LANDSCAPE AND FLORA OF SW VICTORIA

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INTRODUCTION

This talk will include **parts 1-3** in the following list of topics:

1. Origins of Australian landform and flora
2. Classification of flora
3. Regional landscapes and flora
4. Impact of settlement on landscape and flora
5. Fire and plant ecology
6. Aboriginal utilisation of flora

ORIGINS of AUSTRALIAN LANDFORM and FLORA

500 million years BP (Silurian period) – in the Gondwana super-continent at the South Pole the Grampian mountain range was being formed by the sedimentation of mudstones and sandstones. Side pressure over the granite bedrock caused thrust-stacking and folding of the layers. Igneous activity 420 million years BP (Devonian period) led to granite intrusion into the sediments and, to the west of the Grampians, the magma reached the surface as rhyolyte.

The super-continent was later to split and some of the components then drifted slowly north to form S. Africa, S. America, Australia, New Zealand and India. A large block – Antarctica – stayed at the pole.

200 million years BP (Jurassic Period) – Ferns, Cycads and Gymnosperms (including Celery Top Pine and Wollemi Pine) and *Nothofagus cunninghamii* (Myrtle Beech) dominated the land. This was the "Age of Reptiles". Gondwana was wet and warm at this stage. The trachyte plugs around Coleraine (e.g. Giant Rock) formed at this time.

55 million years ago (earlyTertiary Period, Paleocine epoch) – Australia had separated from Antarctica and drifted north to a drier climate. The Murray and Otway Basins filled with sediment when the sea invaded the continent. *Nothofagus* (Southern Beech) was still prominent but Casuarina and Banksia began to appear amidst the rain-forest conifers. The first Eucalypts and Acacias appeared later, dominating the hills in the late Tertiary.

25 million years ago (Tertiary Period, Miocene epoch) – a subtropical monsoonal climate produced our Latrobe Valley coal and strongly laterised, impoverished soils across Australia – soils that our flora was to adapt to so spectacularly. The sea again invaded the Murray and Otway Basins depositing limestones and sandstones. In SW Victoria, dunes of Lowan Sands in our mallee-bearing "deserts" arose from wind-blown siliceous Parilla Sands (low in clay and calcium carbonate) in South Australia. About 20 million years BP (mid-Cainozoic) the Grampian Range was an island in a shallow sea.

Heathlands – with *Epacridaceae, Fabaceae, Proteaceae, Myrtaceae* – are extremely species-diverse yet relish infertile, acidic, sandy soil. Those soils have often been of little use for agriculture and many of our National Parks (e.g. Little Desert NP, Grampians/Gariwerd NP, Lower Glenelg NP) exist for that reason, and the efforts of conservationists to pressure politicians to preserve some relics of that heritage.

A shift to a drier climatic phase, accompanied by more frequent fires, caused the ascendancy of the Eucalyptus genus and other sclerophyllous (hard-leaved) genera. This did not happen in NZ, and to a lesser extent in Tasmania, where Myrtle Beech (*Nothofagus cunninghamii*) is still

present. Myrtle Beech can still be found in the wetter parts of Victoria (e.g. Otway Ranges) and you will recall that 100 individual Wollemi Pines (a relic of the Jurassic & Cretaceous Periods, from 200 million years BP) were found in a deep gorge in the Blue Mountains in 1994. These trees are up to 40 m tall and, from DNA analysis, appear to be the same organism although spread over a km or more of gorge. The Celery Top Pine (*Phyllocladus aspleniifolius*) is still present in Tasmania but the pollen has been found below the volcanic ash layer in the Grange Burn near Hamilton. That happened in relatively recent times (<5 million years BP) where the flows of volcanic lava helped to change the nature of the flora.

4 million years ago (Tertiary Period, Pliocene epoch) – the "Newer Volcanics" created sheets of basalt over SW Victoria. There were major flows 4.5 million years ago.

<2 million years BP (Quaternary Period, Pleistocene epoch) – created alternating cold-dry/warm-wet conditions that markedly affected the present distribution of our flora. There were also major flows of basalt 4-40 m deep in the Hamilton area around 2 million years ago.

