will result in occasional flooding of the pit. To address this

problem a hose would be required to pipe floodwater into the Nepean where dilution would avoid any serious salinity concerns. A longer-term solution would be to install a pit and drain in the base of the borrow pit to serve this purpose.

Salinity and pH

Salinity and pH are potential problems for both lagoons. Barragal lagoon lies immediately below a shale borrow pit which acts as a source of salt and fine sediment.

The 2013 study made repeat-measure samples of salinity in Barragal and Menangle lagoon. The lagoons measured between 550 – 680 µ S/cm, compared to a baseline of 150 – 170 µ S/cm in the River (itself saline due to erosion of shale soils and influx of saline effluent).

Brian Trench also raised concern over low pH and recommended monitoring and treatment if necessary. There is the potential for aluminium toxicity if this is not addressed.

Salinity and pH monitoring should be continued at both wetlands and if necessary remedial actions taken. This is a relatively cheap and simple problem to resolve compared to other problems at these lagoons.

The problem of the plantings

Brian Trench and Sue Rose both recommended tree plantings around Barragal lagoon. A number of tree plantings occurred at Barragal and Menangle lagoon between 1986 and 1991, led by Sue Rose and Dianne Blore.

These plantings were undertaken to assist native wildlife and took considerable effort and consideration. Sue Rose is reported to have spent days sitting at Barragal Hills watching waterbirds land and take off to ensure that plantings '*did not interfere with their flight paths*'.

Unfortunatly these tree plantings near the lagoon are likely to have substantially reduced wetland birds visiting the site – especially the migratory waders.

This same problem was observed at Sydney Olympic Park where extensive tree planting was undertaken beside lagoons in 1998. Thanks to regular bird monitoring it was quickly discovered that waterbirds did not return to areas fringed by the growing trees. It appears that trees block the line-of-sight which wading birds use to detect the approach of predators such as foxes. For this reason wading waterbirds avoid lagoons with fringing trees.

Recommended setbacks between vegetation and wetland birds are shown below.

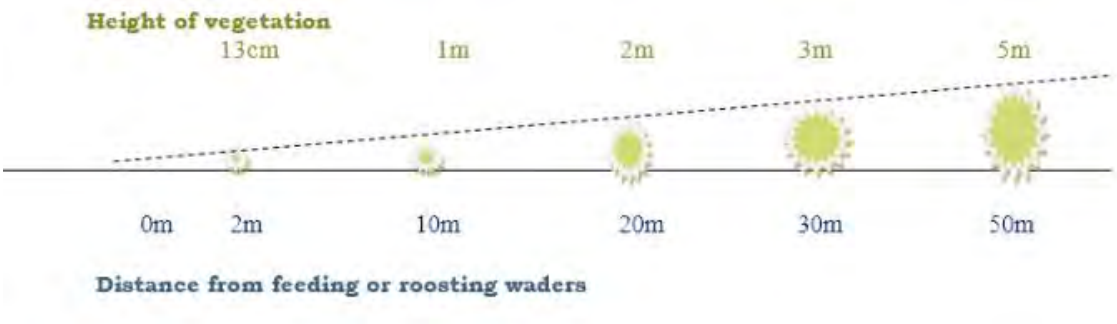


Figure 57- Recommended vegetation offset from wader habitat, adapted from Lawler (1996)

The tree plantings at Barragal and Menangle are over 5 m high and less than 10 m from the edge of the current 'pond' areas (and within the waterline of the original wetland boundaries). This is a serious limitation to wading birds using the site.

The vegetation planted is not local provenance and does not have high botanical value. It is also a major problem for the wetland birds of the Barragal and Menangle lagoons. However as the plantings are the result of effort by community volunteers working to restore the natural areas of EMAI some sensitivity is required in their management.

Serious consideration should be given to removing these plantings pending discussion with staff and local community to explain the issue.

If support is found to remove the trees it is worth noting that the effort to plant and grow them need not be in vain. Barragal and Menangle lagoon both lack fallen timber – a resource which wading birds favor. These tree would provide an ideal source of timber to spread through the grassland and in the water for waterbird use. This would substantially increase not only bird but also frog numbers in these wetlands, and ensure the legacy of restoration at this site is respected.

