History of Canberra Nature Park

Report for the ACT Commissioner for Sustainability and the Environment

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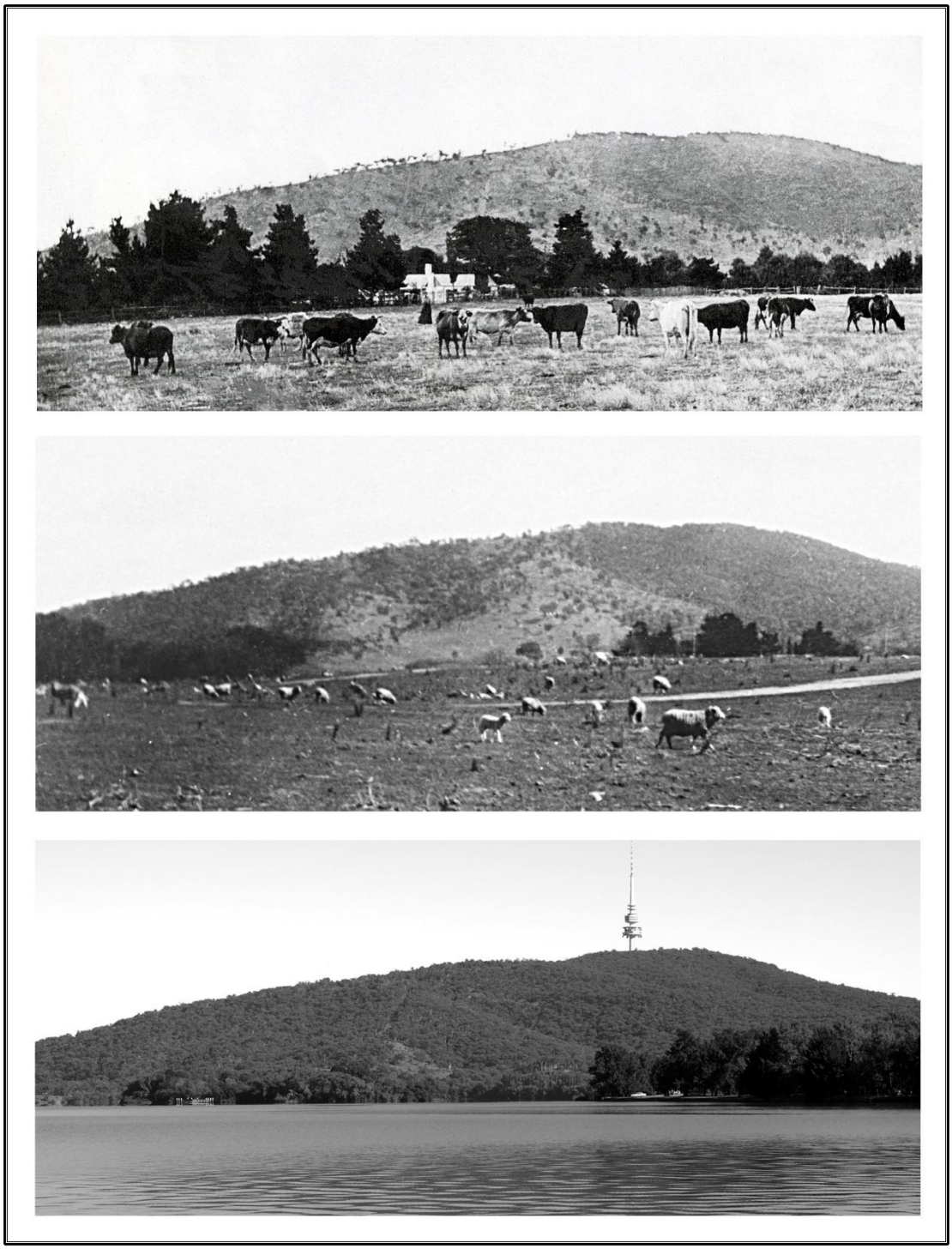

Figure 1. Recovery of vegetation on Black Mountain after being widely cleared in the middle 1800s. Top - about 1870. Middle -1920. Bottom - 2011. The building in the top photograph is Springbank Station.