Recent volcanism (<400,000 years BP) – about 330,000 years ago Mount Rouse (Kolor) erupted and sent a river of basltic lava down to the coast at Port Fairy. More recent volcanic action (31,000 years BP for Mt Napier (Tappoc) & Mt Eccles (Budj Bim) produced scoria cones, lava flows and "stoney rises" over the older lava landscape. The Tower Hill eruption is perhaps younger. The vegetation on the inland areas is restricted, often with only one species of eucalypt, Manna Gum (*E. viminalis*), and with Blackwood (*Acacia melanoxylon*) the other dominant tree.

Recent glacial phases (10-40,000 years BP) – sea level rises and falls of up to 140 m resulted, thus markedly affecting huge areas of vegetation. The land bridges between Australia and Papua-New Guinea and between Victoria and Tasmania were also lost with the last rise. There is evidence of glaciation on the hills between Coleraine and Cavendish.

CLASSIFICATION

Non-vascular plants – fungi, lichen, moss, yeast, mould, smut – cosmopolitan plants in many thousands, without chlorophyll; parasites or saprophytes that reproduce asexually by spores.

Fungi have fruiting bodies and hyphal strands that explore the surrounds and gather nutrients. Fungi cause decay in damp material and some invade trees. Others, such as Dieback Fungus (*Phytophthora cinnammomi*) can infect the roots of Proteaceae and Myrtaceae and kill the plants. Fungal *Mycorrhiza* grow on surface of roots and explore a vast volume of soil beyond, absorbing P, N, S, K & water that is shared with the tree (and the fungi get carbon from photosynthesis by the tree) – there are thousands of fungal species in such symbiotic associations where the vascular plants (eucalypts in particular) could not survive in nutrient-poor situations without the presence of fungi (Keane *et al*. 2000).

Basidiomycetes – spores produced from gills or tubes

- Agarics – gilled fungi *e.g. Amanita, Lepiota, Armillaria, Lactarius, Coprinus, Cortinarius*
- Polypores – gilled fungi with no veil – Bracket fungi such as *Polyporous, Fomes, Corrolus*
- Boletus – gilled Omphalotus have a veil; *Boletus* (spores from tubes) are main group
- *Clavariaceae* (Coral Fungus) – >35 sp. in Vic: main genera are *Clavaria & Ramaria*
- Gasteromycetes (Puff-balls, Earth Stars, Birds Nest) – *Geastrum, Calostoma, Cyathus etc.*

Ascomycetes – spores produced in long flask-like cells

- Cordyceps (Vegetable Caterpillars)
- Morels – *Morchella* spp.
- Orange-peel fungus – *Aleura* spp.

Vascular plants – ferns, confers, flowering plants – about 14,000 native species in Australia, incl. about 3000 in Victoria and almost 1000 in the Grampians/Gariwerd NP.

Pteridophyta – ferns – reproducing by spores – 24 families in Victoria

Spermatophyta – seed-producing plants

- Gymnospermae – conifers – naked seed, stamens & carpels ranged in cones – 1 family
- Angiospermae – flowering plants – "seeds in a vessel", stamens & carpels set in flowers
  - Monocotyledoneae – 1 cotyledon (seed leaf) and no cambium in stem – 33 families
  - Dicotyledonae – 2 cotyledons per seedling and cambium in stem – 120 families

REGIONAL LANDSCAPES AND FLORA

Geology and geography – these factors largely determine the flora that grows in a landscape. Rainfall, temperature, humidity, drainage, frost, aspect, salinity and fire determine what grows on a particular soil. Micro-climate effects (shelter, shade) are also important for many species.

Soils – The soils are usually derived from the local base rocks or sediments but aeolian (windblown) sand or sediments moved by water from elsewhere can modify the picture.

Soil factors – Gibbons & Ronan's chapter on soils in Foreman & Walsh (1993) *Flora of Victoria* provides a good account of the impact of soil factors on plant ecology. The percentage of clay controls the water-holding capacity of a soil and this affects what will grow. Soil acidity and fertility are also major factors. Cracking clay soils (as on basalt plains) disrupt roots and allow drying of the soil, prevent the growth of some species (e.g. Swamp Gum can cope with that but River Red Gum cannot manage as well).

