

Vegetation Changes in Mediterranean Australia Since European Settlement¹

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The Australian continent has only recently been exposed to the effects of the agricultural and industrial revolutions. Its existence was known to navigators of the late sixteenth century, and in particular its northern and western coasts were charted through the early seventeenth century but with few recorded excursions ashore.

The first European settlement was at Sydney in 1788, with the mediterranean regions being settled later: on the Swan River (Perth) in Western Australia in 1828 and in the Gulf of St. Vincent (Adelaide) in South Australia during 1836. At the time of exploration and settlement the continent was home to an aboriginal people who had been there for at least 40,000 years. The dingo (Canis familiaris dingo) was the only animal associated with these hunter-gatherers and their only tools were spears, woomeras (throwing sticks), boomerangs and stone axes, plus their use of fire. Fire, then and now, was used to drive large game into ambush, but more significantly it attracted game to the resulting soft regenerating growth which was also gathered by the women. The Australian aborigine did not practise agriculture; fire was the only agent used to modify the environment.

With the coming of European man, a continent that had known only the sparsely dispersed aborigines was invaded

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Abstract: This paper reviews the vegetation of the mediterranean regions of Australia: as it was before European settlement less than 200 years ago, its degradation under agricultural practices with introduced plants and animals, and current and future land use. The main agencies of change have been clearing, grazing, fertilizing, altered fire regime and introduced species, both exotic plant species and introduced grazers. There have been extinctions (both total and local) while other native species have had their demographics and distributions altered.

by an industrialized people and their retinue of plants, animals and microorganisms. The Australian biota which had evolved in isolation suddenly encountered the domesticated animals and crop plants of Europe. More tragically, the aboriginal people suddenly encountered the disease organisms of Europe, these together with alcohol and the more direct measures of poisoning and shooting, decimated their populations in just a few decades.

Mediterranean Climate in Australia

The occurrence of mediterranean climate in Australia has been interpreted differently by different authors. Those who have used the stricter interpretation of Köppen's Cs type (Köppen 1936), of a distinct summer half-year drought with appreciable rainfall during the winter months, include Aschmann (1973) and Milewski (1979). Specht and Moll (in press) extended this by including the cool semiarid (BSk) type. Figure 1 shows the distributions of these types, as well as that of the hot semiarid (BSh) type where this corresponds more closely with vegetation boundaries. The figure is redrawn from Dick (1975, after Köppen 1936). The mediterranean-type climate (Csa, Csb and BSk) occurs over 8 percent of the continental area.

The mediterranean regions are roughly the south-west of Western Australia and the eastern edge of the Great Australian Bight. Perth and Adelaide are the only centres of population in these regions. To the north the mediterranean regions are bounded by the arid (BW) zone while to the east the climate is humid with more evenly distributed rainfall (Cf).

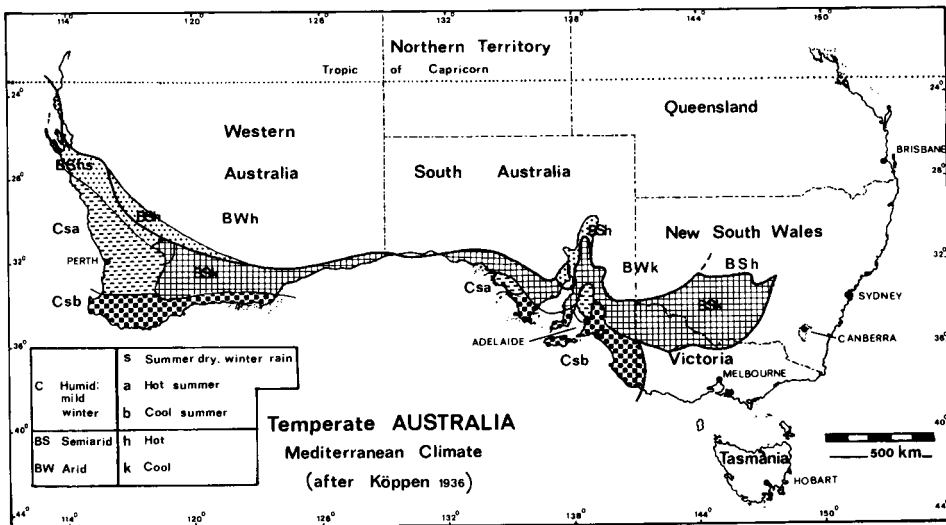


Figure 1--
The climates of temperate Australia after Köppen (1936) from a map by Dick (1975). The mediterranean climates (Cs) and cool semiarid (BSk) types are shown as well as the warm semiarid (BSh) type where this corresponds to vegetation boundaries

THE ORIGINAL VEGETATION

The vegetation of the mediterranean regions of Australia is illustrated in Fig.2 (based on a map by Moore 1969). This ranges from the impressive forests of south western Australia through the woodlands of characteristically "mallee" eucalypts, to the heathlands and chenopod shrublands. Given the uniformity of climate, the principal determinant of vegetation structure is the nature and nutrient status of the substrate and absolute amount of precipitation. The three major soil suites of southern Australia are the base-rich, nutrient-poor and calcium-rich soils, and their relationship to vegetation is reviewed by Specht and Moll (in press).