Contents

Ecosystem change and resilience

Even without human intervention, ecosystems change. Long term geological change, climate change in both the long and short term, events like volcanoes, earthquakes, fire and storms, the evolution of new species and the interaction between these forces and the plants and animals of the planet have produced constant change in ecosystems. Human intervention on a large scale has added to the change and what we see today in the ecosystems of Canberra Nature Park, for example, is just a single point in time of much longer possible trajectories for each of those places. Understanding the nature of ecosystem change, and the dynamics that are already in place is important because they underpin what is possible to achieve with further intervention and thereby realistically shape our expectations about their future condition.

Interactions between all the forces of change in an ecosystem mean that their trajectories of change are not always predictable, linear or incremental. A fire followed by a storm has many times the impact on sediment movement than either a fire or a storm alone. Nevertheless, change is not completely random and a relatively small number of controlling variables and the feedbacks between them usually ensure that an ecosystem remains within the bounds of a stable state until a threshold change in a controlling variable moves the whole system to another state. The ability of a system to absorb disturbance without changing to a different state is called resilience[1]. Sometimes people will want an ecosystem to not cross a threshold so that they retain it as it is, in other cases they will want to deliberately cross the thresholds and move the system to another state. In either case, identifying and quantifying the thresholds is important but this has not been done yet many ecosystems. An important aspect of crossing thresholds is that they often involve a

[1] Walker, B. and Salt, D. (2006) Resilience Thinking. Sustaining Ecosystems and People in a Changing World. Island Press, Washington.

relatively small change with big effect when moving in one direction, but require unequally large efforts to make small changes to move back over the threshold.

This introduction to the dynamics of change in Canberra's ecosystems sets the stage for thinking about the controlling variables in the ecosystems of Canberra's Nature Park and the thresholds that we need to either stay away from, or deliberately cross over.

Geological, soil and climate legacy 480 million years BP–2010

The geological history of the ACT is important for its contribution to today's topography and soil characteristics. The regions' rocks are old. They began to form during the Ordovician period, about 480 million years ago, and continued through the Silurian (beginning 444 million years ago) and into the Devonian (beginning 416 million years ago)[2]. Tectonic plate movements leading to extensive folding and faulting and alternate periods of submergence then exposure to weather, combined with some volcanic activity have produced a variety of geologies in the region.

This has resulted in the reserves in Canberra Nature Park having different geologies. For example, Black Mountain is mostly Black Mountain sandstone, which was formed in the early Silurian from sandstone deposited in a fan on the sea floor, which was then uplifted and exposed as the surrounding softer plain eroded away. This is the only occurrence of this geology in the ACT. Other reserves on geologies formed from sediments include those of the Canberra Formation (e.g. Mulligan's Flat) or the Pittman Formation (e.g. Molonglo Gorge). Other reserves have geologies based on volcanic activity and belonging to either the Laidlow Volcanic Suite (e.g. Mt. Mugga Mugga, Tuggeranong Hill) or the Hawkins Volcanic Suite (e.g. Mt. Ainslie, Mt. Majura, Mt. Painter). The geology of individual reserves is documented in the technical report on landscape function accompanying this investigation[3].

This variety in geologies has produced some distinctive variations in flora. For example, while the trees on Black Mountain are similar to those on other wooded hills, it has a significantly richer shrub and herb flora than anywhere else in the ACT. The implication is that even before legacies of more recent land use are considered, what might be achievable in terms of conservation or rehabilitation on individual reserves needs to take into account the underlying characteristics of that place.

A second implication of the geological history is its influence on soils. The long periods of weathering have produced soils that are relatively infertile with low organic matter and poor structure. On the upper slopes the soils are shallow and gravelly and prone to erosion. On lower slopes the soils are deeper, duplex soils, characterised by sandy topsoils overlying clayey reddish and yellowish, low fertility subsoils. The subsoils are

[2] http://en.wikipedia.org/wiki/Geology_of_the_Australian_Capital_Territory
[3] Sharp, S. (2010) Landscape function in Canberra Nature Park and impacts of threatening processes on landscape function. Report to the Commissioner for Sustainability and the Environment, Canberra. Table 1.

very vulnerable to erosion if the topsoil is lost. Soils on the plains are deeper and more fertile[4].

The basic nature of Australia's vegetation was shaped over the last 50 million years as the continent slowly drifted towards warmer latitudes and the vegetation became adapted to aridity, drought and poor soils. Ice Ages and the warmer periods between them varied the distribution of species. At the peak of the last Ice Age, about 20,000 years ago, the ACT was 10 degrees cooler, drier, windier and probably treeless. The vegetation patterns seen today were formed around 10,000 years ago.