The following outline of 15 regional landscapes and flora is that of Bird (1996), based on the landscape categories of Gibbons and Downes (1964) and Sibley (1967):

1. **Volcanic Plains** – old (2-4.5 million years) basalt plains with shallow, clayey soils), young (<40,000 years) scoria cones with porous soils), and wetlands. The basalt plains were grassy plains and open woodlands with *E. ovata* (Swamp Gum), *Banksia marginata* (Silver Banksia), *A. mearnsii* (Black Wattle), *A. melanoxylon* (Blackwood), *A. paradoxa* (Hedge Wattle), *Allocasuarina verticillata* (Drooping Sheoak), *Bursaria spinosa* (Sweet Bursaria) and *Ozothamnus ferrugineus* (Tree Everlasting), and *Melyctus dentata* (Tree Violet) on rocky banks. *Leptospermum lanigerum* (Woolly Tea-tree) is found along protected rivers and streams. *L. continentale* (Prickly Tea-tree) and *Melaleuca squarrosa* occur rarely. The cones (e.g. Mt Napier, Mt Eccles) support *E. viminalis* (Manna Gum) as the sole eucalypt and *A. melanoxylon* (Blackwood), with Sweet Bursaria and Tree Everlasting as the main tree/shrubs.

   Only about 550 species of plants have adapted to parts of this environment. Some areas were virtually treeless and dominated by Kangaroo Grass (*Themeda triandra*), Wallaby grasses (*Austrodanthonia* spp), Spear Grasses (*Austrostipa* spp.) and Tussock Grasses (*Poa* spp.). Amidst those grasses were/are native lilies (*Bulbine, Dianella, Tricoryne, Burchardia, Caesia, Arthropodium, Hypoxis,* etc), orchids (*Thelymitra, Diuris, Pterostylis, Microtis*) Blue Devils (*Eryngium ovinum*), Beauty-heads (*Calocephalus* spp.), Common Everlasting (*Chrysocephalum apiculatum*), Bindweed (*Convolvulus erubescens*), Creeping Bossiaea (*Bossiaea prostata*), Cut-leaf Goodenia (*Goodenia pinnatifida*), Rice flowers (*Pimelia curviflora* and *P. humilus*), Running Postman (*Kennedia prostrata*), Candles (*Stackhousia monogyna*), Magenta Storksbill (*Pelargonium rodneyanum*) -, Blue Bells (*Wahlenbergia* spp.).

   The DSE brochure ***Grassland Species of the Victorian Volcanic Plain*** has illustrations of these and many other species.

Less than 1% of the Volcanic Plains grasslands remain in a natural state (and most of that is on road reserves) as a result of exploitation for agriculture and it is now EPBC-listed.

Drainage on the volcanic plains has resulted in the loss of 75% of freshwater wetlands, and 90% of those left are on private lands and subject to loss from plantations, cropping and climate change. In the GHCMA region at least 60% of wetlands have been lost as a result of drainage. Clearly, we need to restore some very large wetlands in order to retain this important resource for the future.

2. **Laterised Tablelands** – shallow, acid, sandy loams over clay, derived from Tertiary sediments – grassy woodlands of *E. camaldulensis* (River Red Gum), *E. viminalis* (Manna Gum) and *E. aromaphloia* (Scent-bark), with *E. leucoxylon* (Yellow Gum), *E. melliodora* (Yellow Box) and *E. microcarpa* (Grey Box) in northern areas.

   The Tablelands ("Red Gum country") has representations in the Dundas region (north of the Wannon River at Cavendish, as far as Toolondo and Harrow) as well as east of the Hopkins River between Wickliffe and Woorndoo, and east of the Grampians near Yarrum. The region carries common species already mentioned as well as an enormous list of others, including Purple Diuris (*Diuris punctata*), Clover Glycine (*Glycine latrobeana*) and *A. exudans* (Varnish Wattle). The latter occurs on gravelly rises (e.g. roadsides near Casterton) as a broad-leaved form, contrasting with the darker, narrower phylodes of *A. vernicflua* (also Varnish Wattle) in the Grampians/Black Range population. The Fulham Streamside Reserve (see Bird 2008a) has some 320 native species, although some of these are on part of the reserve that is more typically Wimmera Clay and Sandplain land-zone.