Potential Wetland Plan of Management

Any coordinated recovery of the wetlands will require some direction and expertise.

A *Plan of Management for Wetland sites on EMAI; Barragal Lagoon, Menangle Pond and Navigation Creek* was previously undertaken by Liza Schaeper (IRP Environmental Consultants) and Geoff Sainty (Sainty & Associates) in 2008. However this plan was generic and did not call on the specific expertise needed to deal with the wetlands particular problems (e.g. salinity, pH, hydrology and wading birds).

If there is management and community support for the broader restoration of these wetland areas it is recommended that a Technical Wetland Restoration Plan be developed incorporating geological, hydrological and wading bird expertise.

Summary

Significant improvements can be made to these wetlands to return their former wildlife and historical heritage. Little to no cost is required to plug the old drainage channels. And while other restoration activities will require coordination and external funding to ensure success it is possible, practical and desirable to restore these wetlands to their former glory.

Conclusion

The EMAI property contains amongst the best wildlife remaining in Western Sydney. The diversity and abundance of this wildlife if the result not of the bushaland 'remnants' but primarily by the large area of sustainably managed native pastures and open space.

With increasing suburban development the key challenge for the wildlife of EMAI is to maintain a large, undisturbed rural area in which they are free to live their lives. In an age where the pressure to 'use' land is growing it is likely that there will be considerable pressure for intensive land management at EMAI.

The future for this wildlife lies in the staff and managers of the EMAI institute. I hope that by opening a window on the fascinating lives of the local wildlife I can add in some some way to their future through sympathetic and sustainable management.

It is perhaps best to end with a quote from Mick Starr who grew up on EMAI and developed a life-long passion for its wildlife. He writes:

> *'During my lifetime I have seen a great amount of urban development... large tracts of bush removed forever along with the habitats of the birds and animals... It may well be wise for man to rethink, and instead of changing the environment to suit his needs, tailor his needs to suit the environment... I place before you The Eagles Cry in the hope that you too will look to the skies and see these magnificent birds and do what you can to see [them] receive the utmost protection:*

If you take the time to look skywards

You will see me-soaring high above,

You will hear and understand my cry for help.

Hopefully, you will respond before it's too late.

I need protection as never before,

For I am an eagle

Mick Starr, 2005

Where will EMAIs wildlife be in 20 years' time? The answer lies with us

Species Lists

Birds

Common Name	Scientific Name	Status/Last Observed
Yellow-rumped Thornbill	Acanthiza chrysorrhoa	
Yellow Thornbill	Acanthiza nana	
Brown Thornbill	Acanthiza pusilla	
Eastern Spinebill	Acanthorhynchus tenuirostris	Tench 1996; in laboratory gardens
Brown Goshawk	Accipiter fasciatus	
Indian Myna	Acidotheres tristis	Tench 1996; in pasture
Australian Reed-warbler	Acrocephalus australis	
Australian Owlet-nightjar	Aegotheles cristatus	
Azure Kingfisher	Alcedo azurea	Tench 1996
Australian King-Parrot	Alisterus scapularis	
Chestnut Teal	Anas castanea	
Grey Teal	Anas gibberifrons	Tench 1996
Pacific Black Duck	Anas superciliosa	
Red Wattlebird	Anthochaera carunculata	
Australian Pipit	Anthus novaeseelandiae	
Fork-tailed Swift	Apus pacificus	Tench 1996
Wedge-tailed Eagle	Aquila audax	
Great Egret	Ardea alba	
Cattle Egret	Ardea ibis	Tench 1996
Eastern Great Egret	Ardea modesta	
White-necked Heron	Ardea pacifica	
Dusky Woodswallow	Artamus cyanopterus	
Hardhead	Aythya australis	
Bush stone-curlew	Burhinus grallarius	Regionally extinct (2007)
Sulphur-crested Cockatoo	Cacatua galerita	
Galah	Cacatua roseicapilla	Tench 1996
Little Corella	Cacatua sanguinea	
Long-billed Corella	Cacatua tenuirostris	
Fan-tailed Cuckoo	Cacomantis flabelliformis	
Pallid Cuckoo	Cacomantis pallidus	
Brush Cuckoo	Cacomantis variolosus	
Sharp-tailed Sandpiper	Calidris acuminata	