Aboriginal legacy 40,000 years BP-2010

Aboriginal settlement in the region is at least 21,000 years old, based on dating of a rock shelter at Birrigai. Their occupation may have varied in intensity over that period as climate changed but evidence for a long occupation and use of land in the ACT comes from the traditional stories of today's Ngunnawal people, from accounts of early white settlers, and the material evidence collected or still in place, including camp sites, stone artefact scatters, Indigenous quarries, scarred trees, sharpening grooves in rocks, burial sites, rock shelters and paintings.

The Aboriginal presence here indicates there was often sufficient food and material resources to support them, and trading with both inland groups and coastal groups extended the range of resources available. Many plant species that Aboriginal people were known to use generally are still found locally. An account of Aboriginal people fishing locally in the early days of white settlement illustrates both an effective fishing method, and a productive local food source:

> *"There was a long waterhole in the Molonglo River near the Duntroon Dairy, and about a dozen stalwarts would enter the water at one end. A few minutes later most of the tribe would enter the waterhole at the other end and move forward, making all the noise possible. This disturbance drove the fish to the other end, where the natives speared a great many."*[5]

Ngunnawal people have recently begun documenting some of their knowledge of land use practices to share with school students in the ACT[6]. The knowledge legacy of Aboriginal people is commonly thought of as belonging to a static and distant past but it is more

[4] Sharp p11.
[5] Shumack, S. (1967) An Autobiography or Tales and Legends of Canberra Pioneers. Australian University Press, Canberra. p 151.
[6] Bartle, M. (2010) Understanding the Land Through the Eyes of the Ngunnawal People. A Natural Resource Management Program for ACT Schools. ACT Natural Resource Management Council, Canberra.

dynamic and adaptive than that[7] and can be an important contribution to understanding and managing landscape change.

In terms of their impact on the ecology of the region, the use of patchy fire to stimulate fresh grass growth and attract grazing animals was probably the most significant but is not thought to have materially altered vegetation structure and composition[8]. It possibly kept the grassy woodlands less wooded than they might otherwise have been, but the treeless nature of grasslands on the plains is more commonly attributed to extended periods of severe frost.

White settlement legacy 1820-1910

Charles Throsby Smith's diary records the first white sighting of the Limestone Plains on 7 December 1820[9].

> *"At daylight, calm and cloudy, Set out thro a **fine forest** country for 3 miles, ascending a **Stony Range, Iron Stone and Barren Scrubby timber, Stringy Bark, Gum and Box**; from this Range we had view of some **clear grassy hills** bearing N by West, Distant about 8 miles. Crossed a **chain of ponds**, rather indifferent country. Ascending a **Stony Range, Barren and scrubby**; at 11, on top of the hill; some beautiful **clear plain** in sight, bearing S. by E. ; an extensive **chain of mountains** running S.S.E. and N.N.W. thick hazy wr, with light showers of rain occasionally. We then descended the range into a **scrubby country** for about half a mile, then into a most **beautiful forest country**, **gentle hills and valleys**, **well watered by streams**, and a fine **rich Black Soil**. Came on to one of the plains we saw at 11 o'clock. At half past 1, came to a **very extensive plain**, fine **Rich Soil** and **plenty of grass**. Came to a Beautiful River plains that was running thro' the plains in a S.W. direction, by the side of which we slept that night. When we made the Hut this evening, we saw several pieces of stone that had been burnt by all appearances."* [bolding added to highlight descriptions of the natural resources]

Their camp was near Duntroon and the burnt stone was the limestone that gave the region its name.

The naturally treeless grassy plains, presence of water, good drainage and a source of timber in the hills made the area very attractive for sheep grazing and the first squatters had already appeared by 1823. Alan Cunningham, who led the first botanical expedition to the area in 1824[10], recorded:

> *"The beautiful undulation of surface of this **extensive open forest** is **abundantly watered** by a stream or small river that meanders thro' it but is at the same time*

[7] Muir, C., Rose, D., and Sullivan, P. (2010) From the other side of the knowledge frontier: Indigenous knowledge, social-ecological relationships and new perspectives. The Rangeland Journal 32:4-20
[8] Benson, J. (1999) Setting the Scene. The Native Vegetation of New South Wales. Native Vegetation Advisory Council of New South Wales, Sydney.
[9] Cited in Commonwealth of Australia (1931) Official Year Book of the Commonwealth of Australia, 1931. Reproduced by Australian Bureau of Statistics (ABS cat. no. 1301.0).
[10] Cited in Consultation Draft for Canberra Nature Park 1974/5.

