INDIGENOUS BURNING AND THE EVOLUTION OF ECOSYSTEM BIODIVERSITY

BETH GOTT

School of Biological Sciences, Monash University, Clayton, Vic. 3800

GOTT,B. 2012. Indigenous burning and the evolution of ecosystem biodiversity. *Proceedings of the Royal Society of Victoria* 124(1): 56-60. ISSN 0035-9211.

When Europeans arrived in southeastern Australia they found people who had inhabited the continent for at least 40 000 years. Early reports describe them as healthy and well fed. Vegetable food occupied about half the diet and fire was the chief management tool used to maintain that resource. Food-providing areas, chiefly grasslands and open woodlands, were subject to selective factors which resulted in the evolution of ecosystems adapted to burning at certain seasons and frequencies. The benchmarks for their biodiversity are not pristine, but a product of Indigenous management.

Keywords: Ecosystems, biodiversity, Indigenous fire management.

"*Aboriginal land management has left a major signature on Australian environments*" Keith et al. 2002

We are living in a continent with a history of occupation by human beings for at least 40,000 years. Those first people came with a knowledge of how to make and use fire, and it was their chief tool in managing the land and its resources. (Flannery 1994; Kohen 1995). Initially, ecologists either ignored or gave only a sideways glance at what that occupation implied, but some have recognised its importance in the evolution of Australian ecosystems. Bowman (1998) has called it 'one of the most complex and contentious issues in Australian ecology' and has said 'fire was a powerful tool that Aborigines used systematically and purposefully over the landscape … little doubt that Aboriginal burning was skilful and was central to the maintenance of the landscapes colonised by Europeans … and important for the development of a comprehensive understanding of the dynamics and evolution of the Australian biota,' He further described it as 'central to the formulation of appropriate strategies for the conservation of the nation's biota'.

What was the system and purpose of Aboriginal burning? The aims are commonly given as driving animals for hunting, clearing for walking, signalling, even to reduce snake populations (Penman et al. 2011). On the landscape scale, Bowman (2001) has discussed its importance in the creation and management of grasslands, and Gammage, a historian, (2011) has comprehensively documented original grasslands which disappeared when Aboriginal burning ceased.

Were there other reasons for burning? The primary effect of fire is on the vegetation. Curr (1883), a perceptive early observer, said 'living principally on wild roots and animals, he [the Aborigine] tilled his land and cultivated his pastures with fire'. McLoughlin (2004) has listed Australia-wide records indicating the controlled use of fire and suggested that it is important for conservation to understand the patterns of burning in specific vegetation communities. This becomes important when it is known that vegetable food, gathered by the women and children, constituted at least 50% of the diet (Gott 1982) and was always the fall-back food. 'Aboriginal fire regimes were instituted largely to maintain access to food resources' (Keith et al. 2002).

At first contact the people living in Victoria were described as 'strong and athletic, often 6 ft tall, very intelligent and quick in their perceptions, with exceptional eyesight and particularly fine teeth' (Gellibrand in Bride 1898). They were clearly not lacking nourishment. Eyre (1845) said: 'in almost every part of the continent…I have found that the natives could usually, in 3 or 4 hours, procure as much food as would last for the day, and that without fatigue or labour'.

In wide areas of south-eastern Australia the staple vegetable foods were underground plant storage roots (Curr 1883), available year-round, unlike seasonal fruits and seeds. 'Their natural food consists of the meat of the country when they can kill it, but chiefly roots' (Thomas Winter 1848, in Bride 1898) The species providing the roots were small herbaceous perennials which grow during the winter, building up an underground food store. They flower in spring and early summer, shed seed, and in the hot dry part of the summer the above ground parts die off. The plants aestivate and resume vegetative growth in autumn, when temperatures fall and rains arrive. Lilies, Orchids, native *Geranium* and *Pelargonium* species, and especially *Microseris lanceolata* were eaten.

Of the 1100 Victorian species recorded as used for food, 35% were used for their underground storage organs (Gott 2010). This paper examines the use of fire in those plant communities where storage root foods were most abundant - in the widespread open woodland, open forest and grassland ecosystems. In the dense wet sclerophyll forests, although Tree-fern pith and Bracken rhizomes were eaten, they were occasional foods, used when people visited such areas to collect specific materials.

In communities where plant foods were abundant, it was important to apply fire in a way that ensured not only maximum yield, but the continued existence of the desired species. Their life histories show that to preserve the root-providing plants it is safe to burn in late summer and autumn, when they are underground as storage roots. Winter and Spring burns are contra-indicated (Baird 1977). The early reports of the health of the Aborigines, living easily off the land, show that they had learned how to exploit this food resource without destroying it.