   The flora of the Wannon River (Bird 2011b) can be regarded as being from the Laterised Tableland land-zone, although the volcanic plains press hard towards the Wannon Falls and near Bulart. From the Red Rd Bridge to Wannon Falls Reserve 363 native species have been recorded. Notable plants include *Glycine latrobeana* (Clover glycine), *Gahnia clarkei* (Tall saw-sedge), *Dicksonia antarctica* (Soft tree-fern), *Dodonaea cuneata* (Wedge-leaved hop-bush), *Myoporum viscosum* (Sticky boobialla), *Dillwynia cinerascens* (Grey parrot-pea), River Bossiaea (*Bossiaea riparia*) and Clustered Bush-pea (*Pultenea dentata*). Rare outliers from the Wimmera and further north also occur: *Aristida ramosa* (Cane wire-grass), *Triodia bunicola* (Porcupine grass), *Pimelia stricta* (Gaunt rice-flower), & *Philotheca angustifolius var. angustifolius* (Small-leaved wax-flower).

3. **Glenthompson Rolling Hills** – Ordovician quartzose sandstone, shale and metamorphic rocks, with Tertiary sediments of sand, gravel and ironstone, Devonian granodiorite and rhyolite, Cambrian chert and greenstone or Silurian quartzose sandstones, gave rise to infertile sands and sandy-loams that are erodible by wind and water. Grassy woodlands of *E. camaldulensis* (River Red Gum), *E. viminalis* (Manna Gum) *E. ovata* (Swamp Gum), *Banksia marginata* (Silver Banksia), *A. mearnsii* (Black Wattle), *A. melanoxylon* (Blackwood), *A. paradoxa* (Hedge Wattle), *Allocasuarina verticillata* (Drooping Sheoak) and *Bursaria spinosa* (Sweet Bursaria) once graced these hills and plains.

   A notable roadside is to be found near Back Creek, a few kilometres west from Wickliffe. The reserve there contains a host of species, including those mentioned for Basalt Plains, and also a wonderful display in spring and early summer of Featherheads *(Ptilotus macrocephalus*) and Hoary Sunray (*Leucochrysum albicans*). Regrettably, a number of damaging incidents (herbicide and cultivation) have compromised this magnificent area (perhaps the best small area in all of Victoria) – and all in the misplaced belief that was a good firebreak (the area is burned every year). The affected strip – some 10 m wide now – has produced exotic grasses, including Phalaris and Bent Grass, although the natural infertility of the soil may enable the natives to fight back.

4 Grampians Ranges & Plains – infertile, acidic soils from quartzose sandstones and granite on outwash slopes, with alluvial silty-loams on flats. The soils support a wide range of eucalypts and around 950 other native flora. This 180,000 ha "island" of native vegetation is on land formed some 500 million years ago as deposits in a tropical sea and then propelled skyward by a tectonic event of folding and faulting a million years later to create the ranges (Cayley and Taylor 1997). It exists now amidst a sea of agriculture. The Western Black Range and Dundas Range are of similar origin. The land was not alienated for agriculture because no-one wanted to buy such poor land! (pine plantations were established at Glenisla and Mt Difficult in the 1960s). Granite intrudes at Zumsteins, Mafeking, Victoria Valley and Eastern Black Range. Images of the Grampians landscape and flora are found in Pouliot & Wettenhall (2006).

The vegetation ranges from sub-alpine (*Grevillea confertifolia, E. pauciflora* and Snow Daisy) on the Major Mitchell Plateau to River Red Gum flats and wet heaths and swamp flora (e.g. *Melaleuca squamea* and *M. squarrosa*). At higher levels may be found *B. saxicola* (Rock Banksia) and on the sand ridges of the plains (e.g. near Glenisla Flat) are *B. ornata* (Desert Banksia). *B. marginata* (Silver Banksia) varies from a stunted shrub 1 m tall (on wet heaths or sub-alpine areas) to a tree 15 m tall, depending on the situation. On the slopes is a range of closed-forest on moist, east or south-facing gullies (*E. obliqua & E. alaticaulis* [related to *E. cypellocarpa*], Rough Tree Fern (*Cycathea*), Long-leaved Hovea (*Hovea corrickiae*), to *E. melliodora, E. leucoxylon, E. baxteri, E. willisii ssp. falciformis* (Grampians Peppermint) Long-leaved Box (*E. goniocalyx*) and *B. marginata* on the drier northern outwash slopes.