*perfectly **dry** by reason of the facility with which the rains can escape hence their eligibility as **extensive pastures** for sheep, the **boundary hills** furnishing the necessary **timber** for the construction of huts and sheep yards of magnitude."*
[bolding added]

Grants and purchases of further land followed and all the good land had been allocated to either leases or freehold ownership by the early 1830's. Land use was predominantly grazing; sheep on the eastern side of the Murrumbidgee and cattle in the mountains on the other side, but there was also wheat farming on the plains at Tuggeranong and Ginninderra, and mixed farming on the Molonglo floodplain and the valleys of the Ginninderra and Majura creeks[11]. From 1861 the *Robertson Act (1861)* allowed people to purchase small holdings within leased Crown land and some closer settlements were established.

There is no systematic documentation of the nature of the land before white settlement but explorers' journals and settlers' letters and accounts of specific places where undisturbed remnant vegetation remains today suggests that these remnants do present a reasonable picture of the land at the time[12]. Accounts from early settlers in the region (e.g. Samuel Shumack[13] and excerpts from his account in Box 1) and photographs from the later 1800s (e.g. Figure 1) document some of the changes that occurred and the impacts on ecosystem function were significant.

These changes impacted on many ecosystem functions. Trees were felled to provide timber for housing and fencing, ringbarked to encourage more grass growth or cleared to enable land to be cultivated. The removal of trees altered nutrient cycles and diminished habitat and food supplies for birds and animals. Soil bared in cultivation or as the result of the combined effects of drought, grazing and loss of grass cover, washed or blew away. Bared grazing ground became compacted leading to reduced water infiltration, more runoff and erosion and reduced plant growth. Grazing depended on native species in this period but the soil disturbance provided opportunities for agricultural weeds to become established and slowly the composition and structure of the native understorey changed. Loss of ground cover on slopes led to faster shedding of water and more erosive flows in creeks and rivers. Water quality was affected by increased sediments, uncontrolled stock access to water, lack of controls on human sewage, and on the Molonglo, by establishment of a mine at Captain's Flat in 1874 which leached contaminants into the river. Many willows were planted and these contributed to changes in river ecology[14]. A number of native animals threatened, or were perceived to threaten, crop and livestock production and were hunted and killed in large numbers.

[11] ANZAAS (1954) Canberra. A Nation's Capital. Ed. H.L. White
[12] Benson.
[13] Shumack.
[14] Zukowski, S. and Gawne, B. (2006). Potential Effects of Willow (Salix spp.) Removal on Freshwater Ecosystem Dynamics. A Literature Review. Report for the North East Catchment Management Authority. Murray-Darling Freshwater Research Centre, Wodonga.

Box 1. Observations of some changes in ecosystem functions 1820-1909. From Shumack.

"we split thousands of posts and rails" [1867, p46]

"John Mayo had a contract ringbarking 7,000 acres at Belconnen" [1882, p 110]

"a huge dam was constructed near the Bandicoot Plain run" [1858, p32]

"the farmers had a hard time ploughing as the land was hard" [1865, p 46]

"No growth followed this rain as the rush of water had carried away the loose topsoil and the hot, dry winds did the rest. I usually commenced ploughing at Easter, but in this year the ground was too hard." [1882, p110]

"a series of thunderstorms passed over the locality, but not enough rain fell to lay the thick carpet of dust" [1865, p46]

'When I first saw Canberra [1856] there were less than a than a dozen willows on the river; a few years later they lined the bank from Duntroon to Yarralumla." [p12]

"my favourite pool … had silted up. A flood in 1879 cleaned [it out]. … This silting process has been repeated several times since." [p 108]

A shooting expedition *"shot 2,700 wallabies"* [1876, p106]

"there was a good roll-up and more than 1,000 possums were shot" [1880, p152]

"with the introduction of strychnine … the native and tiger cats were almost exterminated" [1870's, p 152]

"A plague of rabbits caused much injury to pasture and crops … and in the season 1906-7 a great crusade was carried out against them." [p161]

This was a short period of time but it left a significant legacy of altered landscape function, species loss and introduction of pests and weeds. Many photographs of the region were taken during and after the selection of the site for Canberra and they almost all attest to the very poor condition of the land on the plain by the end of the period (e.g. middle photo, Figure 1.).