Initial observers such as James Cook and Sidney Parkinson in the 1770's were impressed with the extent of open woodlands on the east coast of southern Australia, often describing them as 'free from underwood… resembling a 'gentleman's park' - an English example of a controlled landscape (Gammage 2011). As soon as Aboriginal burning was prevented, this open structure was lost (Mitchell 1848, Howitt 1890, Lunt 1998). In the absence of fire the growth of a shrubby understorey eventually restricted the intensity of light reaching the ground level of the woodlands and limited the growth of the food plants. This is well illustrated by a detailed ten-year study of the recovery of woodland at Anglesea after the 1983 fire. (Wark 1996). The fire was in February, when the tuberous perennials were safe from harm underground. In the first year after the fire, herbaceous species were very abundant, including 49 species of underground food plants. 'The early herbaceous phase declined in cover and density of flowering during the second and third years as shrub and canopy cover increased'. (Wark 1996). Species richness decreased after the third year, and ten years after the fire was only 40% of the year 1–3 level. This would indicate that renewal of fire after the third year would be necessary to preserve the herbaceous abundance, and it is to that frequency that the woodland has become adapted. Christensen et al. (1981) state that 'there is a natural maximum fire frequency of 3 to 4 years in dry sclerophyll forests'

A similar response is found in grasslands. As the tussocks of the native grasses grow in size, the inter-tussock spaces become covered with both living and dead material, hindering the growth of the perennial food plants. Long unburnt sites have fewer non-grass species (Stuwe 1994). In the Victorian Western Plains grassland the rapid recovery of the fire-adapted tussock grasses causes light between the tussocks to become low 2-4 years after fire and eventually minimal at 6 years, when renascent perennials [such as the food plants] 'decrease to invisibility' (Cheal 2010). Lunt & Morgan (2002) emphasise 'the importance of disturbances such as fire for preventing competitive exclusion by the dominant grasses'. Lunt (1998) and Morgan (1998) suggest that burning at 1-4 year intervals is necessary to optimise species diversity in grasslands (Table 1).

Aboriginal decisions to burn were informed by long-accumulated knowledge of the responses of plants, passed down as oral history. Fire was applied in controlled patches (Stokes 1846; Murray 1802) resulting in the establishment of a mosaic of areas in differing stages of fire recovery. Latz (1995) showed the advantages for the survival of plants and animals. In Victoria, Quin & Williamson (1996) showed that a landscape of patches in different stages of fire recovery is the optimum condition for the survival of the New Holland Mouse. Other animal populations and behaviours were adapted to periodic fire (Gill 2009). For the important aquatic food plant Cumbungi (*Typha* spp.) individual stands were burned in the winter, when the emergent leaves and stems were dry (Gott 1999).

Aboriginal practices other than fire also affected biodiversity. Digging by women and children to collect roots had the effect of maintaining a loose structure to the soil. Ash from fire and litter were turned in, enriching it, and rain was readily absorbed. The cessation of digging and the advent of sheep and cattle resulted in compaction and rapid runoff of rain (Batey no date). Many of the food plants tend to be locally abundant, growing in clumps. Removing some plants from the clumps enabled the remaining plants to grow better (Gott 1982). Harvesting methods were observed which removed suitable tubers and left the plant in the soil:

'Root foods were never, so we were told, dug indiscriminately: no known patch was completely denuded…. The old seed bulb was termed PAKALI (grandmother), smaller ones were the 'grandchildren'; only the 'parent' ones would be collected. After

digging, the earth would be pushed back and the plants made firm so that their natural cycle was not radically interfered with and their increase was ensured' (Berndt & Berndt 1993.) Some species may owe their present distribution to the Aborigines, since desirable plants were widely traded. (Morgan 1852)