At least 21 species of higher plants are endemic to the Grampians, including, *Thryptomene calycina* (Grampians Thryptomene), *E. "alpina'* (now *E. serraensis & E. verrucata*), *Grevillea dimorpha* (Flame grevillea), *G. confertifolia* (Grampians Grevillea), *Calytrix sullivani* (Grampians Fringe-myrtle), *Bauera sessiliflora* (Showy Bauera), *Stylidium soboliferum* (Grampians Trigger-plant), *Pultenea patelliflora* (Mt Byron Bush-pea), *P. subalpina* (Rosy Bush-pea), *Pultenaea victoriensis* (formerly *P. scabra), Dillwynia oreodoxa* (Grampians Parrot-pea), *Allocasuarina grampiana* (Grampians She-oak), *Grevillea gariwerdensis* and *Leptospermum turbinatum* (Shiny tea-tree).

There are disjunct occurrences of *Eucryphia lucida* (Leatherwood, also in Tasmania), *Cyphanthera anthocercidia* (Large Ray-flower, also in NSW), *Marianthus bignoniaceus* (Orange Bell-climber, also in Mt Loft Ranges), *Borya miriabilis* (Pincushion Grass; a related species is present in WA), *Howittia trilocularis* (Blue Howittia, also in Gippsland), *Pomaderris apetala* subsp. *apetala* (also in Tasmania), *Banksia saxicola* (Rock Banksia, also in Wilson's Promontory).

The Grampians has, at 51 m, possibly the tallest River Red Gum in Australia, near the former Lodge Rd Hall in the upper Victoria Valley (see Bird 2011c). The Jan. 2006 wildfire badly damaged the tree (burning out the butt and scorching off the foliage). It is/was a magnificent specimen (see Bird 2008c) with a girth of 7.1 m at 1.3 m above ground. That, however, is less than the 12.1 m for Big Red at Mullinger Swamp on the SA border near Kybybolite, 13.1 m for the Dwyers Ck tree near Mirranatwa or the 9.9 m tree on Andrew Beveridge's property "Bowacka", 9.2 m for a tree on Moran's farm at Nangeela, or 7.7 m for the Bilston's Tree at Brimboal (touted as "The World's Largest Red Gum").

These trees are insignificant when compared with the 100-m-tall Mountain Ash (*E. regnans*) in the Styx Valley, Tasmania, the 57 m Cypress in Mexico (girth 45 m) or the magnificent Redwoods of America. The 84 m General Sherman has a breast height girth of 45 m (DBH 7.6 m) and volume of 1500 m^3 (cf. a max. vol of Red Gums of 75m^3).

5 Casterton Rolling Hills – alkaline, sandy clay loams and cracking "black" clays. These were the open grasslands of Kangaroo Grass (*Themeda triandra*), Wallaby Grass (*Austrodanthonia* spp.*)*, Weeping Grass (*Microlaena stipoides*), Tussock Grass (*Poa* spp.) and Speargrass (*Austrostipa* spp.), with scattered *E. camaldulensis* (River Red Gum), that attracted the pastoralists in 1838, after Major Mitchell traversed the region in 1836. These grasslands were soon degraded by over-stocking or continuous stocking (most of the native perennials cannot stand the latter) and within 10 years land was reported as being eroded, with salt breaking out in the gullies (see Bird 2011a). An interesting stand of *E. pauciflora* occurs on Satimer Rd, Wando Heights.

6 Cobboboonee Basaltic Tableland – well-drained, fertile, weathered gravelly sandy loams. Trees include *E. obliqua* (Messmate), *E. willisii ssp. falciformis* (Grampians Peppermint), *E. baxteri* (Brown Stringybark), *E. ovata* (Swamp Gum), *E. viminalis* (Manna Gum) and *A. melanoxylon* (Blackwood). This area has been cut over for timber, mainly from Messmate, but in 2008 a significant portion was reserved in a National Park and Forest Park. Massive Blackwood and Messmate can be seen in the wet gullies at Surrey Ridge Picnic Ground.