Urban development legacy 1911-2010

In 1901, the six colonial states of Australia federated to form a new government, the Commonwealth of Australia. It had been agreed that the seat of government would be located in NSW, but the decision to set the Australian Capital Territory in the Limestone Plains region wasn't made until 1908 and the Territory was formally declared in 1911. In 1912 Walter Burley Griffin won the design competition for the layout of Canberra, principally because of his sensitivity to the surrounding landscape and its central role in shaping the city design, even if this was because, *"Lacking the cultural history, artefacts and monuments of Old World capitals, the Griffins' Canberra would showcase nature instead"*[15].

[15] http://www.idealcity.org.au/win-1.html. Accessed 7 September 2010.

Griffin described the role of the natural features like this[16]:

> *"The peculiar advantages of Canberra lie principally in the following characteristics … **MOUNTAIN RANGES**. Beautiful blue and snow-capped peaks of the Australian Alps … **LOCAL MOUNTS.** Ainslie, Black Mountain, Mugga Mugga, rising almost 700 feet (too lofty and too exposed for building purposes), afford objective points of prospect to terminate great garden and water vistas, with conspicuous positions for future commemorative monuments, and conversely offer points of outlook over a city arranged in an orderly way with references to them. … **HILLS AND SPURS**. Eminences rising to 200 feet furnish most appropriate public building sites to terminate main thoroughfares disposed with reference to them and often in apposition with the mountains also. … **MOLONGLO RIVER AND FLOOD BASIN**. The considerable central flats are unavailable for building purposes, but eminently suitable for a waterway of the largest extent that would be consistent with a location in the heart of the city ….* [bolding added]

Once this vision was accepted and the plan began to be implemented, more detailed decisions had to be made about landscaping the city, including the vegetation on the inner hills, and Charles Weston was appointed officer in charge of afforestation in 1913. The degraded state of the hills was well recognised. For example, a 1918 report[17] on the condition of Mt. Majura recorded *"… the denudation which is rapidly taking place, the unsightliness of which is at present quite apparent … a considerable extent of brown mineral soil is exposed, having no vegetation whatever on it."* There was a distinct reafforestation movement in southeastern Australia at the time as it was becoming more widely recognised that the uncontrolled removal of trees had had undesirable consequences.

Griffin was of the same mind, recognising the *"… desirability that the lands at the Federal Capital which are to form local National Parks, and on which it is proposed to establish forests, be preserved in or reforested in their natural state."* He devised several schemes for revegetating the inner hills (in one, each hill would have plants from each of the seven continents, in the other, plants of different colour), but his species selection was poor and due to lack of resources and then his departure in 1920, neither was implemented. Meanwhile both Griffin and Weston recognised the impact of continued grazing, ringbarking and chopping of vegetation for fodder and grazing leases were withdrawn first from Green Hills, Red Hill, Mugga, Black Hill [Mountain] and the Ainslie paddocks. Specific revegetation designed by Weston was carried out on Mt. Majura in 1919. An area was fenced and 4000 seedlings and 2.3 kg of kurrajong seed were planted (species included

[16] Griffin, W.B. (1913) The Federal Capital. Report Explanatory of the Preliminary General Plan. Commonwealth of Australia.

[17] Corbin, H, Johnstone, J. and Campbell, D. (1918) Reports relating to afforestation [in the Federal Capital Territory], Melbourne, Government Printer p6.

she-oak, *Casuarina stricta*; kurrajong, *Brachychiton populne;* elms; and *Robinia pseudoacacia)* [18].

An important legacy from this period of Canberra's history for understanding the condition of the Nature Park of today is the differential revegetation of the hill reserves in the Park. The inner hills have not been grazed by stock for nearly 100 years and the early rehabilitation actions are now fully mature. More recent additions to the Nature Park, like Goorooyarroo, were grazed as recently as 2005, giving them nearly a 200 year grazing history and a very short history of rehabilitation.