White-throated Nightjar	Caprimulgus mystacalis	Tench 1996
Shining Bronze-cuckoo	Chalcites lucidus	
Australian Wood Duck	Chenonetta jubata	
Golden-headed cisticola	Cisticola exilis	
Grey Shrike-Thrush	Colluricincla harmonica	
Black-faced Cuckoo-shrike	Coracina novaehollandiae	
White-winged Chough	Corcorax melanorhamphos	
Australian Raven	Corvus coronoides	
Brown Quail	Coturnix ypsilophora	
Australian Magpie	Cracticus tibicen	
Grey Butcherbird	Cracticus torquatus	
Black Swan	Cygnus atratus	Tench 1996
Laughing Kookaburra	Dacelo novaeguineae	
Mistletoebird	Dicaeum hirundinaceum	
Emu	Dromaius novaehollandiae	Moloney 1929; regionally extinct
White-faced Heron	Egretta novaehollandiae	
Black-shouldered Kite	Elanus axillaris	
Black-fronted dotterel	Elseyornis melanops	
Galah	Eolophus roseicapillus	
Eastern Yellow Robin	Eopsaltria australis	
Dollarbird	Eurystomus orientalis	
Brown Falcon	Falco berigora	
Nankeen Kestrel	Falco cenchroides	
Australian Hobby	Falco longipennis	
Eurasian coot	Fulica atra	
dusky moorhen	Gallinula tenebrosa	
Bar-shouldered Dove	Geopelia humeralis	
Peaceful Dove	Geopelia striata	
Crested Pigeon	Geophaps lophotes	Tench 1996
White-throated gerygone	Gerygone albogularis	
Brown Gerygone	Gerygone mouki	
Musk Lorikeet	Glossopsitta concinna	
Magpie-Lark	Grallina cyanoleuca	
Brolga	Grus rubicunda	Moloney 1929; regionally extinct
Sacred Kingfisher	Halcyon sancta	Tench 1996
White-bellied Sea-eagle	Haliaeetus leucogaster	
Black-winged Stilt	Himantopus himantopus	

Welcome Swallow	Hirundo neoxena	
White-eared Honeyeater	Lichenostomas leucotis	Tench 1996
Yellow-faced Honeyeater	Lichenostomus chrysops	
White-plumed honeyeater	Lichenostomus penicillatus	
Chestnut-breasted Mannikin	Lonchura castaneothorax	Tench 1996
Superb Fairy-wren	Malurus cyaneus	
Noisy Miner	Manorina melanocephala	
Bell Miner	Manorina melanophrys	
Lewin's Honeyeater	Meliphaga lewinii	
Jacky Winter	Microeca fascinans	
Scarlet Honeyeater	Myzomela sanguinolenta	
Red-browed Finch	Neochmia temporalis	
Southern Boobook	Ninox boobook	
Barking Owl	Ninox connivens	Mick Starr 2006 Turkey Dam
Nankeen Night Heron	Nycticorax caledonicus	
Crested Pigeon	Ocyphaps lophotes	
Olive-backed Oriole	Oriolus sagittatus	
Sparrow	Pacer domesticus	Tench 1996
Golden Whistler	Pachycephala pectoralis	
Rufous Whistler	Pachycephala rufiventris	
Spotted Pardalote	Pardalotus punctatus	
Striated Pardalote	Pardalotus striatus	
Australian Pelican	Pelecanus conspicillatus	Tench 1996
Fairy Martin	Petrochelidon ariel	
tree martin	Petrochelidon nigricans	
Little Pied Cormorant	Phalacrocorax varius	Tench 1996
Noisy Friarbird	Philemon corniculatus	
Yellow-billed Spoonbill	Platalea flavipes	
Royal Spoonbill	Platalea regia	
Crimson Rosella	Platycercus elegans	Tench 1996
Eastern Rosella	Platycercus eximius	
Tawny Frogmouth	Podargus strigoides	
Hoary-headed Grebe	Poliocephalus poliocephalus	
Purple Swamphen	Porphyrio porphyrio	Tench 1996
Red-rumped Parrot	Psephotus haematonotus	
Whipbird	Psophodes olivaceous	Tench 1996
Eastern Whipbird	Psophodes olivaceus	