7 Wimmera Clay and Sand Plains – marine and alluvial sediments giving heavy clay soils and sandy dunes. Woodlands of *E. microcarpa* (Grey Box), *E. leucoxylon* (Yellow Gum), *E. melliodora* (Yellow Box) and *Allocasuarina luehmanni* (Buloke) on the clay plains and rises, with *E. arenacea* (Desert Stringybark), *Callitris* spp. and *Banksia* spp. on the deep sands.

8 North Kanawinka Sand Plains – Sheets and dunes of acid white sand overlying clayey lagoon deposits of the coastal plain, extend north-south from Dartmoor to Edenhope. Parallel swamps occur in parts. Sand overlies laterised tableland in the eastern part of the zone (Dergholm, Wilkin and Weecurra). Soils are generally leached, acidic sands, poorly drained on the flats. Major trees are Grampians Peppermint, Swamp Gum, Brown Stringybark, Manna Gum and Black Wattle). Yellow Gum, River Red Gum, Messmate and Snow Gum occur in odd spots throughout, but mainly in the north. *E. fasiculosa* (Pink Gum) occurs on parts of the north-west area (Dergholm-Palaijelo).

9 South Kanawinka Sand Plains – sheets and dunes of acid white sand overlay clayey lagoon deposits of the coastal plain, occurring in patches from Narrawong, Portland through Mumbannar into South Australia. Sand also overlies weathered Cobbobboonee basalt. The soils are poorly drained, highly leached, acidic sands. The vegetation is wet heath with stunted trees – mostly Brown Stringybark, Manna Gum, Swamp Gum, Grampians Peppermint, with some Snow gum and Gippsland Mallee (*E. kitsoniana*).

10 Coastal Plains – poorly drained sandy loam or clay loam alluvium over basalt or limestone. Major trees were *E. ovata* (Swamp Gum) *A. mearnsii* (Black Wattle) and *A. melanoxylon* (Blackwood) and *Banksia marginata* (Silver Banksia). *Leptospermum continentale* (Prickly Tea-tree) and *L. lanigerum* (Woolly Tea-tree) are significant shrubs in this zone.

11 Coastal Sand Sheets & Dunes – calcareous sand over limestone. Major trees are *E. baxteri* (Brown Stringybark), *E. ovata* (Swamp Gum), *E. viminalis* (Manna Gum), *Allocasuarina verticillata* (Drooping Sheoak), *Banksia marginata* (Silver Banksia), *Myoporum insulare* (Boobialla) and *A. longifolia* ssp. *sophorae* (Coast Wattle). This area includes much of the Lower Glenelg NP and there, on the limestones cliffs and hanging over the water near Sapling Creek, may be found *E. leucoxylon* ssp. *megacalyptra* (the large-fruited form).

12 Parrie Yalloak Plains and Swamps – this is a flat depositional plain of sand and clay, lying between the Grampians Range and the basalt plains, with many fresh and saline

swamps and associated lunettes. The freshwater swamps are large and the lunettes are extensive, deep, infertile and erodible sands. The saline swamps are small and the lunettes are sandy loam or sandy clay-loam. The major trees are River Red Gum and Swamp Gum, with Manna Gum, Drooping Sheoak, Black Wattle and Silver Banksia on lunettes.

13 **Ararat Hills and Plains** – hills, rolling plains and undulating plains comprise the landscape. The erodible sandy-loam soils are derived from quartz from the intruding granite, quartz reefs and Ordovician sedimentary rock (mudstone, shale and sandstone) and metamorphosed sediments. The major trees are Long-leaf Box, Red Stringybark (*E. macrorhyncha)*, Yellow Box, Scent-bark, Yellow Gum, Ddrooping Sheoak and River Red Gum.

14 **Strathdownie Plain** – a low-lying plain of sandy-clay river alluvium over a limestone basement, with many small to medium sized swamps, some covered with sand. The major tree species are River Red Gum, Swamp Gum, Grampians Peppermint and Silver Banksia, with Brown Stringybark and Manna Gum on the sandy rises. Most of this area has been extensively drained and the wet heath vegetation has been cleared away.

15 Lowan Limestone Plains – this is a flat plain of Tertiary limestone in the Apsley-Edenhope area, covered with a veneer of Quaternary alluvium and dotted with small lakes and swamps. Major trees are River Red Gum, Yellow Gum and Moonah; Pink Gum and Silver Banksia occur on slight sandy rises and ridges.