Temperate sclerophyll forests grow in mediterranean regions of the south-west of Western Australia. These forests are dominated by eucalypts, the wetter tall

open forests on soils derived from granite and gneiss by karri (*E. diversicolor*), the drier open forests on soils from the ancient laterites by jarrah (*E. marginata*). Woodlands are also usually dominated by eucalypts such as the black box (*E. largiflorens*) of south-western NSW, but may also be composed of acacias such as mulga (*A. aneura*).

The eucalypt shrublands or mallee is the form of vegetation most closely associated with the mediterranean regions. These multistemmed, low (usually less than 10m) eucalypts grow where the soil is sandy but often overlies an alkaline clay subsoil (Rossiter and Ozanne 1975). The understorey can vary from a chenopod synusium to one dominated by porcupine grass (*Triodia irritans*).

Much comparative work has been done on the sclerophyllous low shrublands or heaths of Australia and other mediterranean

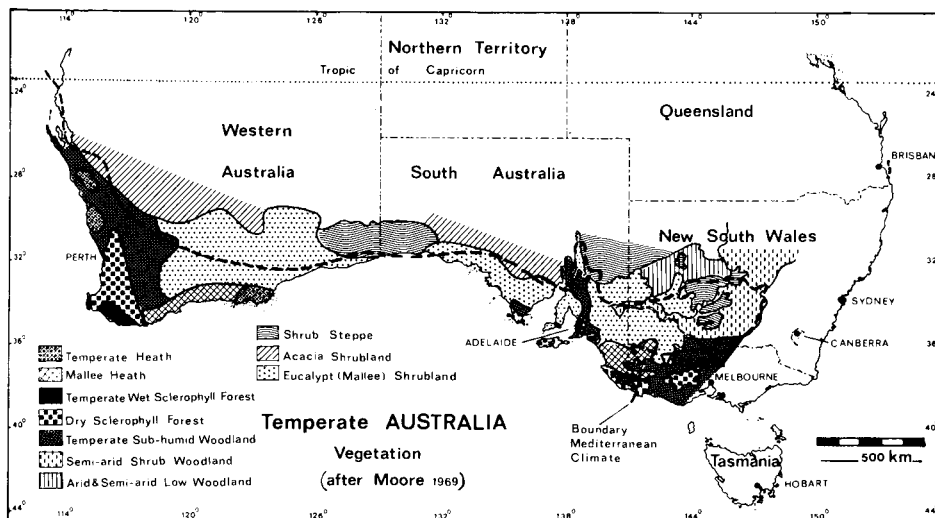


Figure 2--
The vegetation of the mediterranean regions of Australia from a map by Moore (1969). The limit of the mediterranean-type climate (Csa, Csb and BSk) is shown as a heavy dashed line.

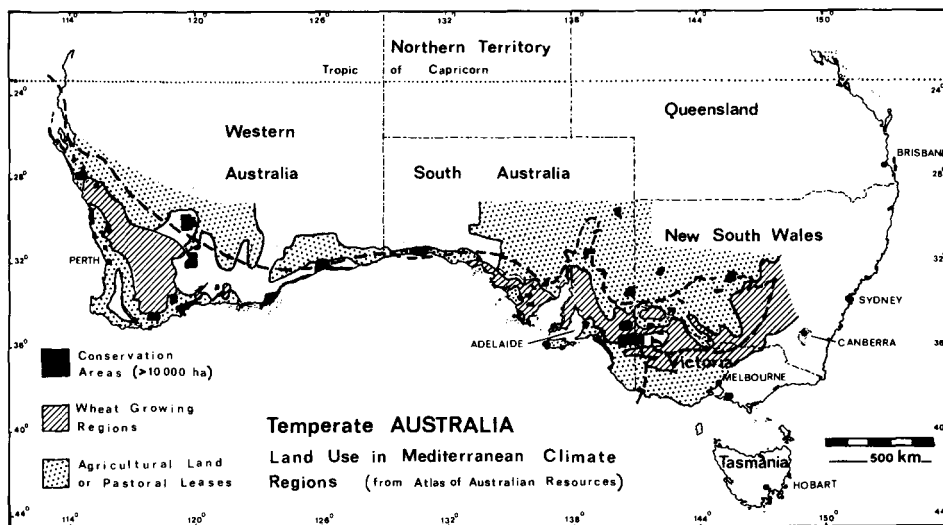


Figure 3-- Sources of alienation of the mediterranean regions of Australia. The distribution of the wheat belts and sheep grazing areas are shown and the limit of the mediterranean-type climate. The location of major conservation areas is also shown.

regions (e.g. Specht and Moll in press). Extending into the semiarid regions, this is replaced by chenopod shrublands or shrub steppe of Moore (1969).

The arid zone extends to the coast at the head of the Great Australian Bight and effectively divides the mediterranean regions into western and eastern provinces. These are recognised as separate floristic zones (Burbidge 1960), the south-western temperate zone being the richest floristic zone on the continent.