Since the initial design of Canberra, key influences on the condition of Canberra Nature Park have been a growing valuing and understanding of conservation and its management, and the urban planning decisions made to accommodate a growing population. Along with ecosystem dynamics, society's values and knowledge are dynamic and interact with each other. Beginning with the afforestation movement mentioned, ideas about urban open spaces[19] were later influential in shaping Canberra Nature Park, as have been developments in conservation ecology and the conservation movement.

The legislative development of what is now Canberra Nature Park over this time has been complex as both goals and the managing authorities have changed. A few key events include:

- 1958 - 1989 National Capital Development Commission (NCDC) oversaw the growth of Canberra's population from 40,000 to 300,000[20.] A Commonwealth Government department (e.g. the Department of the Capital Territory) managed the lands of the ACT. Policy was developed to maintain the open character of the national capital and preserve its hilltops and ridges in a natural state[21].
- 1970 – Black Mountain nature reserve gazetted, adding nature conservation to the landscape goals of the hilltops and ridges.
- 1976 – NCDC released the National Capital Open Space System (NCOSS) to develop linked open spaces and ensure protection of the natural settings for the capital.
- 1980 – Nature Conservation Act.
- 1989 – Introduction of self government. The National Capital Authority (NCA) was established to retain a Commonwealth Government interest in the planning and development of the national capital.

[18] Gray, John (1999) T.C.G. Weston (1866-1935). Horticulturalist and Arboriculturist. A critical review of his contribution to the establishment of the landscape foundations of Australia's National Capital. PhD Thesis, University of Canberra.
[19] Seddon, G. (1977) An Open Space System for Canberra. Technical Paper No. 23. National Capital Development Commission, Canberra.
[20] http://www.nationalcapital.gov.au/index.php?option=com_content&view=article&id=136&Itemid=171. Accessed 5 September 2010.
[21] Sharp.

- 1993 –-Canberra Nature Park[22] gazetted under the Territory Plan. This initially protected 23 reserves. Between 1993 and 2010 a further 10 have been added in recognition of their significant biodiversity conservation values.
- 1998 - ACT Nature Conservation Strategy.
- 1999 - Commonwealth Environment Protection and Biodiversity Conservation Act.
- 1999 - Canberra Nature Park Management Plan.
- 2004 - ACT Lowland Woodland Conservation Strategy.
- 2005 - ACT Lowland Native Grassland Conservation Strategy.

In terms of the condition of the reserves in the Park, it is how their land has been used and managed that is more important than their legislative history. Key legacies in Canberra Nature Park from this period of urban development in Canberra include those that are the direct impact of land being converted to urban uses and a great number of indirect impacts. For the Park as a whole, the largest direct impact has been the selective use of lowland grasslands and lowland woodlands for urban use. These have been favoured elsewhere for agriculture as well, resulting in them now being nationally endangered ecosystems. In conservation terms, they are under-represented in Canberra Nature Park as the inner hills and ridges were protected earlier for their contribution to the planned city landscape.

Indirect urban development impacts over this time, whose legacy still affects the condition of some or all of the reserves in the Park, and the Park as a whole, include:

- Removal of habitat. In the early days, Black Mountain was managed for firewood production and the absence of timber on the ground in other reserves suggests the taking of timber for this purpose was widespread. The result has been loss of shelter for native birds and animals and a decrease in decomposing material that supports invertebrates that in turn become food for birds.
- Removal of stone, sand and gravel for urban construction purposes, leaving disturbed quarry sites and alterations to creek and river ecology.
- Construction of banks and dams in the hill reserves to protect suburbs below them from flooding. This has altered water flows, and introduced permanent water into places where it was previously ephemeral.
- A relaxation in predation of kangaroos, either by foxes or humans, combined with better water access, has led to increases in kangaroo populations, over-grazing and erosion.
- The creation of Lake Burley Griffin on the Molonglo River created a new wetland ecosystem which is now part of the Park, the Jerrabombera Wetlands. Its history since white settlement has been one of intensive land use.
- Use of reserves for infrastructure like rubbish tips, reservoirs, telecommunication substations, underground cables, power lines, trig points, radar and aircraft

[22] Dates of individual reserves entering Canberra Nature Park are in Sharp, Table 1.

warning lights. These have brought additional access tracks which disturb the soil and lead to erosion and weed invasion.