Aboriginal burning in selected areas aimed to maximise and preserve vegetable foods or other desirable species. European burning now has the necessary aim of reducing the likelihood of fire by fuel reduction burning to protect assets and life, but also aims at the preservation of biodiversity.(Penman et al 2011). What is implied in the preservation of biodiversity ? Europeans have recorded biodiversity from the time they first encountered the Australian landscape. Initially they regarded the land as pristine, and this belief continued well into the 20th Century, and unacknowledged, still lingers. What the Europeans found was a biodiversity produced by thousands of years of Indigenous occupation and management, particularly with the use of fire (Bowman 2001; Gill 2009; Gott 2005). Even today it is not always realised that Aboriginal burning had purpose, that it was carefully controlled and applied only to those parts of the land which would fulfil the required purpose. For Europeans, as for the Aborigines, a detailed knowledge of the response to fire of different areas in which the aim is the preservation of biodiversity is essential. Cheal (2010) using comprehensive field data for thirty-two Victorian ecological divisions, described the fire recovery stages and fire intervals which can be tolerated for survival in each division. He said: 'fire regimes may result in both extinctions and regeneration opportunities for vegetation communities and their flora and fauna. Applying an inappropriate fire regime may lead to undesirable changes in species composition and local extinctions. Applying an appropriate fire regime may lead to the maintenance of desirable species composition and the recovery of threatened species.' He recommends a 'maximum time required between two successive fire events in order that a vegetation community or its constituent species can persist in the absence of fire'. Cheal (2010) noted a Minimum Tolerable Fire Interval – 'the minimum time required between two successive fire events at a site in order that a vegetation community can persist and have every reasonable chance of reaching maturity and producing propagules before the before the following fire event.' The second fire must be applied with close observation of the growth stage reached since the last fire. This would have been Aboriginal practice. Here Cheal makes a distinction between the effects of an initial high severity fire – for example when the fuel load is high – and a low severity, patchy fire, which leaves unburnt patches. Evidence points to Aboriginal fires being of the latter type (see above). If we aim to preserve biodiversity in selected ecosystems, the complete exclusion of fire will not serve; regular burning on the Aboriginal pattern is essential. Modern fire studies to preserve biodiversity can uncover appropriate fire intervals, which we may assume were close to the Aboriginal intervals under which that biodiversity existed (Table 1).

Table 1 Frequency of burning in grassland and open woodland to preserve biodiversity

Author	Year	Interval (years)
Curr (Aboriginal)	1883	5
Christenson et al.	1981	3-4
Stuwe	1994	3
Wark et al.	1996	3(est.)
Lunt	1998	5
Morgan	1998	1-3
Lunt & Morgan	2002	2-4
Abbott (Aboriginal, W.A.)	2003	2-4
Cheal (patchy fire)	2010	2-5

FREQUENCY OF BURNING IN GRASSLAND AND OPEN WOODLAND TO PRESERVE BIODIVERSITY

It is important not to underestimate the knowledge of plant response to fire which resulted from thousands of years of observation and was passed down orally as part of Aboriginal culture. People had a deep sense of responsibility and attachment to their designated lands, and understood and treated those lands in such a way that they continued to yield the necessities of life which enabled their people to survive successfully for so many thousands of years on this unreliable continent. This was the case for all of Australia, not just the specific areas I have examined in this paper.

REFERENCES.

Abbott,I., 2003. Aboriginal fire regimes in south-west Western Australia: evidence from historical

documents. In *Fire in ecosystems of south-west Western Australia: Impacts and management*, I.Abbott & N.Burrows, eds, Backhuys Publishers, Leiden.

Baird, A.M., 1977. Regeneration after fire in King's Park, Perth, Western Australia. *Journal of the Royal Society of Western Australia* 60, 1–22.

Batey, I.D., no date. Unpublished MS, Royal Historical Society of Victoria.

Berndt, R.M. & Berndt C.H., 1993. *A World that was – the Yaraldi of the Murray river and the Lakes, South Australia*. University of British Columbia Press, Vancouver.

Bowman, D.M.J.S., 1998. The impact of Aboriginal landscape burning on the Australian biota. *New Phytologist*, 140, 385–410

Bowman, D.M.J.S.,2001. Future eating and country keeping: what role has environmental history in the management of biodiversity? *Journal of Biogeography*, 28, 549-564.

Bradstock, R.A., Williams, J.E., & Gill, M.A., eds, 2002. *Flammable Australia*. Cambridge University Press, Cambridge.

Bride, T.F., 1898. *Letters from Victorian Pioneers* ,1983 edn, Currey O'Neil, Melbourne.

Cheal, D., 2010. *Growth stages and tolerable fire intervals for Victoria's native vegetation data sets*. Fire and adaptive management. Report 84, Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Melbourne.

Christensen, P., Recher, H. & Hoare, J., 1981. Responses of Open Forests (dry sclerophyll forests) to Fire Regimes. In *Fire and the Australian Biota,* A.M. Gill, R.H. Groves and I.R. Noble, eds, Australian Academy of Science, Canberra, 367–393.

Curr, E.M., 1883.*Recollections of squatting in Victoria, 1841–1851*. Robertson, Melbourne.