IMPACT OF SETTLEMENT ON LANDSCAPE AND FLORA

A short history of the impacts of settlement and subsequent events on the landscape, people, flora and fauna may be seen in Bird (2011a). In brief, we can summarise those impacts as:

1. Squatters and sheep – compaction of soil, continuous stocking of native pasture (eradicating many native perennial grasses and herbs) and loss of many native species.
2. Fencing and fire – wire fencing from 1850, accentuated by labour shortage in 1860s gold rush. Reluctance to burn pastures after fences erected led to tree regeneration.
3. Land Acts of 1860s – selections of up to 260 ha – pastoral leases not issued after 1870. Beginning of land-clearing for more intensive farming.
4. Clearing – obvious from 1860 onwards, particularly after Land Act of 1884 which required trees to be cleared to obtain freehold.
5. Drainage – fluke and end of gold era – massive loss of wetlands from 1890s.
6. Closer Settlement Acts – 1898 onwards (1920s Dundas Tableland) – land clearing.
7. Soldier Settlement schemes – sub-division of large estates
8. Forestry – Red Gum milling from 1890 and wattle bark harvesting
9. Tax concessions for clearing marginal lands – developed land then sold exempt from capital gains
10. Superphosphate and subterranean clover – intensive farming and loss of native pastures
11. Pine plantations on Crown lands – >100,000 ha in 1960-1970s in Portland-Nelson-Dartmoor-Weecurra-Wilkin-Grampians.
12. Land Conservation Council – establishment of first National Parks and reserves (e.g. Lower Glenelg, Little Desert, Mt Richmond).

FIRE AND PLANT ECOLOGY

Fire effects on the plains

Fire has fashioned the environment in which the present flora resides. Aborigine burning had a major influence on botanical composition and numbers of plants (see Bill Gamage's monumental work for a full discussion). The plains were kept fairly open (free of large trees) by frequent, although small, managed fires lit in autumn. It is thought that a mosaic was achieved of burned areas and other areas burned at other times. This enabled the hunters to more effectively target the game that was attracted to the green young grass. They did not employ large fires.

Fire was also used on the plains by the women when harvesting Yam Daisies (*Microseris lanceolata*), a major cultivated source of food. The impact of lightning strikes in summer would have been lessened by the annual mosaic burn pattern instituted by the people.

The impact of annual burning of some road reserves over a period of 50 or more years was twofold:

- It reduced the invasion of the site by exotic grasses from adjacent paddocks (due to loss of nutrients, destruction of seed and direct impact on perennial pasture)
- The native flora was reduced to those species that have survived the treatment – but the population appears stable and the species list quite diverse.

Some research has shown that grasslands require burning to maintain a diverse population. This is particularly evident with Kangaroo Grass, where the species can leave no space for other grasses or herbs. The suggestion is that a fire frequency of 3-5 years is needed to control the Kangaroo Grass. However, some reserves are not dominated by Kangaroo Grass and there is little evidence that such frequent fires are needed, a fact often overlooked by academics.

Fire effects in our forests, woodlands and heaths

The impact of fire on species in these ecological zones depends on the following factors:

- Plant niche – degree of protection afforded in wetlands, rocky sites, damp gullies
- Fire sensitivity of species – protective bark, oil in foliage, lignotubers, epicormic shoots (some Eucalypts and *Melaleuca*), tubers or corms (Lilies, Orchids), seeds in capsules (*Hakea, Grevillea, Eucalyptus, Banksia, Allocasuarina*), hard seeds (*Acacia, Fabaceae* - Pea-flowers).
- Fire intensity – intense fires can kill many species and destroy old trees (and the refuge hollows that are important for over 80 species of birds and most gliders and possums.).