- Fire protection measures to safeguard people and buildings have introduced access roads and altered fire regimes. In buffer areas at the margins of reserves, controlled burning has increased fire frequency; within reserves fire frequency has probably diminished. Both impact on the capacity of native plants to regenerate themselves in the long term.
- Domestic dogs and cats have contributed to the decline in native fauna, both inside and outside the reserves.
- Garden plants have escaped and some have become serious weeds. They displace native plants, compete for light and nutrients and few are good food sources for native fauna.
- Car, motorbike, bicycle, horse and walkers have created tracks which have led to erosion and weed dispersal.
- In reserves where grazing continued past the 1950s, the introduction of fertiliser and exotic grasses and legumes led to substantial changes in the composition of pasture. Tall, warm season, perennial tussock grasses were replaced with short, cool season, perennial native or exotic grasses and herbs[23].
- For the Park as a whole, the continued urban development has led to loss of connectivity between reserves.
- Finally, and in a broader context, the same kind of growth and development has led to an accumulation of greenhouse gases in the atmosphere and rising global temperatures. The legacy in the Park will include direct temperature effects on biological processes and the plants and animals that can live there, and effects through alterations in rainfall amounts and patterns.

But there are positive legacies too from these years. They include:

- A strong adherence to the Griffin vision for the city landscape. The National Capital Plan in Section 8.5.3, Policies for Hills, Ridges and Buffer Spaces, confirms "The inner hills will be protected as key symbolic and landscape elements in the National Capital Plan expressing the defined land, water and municipal axes and providing the dominant backdrop feature to the city."[24]
- The increase in institutional arrangements for controlling activities in the Nature Park. A number of the activities and impacts listed above have been curtailed and trajectories of improving condition in specific places can be identified. For example, the revegetation of Black Mountain (Figure 1), the oldest reserve in the Park, indicates what can be achieved given the will, re-setting of the human

[23] Environment ACT (2003) ACT Lowland Woodland Conservation Strategy. Australian Capital Territory, Canberra.

[24] http://www.nationalcapital.gov.au/index.php?option=com_content&view=article&id=372&Itemid=260#2. Accessed 7 September 2010.

influences and the passage of time for ecological processes to work. Stabilisation of road cuttings and previously eroded gullies and streams with self-seeded native vegetation can be seen in this reserve and others of longer reserve status.

- An enormous growth in scientific understanding of biology, ecology, landscape processes, biodiversity conservation, pest management etc. has enabled a more evidence-based approach to managing the Nature Park.
- A heightened community awareness of environmental issues and a high use of, and identification with, reserves by local residents has led to strong community pride and concern for their future. Through the landcare movement and park care groups, volunteers make substantial contributions to the care of their local reserves.

At the same time, legacies from the first period of settlement of the region have continued their impacts. In particular rabbits continue to impact on the vegetation in many reserves.

Impacts and implications of the combined legacies 2011

One measure of the combined impact of both periods of white settlement across the ACT is that two species are thought to have become extinct in the ACT since white settlement (the brush-tailed rock wallaby and a gentian) and a further 29 species and 2 ecosystems (Yellow Box/Red Gum Grassy Woodland and Natural Temperate Grassland) have been declared vulnerable or endangered. There are also concerns about a number of bird populations in the region. While not yet formally threatened under conservation rules, their trajectories of decline over time indicate they are not being supported by current ecosystem conditions. This highlights the importance of understanding the longer term dynamics of ecosystem change, where there might be thresholds to avoid or to cross, and what interventions are likely to be successful.

Three implications arise from having taken this particular view of the history of Canberra Nature Park.

1. Each park has a different history – a different combination of legacies from geology, climate, soil, early white settlement and urban development. Actions to protect and rehabilitate a particular reserve need to be tailored to the combined impact of those legacies in that particular place.
2. Expectations about the rate of rehabilitation need to be realistic. The photographs in Figure 1 show how long it took for Black Mountain to recover from the impact of clearing and grazing, but it did recover with relatively little intervention beyond stopping tree removal and grazing by stock.
3. Knowing the direction of long term (not year to year variability) change in condition of each reserve, and how close its controlling variables are is important in deciding what and how much action is required. Slow change, like the recovery of Black Mountain, is acceptable, as long as the direction of change is away from critical thresholds and the system is becoming more resilient.