Eyre, E.J., 1845. *Journals of expeditions…in the years 1840–1*,Vol. 2. Boone, London.

Flannery, T.F., 1994. *The Future Eaters.* Reed Books, Sydney.

Gammage, B., 2011 *The Biggest Estate on Earth. How Aborigines made Australia*. Allen & Unwin, Sydney.

Gill, A.M., 2009. *Underpinnings of fire management for biodiversity conservation in reserves*. Fire and adaptive management. Report 73, Department of Sustainability and Environment, Melbourne.

Gott, B., 1982. Ecology of root use by the Aborigines of southern Australia. *Archaeology in Oceania* 17:59-67.

Gott, B., 1983. Murnong - *Microseris scapigera*. a study of a staple food of Victorian Aborigines. *Australian Aboriginal Studies* 1983 :2-17.

Gott, B., 1993. *Use of Victorian plants by Koories. Flora of Victoria*, Vol. 1 D.B. Foreman and N.G. Walsh eds., pp. 195–211. Inkata Press, Melbourne.

Gott, B., 1999. Cumbungi, *Typha* species, a staple Aboriginal food in southern Australia. *Australian Aboriginal Studies*, 1999(1), 33–50.

Gott, B., 2005. Aboriginal fire management in south-eastern Australia: aims and frequency. *Journal of Biogeography* 32, 1203–1208.

Gott, B., 2010. VICUSE Database. (Copy at Australian Institute of Aboriginal and Torres Strait Islander Studies, Canberra)

Howitt, A.W., 1890. The eucalypts of Gippsland. *Transactions of the Royal Society of Victoria* 2, 81–120.

Keith, D.A., McCaw, W.L & Whelan, R.J., 2002. Fire regimes in Australian heathlands and their effects on plants and animals. *Flammable Australia*, In R.A. Bradstock, J.E. Williams & A.M. Gill, eds, Cambridge University Press, Cambridge.

Kohen, J., 1995. *Aboriginal Environmental Impact*. UNSW Press, Sydney.

Latz, P.K.,1995. *Bushfires and Bushtucker*. IAD Press, Alice Springs.

Lunt, I.D., 1998. Two hundred years of land use and vegetation change in a remnant coastal woodland in southern Australia. *Australian Journal of Botany* 46, 629–647.

Lunt, I.D. & Morgan, J.W., 1999. Effect of fire frequencyon plant composition at the Laverton North Grassland Reserve, Victoria. *Victorian Naturalist* 116, 84–89.

Lunt, I.D. & Morgan, J.W., 2002. The role of fire regimes in temperate lowland grasslands of south-eastern Australia. In *Flammable Australia*, R.A. Bradstock, J.E. Williams & M.A. Gill, eds, Cambridge University Press, Cambridge.

McLoughlin, L.C., 2004. Patterns of pre-European Aboriginal vegetation management by fire in South-eastern Australia. What do we know? *Victorian Naturalist* 121, 99-106.

Mitchell, T.L., 1848. *Journal of an Expedition into the Interior of Tropical Australia*. Longmans, London.

MORGAN, J. 1852. *The life and adventures of William Buckley* (1980 reprint) ANU press, Canberra.

MORGAN, J.W., 1998. Importance of canopy gaps for recruitment of some forbs in Themeda triandra dominated grasslands in south-eastern Australia. *Australian Journal of Botany* 46, 609–627.

MURRAY, Lt. 1802. *Extract from the logbook of the Lady Nelson. MS 8283*. Mitchell Library, Sydney.

PENMAN,T.D., CHRISTIE, F.J., ANDERSON, A.N., BRADSTOCK, R.A., CARY, G.J., HENDERSON, M.K.,PRICE, O.,TRAN, C.,WARDLE, G.M.,WILLIAMS, R.J., YORK, A., 2011. Prescribed burning: how can it work to conserve the things we value? *International Journal of Wildland Fire 2011*, 20,721-733.

QUIN, B.R. & WILLIAMSON, R.C., 1996. New Holland Mouse, *Pseudomys novaehollandiae* in South Gippsland, part 2. *Victorian Naturalist* 113, 281–288.

STOKES, J.L., 1846. *Discoveries in Australia. Voyage of the Beagle 1837–1843 Vol. 2*. Boone, London.

STUWE, J., 1994. The Role of Fire in Ground Flora Ecology. *Victorian Naturalist* 111, 93–95.

WARK, M.C., 1996. Regeneration of heath and heath woodland in the North-eastern Otway Ranges three to ten years after the Wildfire of February 1983. *Proceedings of the Royal Society of Victoria* 108 121-141.