  Fire intensity depends on:
  - Fuel mass (particularly dry "fine fuels")
  - Plant species present
  - Fuel moisture – a function of seasonal rain and vegetation type
  - Temperature
  - Wind – hot, strong ,drying winds are particularly problematic
  - Terrain
  - Ignition method
- Fire season – summer-autumn burns appear to be more "natural", leading to better germination and establishment. Spring burns may also be implicated in greater problems with *Phytophthora*, since open canopies allow higher soil temperatures and greater fungal activity.
- Fire frequency – burning on a fixed short rotation of 3-4 years can be disastrous for some plants and most animals and, equally, if the fire interval is too long then species may be lost.
  - Time to set seed – if longer than the fire interval the species may be lost (thus, Desert Banksia can be eliminated by frequent fire, whereas Silver Banksia is not (it can re-sprout).
  - Age of the stand – a climax species like *E. delegatensis* (Alpine Ash) can die out after 300-400 years without fire, giving way to Nothofagus and Blackwood.
- Fire size – fires on a landscape-scale of many hundreds or thousands of hectares could remove many species, particularly if repeated often or if the fire is so intense as to leave no unburned patches. There is then no possibility of recruitment from patches within the burned area. The impact on Potoroo, Bandicoot, *Pseudomys* spp., *Antechinus* spp., reptiles and birds may also be disastrous because they have a specific requirement for shelter, for nesting and for feeding.

UTILIZATION OF FLORA BY ABORIGINES

A good reference is that of Beth Gott (1993) in Vol.1 of Flora of Victoria (see Foreman & Walsh). James Dawson's classic 'Australian Aborigines' of 1881 has recently been re-published (Dawson 2009) and has a lengthy discussion of Aborigne food items, plant and animal.

Plants used for food include:

- *Microseris lanceolata* (Murnong) – tubers were the main source of carbohydrate
- *Pteridium esculentum* (Austral Bracken) – starchy rhizomes used to make bread
- *Clematis microphylla* (Small-leaved Clematis) – woody root used to make a dough
- *Polyporus sp.* (Native Bread) – underground sclerote eaten raw or cooked
- *Linum marginale* (Native Flax) – seeds were ground to make a flour
- *Orchidaceae* – tubers of many species were a source of carbohydrate (fructans)
- *Liliaceae* – tubers of many species were a source of carbohydrate (fructans)
- *Cyathea* & *Dicksonia* (Tree Ferns) – top 0.5 m of stem stripped for carbohydrate
- *Typha* (Bulrush) – young shoots eaten in early summer
- *Solanum* spp. (Kangaroo Apple) – fruit eaten when over-ripe (orange and soft)
- *Coprosma quadrifida* (Prickly Current-bush) – red drupes eaten
- *Exocarpos cuppressiformis* & *syrticloa* (Cherry Ballart & Coast Ballart) – pinkish fruits eaten
- *Kunzea pomifera* (Muntries) – fruits eaten in summer (traditional gathering on the coast)
- *Leucopogon parvifolius* (Coast Beard-heath) – small, white drupes (not mentioned by Gott?)
- *Rubus parvifolia* (Small-leaved Bramble) – pinkish fruits eaten
- *Carpobrotus* spp. (Noon Flower) – fruits and young, green leaves eaten
- *Acacia* (Wattles) – Black Wattle and other gums used for eating, as a syrup or as a glue. Presumably the seeds of various acacias were also collected and ground up for flour.
- *Banksia* spp. - flowers for nectar
- *Xanthorrhoea* spp. – flowers for nectar
- *Eucalyptus spp.* – sugary deposits on leaves from lerp insects were eaten

Plants used for weapons, fabrics, medicines and fire-carriers:

- *A. melanoxylon* (Blackwood) – spear-throwers and shields
- *Allocasuarina verticillata* (Drooping Sheoak) – boomerangs
- *E. leucoxylon* and *E. tricarpa* (Yellow Gum and Ironbark) – boomerangs
- *Melaleuca & leptospermum* – heavy spears & digging sticks
- *Phragmites australis* (Common Reed) – light spears
- *Acacia* – bark stripped to make buckets
- *Typha* – to make string and nets after heating, chewing & soaking
- *Lomandra longifolia* – basket-making
- *Carex tereticaulis* (Poongort) – basket-making in *Gunditjmara* territory
- *Dianella spp.* (Flax-lily) – basket-making
- *E. camaldulensis* (Be-al, River Red Gum) – bark stripped to make canoes and shields
- *Centipeda cunninghamiana* (Sneezeweed) – a cure-all for fever, colds & skin infections
- *Acacia sp.* – tannins from wattle bark to treat indigestion, or applied to rheumatic joints
- *Piptoptorus sp.* – the fungus 'punk' was used to carry a smouldering fire

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