Satin Bowerbird	Ptilonorhynchus violaceus	
Red-whiskered Bulbul	Pycnonotus jocosus	
Grey Fantail	Rhipidura albiscapa	
Willie Wagtail	Rhipidura leucophrys	
Rufous fantail	Rhipidura rufifrons	
Channel-billed Cuckoo	Scythrops novaehollandiae	
White-browed Scrubwren	Sericornis frontalis	
Weebill	Smicrornis brevirostris	
Pied Currawong	Strepera graculina	
Spotted Turtle-Dove	Streptopelia chinensis	
Common Myna	Sturnus tristis	
Common Starling	Sturnus vulgaris	
Australasian grebe	Tachybaptus novaehollandiae	
Double-barred Finch	Taeniopygia bichenovii	Tench 1996
Zebra Finch	Taeniopygia guttata	Tench 1996
Australian White Ibis	Threskiornis molucca	
Straw-necked Ibis	Threskiornis spinicollis	
Sacred Kingfisher	Todiramphus sanctus	
Rainbow Lorikeet	Trichoglossus haematodus	
Eurasian blackbird	Turdus merula	
Barn Owl	Tyto alba	Tench 1996
Masked Lapwing	Vanellus miles	
Banded Lapwing	Vanellus tricolor	Tench 1996
Silvereye	Zosterops lateralis	

Mammals

Common Name	Scientific Name	Current Abundance or last record
Monotremes		
Short-beaked Echidna	*Tachyglossus aculeatus*	Moderately common
Platypus	*Ornithorhynchus anatinus*	Community reports (2003); unconfirmed
Marsupials (General)		
Common Brushtail Possum	*Trichosurus vulpecula*	Common
Common Ringtail Possum	*Pseudocheirus peregrinus*	Uncommon
Feathertail Glider	*Acrobates pygmaeus*	Shot by 'Charles Starr' (undated) - species of concern
Sugar Glider	*Petaurus breviceps*	Common across site
Squirrel Glider	*Petaurus norfolcensis*	WIRES 1990s; now regionally extinct
Greater Glider	*Petauroides volans*	Regionally extinct
Yellow-bellied Glider	*Petaurus australis*	Regionally extinct
Koala	*Phascolarctos cinereus*	Moloney 1929; regionally extinct
Common Wombat	*Vombatus ursinus*	In decline; now restricted to riparian areas
Dasyurids		
Thylacine	*Thylacinus cynocephalus*	Extinct
Brush-tailed Phascogale	*Phascogale tapoatafa*	Regionally extinct. Shot on site in 1820 by Arthur Onslow, and lodged with Australian Museum
Spotted-tailed Quoll	*Dasyurus maculatus*	Kris Riley 2010; occasional visitor
Eastern Quoll	*Dasyurus viverrinus*	Regionally extinct since 1940
Antechinus	*Antichinus sp*	Regionally common until 1990; now regionally extinct
Dunnart	*Sminthopsis murina*	Regionally common until 1940; now regionally extinct
Macropods		
Common Wallaroo	*Macropus robustus*	Very common
Eastern Grey Kangaroo	*Macropus giganteus*	Very rare
Swamp Wallaby	*Wallabia bicolor*	Occasional across site