The vegetation of Western Australia has recently been mapped by Beard (see Beard 1979 for a review). Satellite imagery was used to map the environments (including vegetation) of South Australia (Laut et al 1977) and previously the vegetation was described by Specht (1971). The mediterranean region of Victoria has received the sporadic attention of ecologists and botanists. It is mapped on Carnahan's (1976) map of the natural vegetation of Australia. The vegetation of western New South Wales was mapped by Beadle (1948) and Fox (1980) is currently mapping it at a larger scale.

LAND USE IN MEDITERRANEAN REGIONS OF AUSTRALIA

Degree of Alienation

In less than 200 years of European settlement the entire continent has been alienated to some extent. The degree of alienation ranges from clearing and subsequent cultivation, altered nutrient levels, altered fire regime, to interaction with introduced animals and plants.

Figure 3 summarizes the major land uses or sources of alienation within the mediterranean regions. Major conservation areas are also shown; these are usually national parks, however some are aboriginal reserves.

The mediterranean regions correspond with the wheat belts and sheep grazing areas so that generally the level of disturbance is high (Adamson and Fox, in press). In such areas the alienation is compounded by the use of fertilizers, suppression of fire and an abundance of introduced animals and plants.

With the loss of habitat many native animals have become locally extinct. A small marsupial, the tamar wallaby (*Macropus eugenii*), which was once "the most plentiful and widely-distributed wallaby in the south-west" (Thomas, 1888), but "rapidly disappearing in the cultivated districts" (Shortridge 1909) is "now restricted to a few small scattered mainland colonies, and a number of islands" (Poole 1978).

The effects of fertilizers on composition and growth of heathlands in mediterranean South Australia have been demonstrated by Heddle and Specht (1975). Contamination of conservation areas, often islands in a sea of alienated land, is a major management problem. There is the dual response of death or suppression of native species and invasion by exotic species adapted to the higher nutrient levels.

At present about ten percent of vascular plants in Australia are exotics (Wace 1973). The highest incidences of these

There is a range of responses of plant species to the altered environments in which they now grow. The most extreme of these is extinction; this can be total and there are some species believed to be extinct (Hartley and Leigh 1979), or it can be local. An example of local extinction is of the highly palatable old man saltbush (Atriplex nummularia). This once widespread chenopod is now found in very restricted areas. Other palatable plants are now less dense and restricted compared to their former distributions. By contrast unpalatable species may become more dominant. These often woody shrubs such as turpentine bush (Eremophila sturtii) are an increasing problem in grazed semiarid regions such as western New South Wales.

There may also be delayed responses still working through ageing populations. Recent studies have demonstrated that many individuals of shrubs and small trees of the mediterranean and semi-arid zones may be older than European settlement here. Crisp (1978) has found that mulga (Acacia aneura) and other acacias can live to about 250 years and that bluebush (Maireana sedifolia) individuals reach similarly impressive ages. However, recruitment of seedlings is very rare or episodic, and given the current grazing pressure it is possible that individuals of these dominant shrubs will not be replaced. It is probable that this combination of very old and senescing individuals with reproduction suppressed by grazing pressure is a common feature of especially the semiarid zone. The progressive senescence and eventual death of living shrubs may cause slow extinction.

In discussing these changes to the vegetation I have emphasized the role of grazing. Altered fire regimes can have similar effects with some species being enhanced, others disadvantaged by changed intensity, frequency or season of burn.

Regeneration Studies

Although the history of settlement is short there are some outstanding studies of regeneration after degradation of habitat. One of the most famous is for Koonamore in the semiarid region of South Australia (Osborn, Wood and Paltridge 1935). The vegetation reserve was established in 1925 and permanent quadrats were studied from 1926. In particular permanent photopoints have supplied data on the regeneration (after sheep and

rabbit grazing) of the perennial vegetation (Hall, Specht and Eardley 1964).

Much of the mallee country of north-western Victoria has been cleared and Onans and Parsons (1980) have recently reported on the regeneration of sites cleared and left undisturbed for periods up to 39 years. When an adequate seed source is lacking they found areas would regenerate to a shrubland of seral species of Acacia and Dodonaea.

THE FUTURE OF THE VEGETATION IN MEDITERRANEAN REGIONS OF AUSTRALIA

Vast areas of the mediterranean regions of Australia have been modified since the arrival of European settlement. Even where the overt forms of alienation such as clearing are absent, there are covert forms in the introduced animals with their destructive grazing. The grazing pressure from feral and domestic animals may have reduced some long-lived shrub and tree species to senescent populations which will not be replaced unless the grazing pressure is reduced.

There are some large conservation areas within the mediterranean regions and attempts are being made to minimize the impact of exotic grazers. However park authorities must accept the responsibility when land is acquired to attempt to have it revert to its pre-European condition. As well as removing exotic weeds and pests, this means removing sources of nutrients and maintaining "natural" fire regimes (or at best a mosaic of patches of different ages since last fire).

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