Brush-tailed Bettong	*Bettongia penicillata subsp. penicillata*	Barrallier 1802; regionally extinct
Long-nosed Bandicoot	*Perameles nasuta*	Rose 1990; in Bamboo opposite sawyers; now regionally extinct
Monotremes		
Bush Rat	*Rattus fuscipes*	Regionally common until 1990; now regionally extinct
Rakali (Water Rat)	*Hydromys chrysogaster*	Unknown; priority for survey
Grey-headed Flying-Fox	*Pteropus poliocephalus*	Occasional
Microbats		
Large-eared Pied Bat	*Chalinolobus dwyeri*	Occasional
Gould's Wattled Bat	*Chalinolobus gouldii*	Very common
Chocolate Wattled Bat	*Chalinolobus morio*	Occasional
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	Rare
Little Bentwing-bat	*Miniopterus australis*	Occasional
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	Rare
Eastern Freetail-bat	*Mormopterus norfolkensis*	Occasional
Gould's Long-eared Bat	*Nyctophilus gouldi*	Very common
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	Occasional
Greater Broad-nosed Bat	*Scoteanax rueppellii*	Rare
Eastern Broad-nosed Bat	*Scotorepens orion*	Rare
White-striped Freetail-bat	*Tadarida australis*	Common
Little Forest Bat	*Vespadelus vulturnus*	Rare
Introduced Species		
*Black Rat	*Rattus rattus*	Rare
*Cat	*Felis catus*	Occasional

*Fox	*Vulpes vulpes*	Abundant
*Rabbit	*Oryctolagus cuniculus*	Occasional
*Brown Hare	*Lepus capensis*	Abundant
*Pig	*Sus scrofa*	Rare visitor
*Goat	*Capra hirsus*	Rare visitor
*Fallow Deer	*Dama dama*	Rare visitor

Frogs

Common Name	Scientific Name	Current Abundance or last record
Common Eastern Froglet	*Crinia signifera*	Abundant
Green Tree Frog	*Litoria caerulea*	Rare
Eastern Dwarf Tree Frog	*Litoria fallax*	Abundant
Lesueur's Frog	*Litoria lesueuri*	Rare
Peron's Tree Frog	*Litoria peronii*	Very common
Tyler's Tree Frog	*Litoria tyleri*	Rare
Verreaux's Frog	*Litoria verreauxii*	Rare
Smooth Toadlet	*Uperoleia laevigata*	Rare

Reptiles

Common Name	Scientific Name	Current Abundance or last record
Eastern Snake-necked Turtle	*Chelodina longicollis*	Common
Bearded Dragon	*Pogona barbata*	Common
Lace Monitor	*Varanus varius*	Common
Dark-flecked Garden Sunskink	*Lampropholis delicata*	Common
Pale-flecked Garden sunskink	*Lampropholis guichenoti*	Common
Water Dragon	*Physignathus lesueurii*	Rose 1990; common along river; unknown
Red-bellied Black Snake	*Pseudechis porphyriacus*	Common near water
Eastern Brown Snake	*Pseudonaja textilis*	Uncommon
Red-naped Snake	*Furnia diadema*	Rare
Scaly-foot (Legless Lisard)	*Pygopus lepidopodus*	Rose 1989; found during earthworks; unknown status
Whip Snake	*Demansia psammophis*	Moloney 1929 - may still be present
Green Tree Snake	*Dendrelaphis punctulatus*	Moloney 1929; regionally extinct
Tiger Snake	*Notechis scutatus*	Moloney 1929; regionally extinct
Diamond Python	*Morelia spilota*	Moloney 1929 - may still be present

Invertebrates

Common Name	Scientific Name	Current Abundance or last record
*Brown gardensnail	*Helix aspersa*	Uncommon
Native Carnivorous Snail	*Austrorhytida capillacea*	Uncommon
Cumberland Plain Land Snail	*Meridolum corneovirens*	Uncommon
Macgillivray's Ambersnail	*Austrosuccinea macgillivrayi*	Greg Steenbeeke 2014 Uncommon
Weakly Toothed Pupasnail	*Gastrocopta pediculus*	Au Museum 1941; probably common
Freshwater Snail	*Gabbia vertiginosa*	Au Museum 1912; probably common
Freshwater Clam	*Corbicula (Corbiculina) australis*	Au Museum 1958; probably common
Gordian Knot Worm	Gordius sp.	Au Museum; uncommon?

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