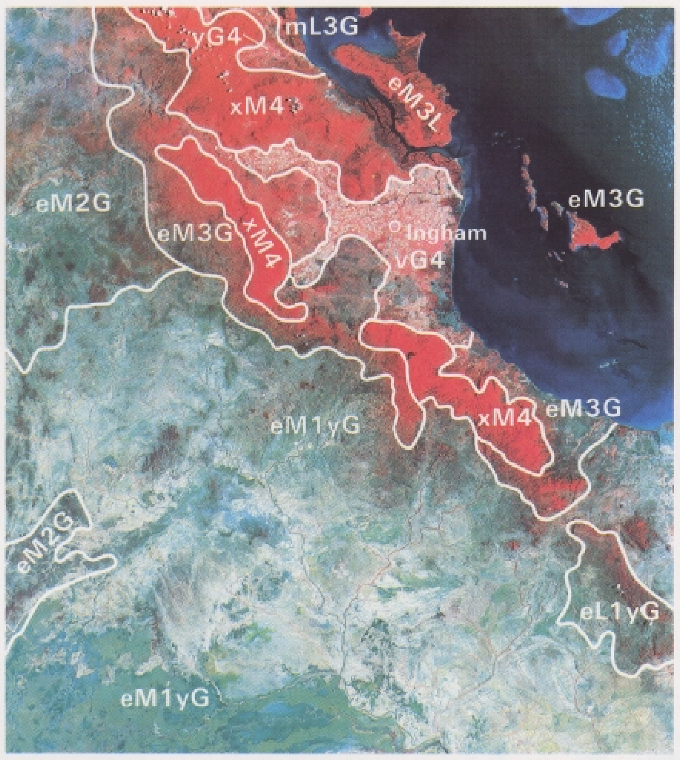
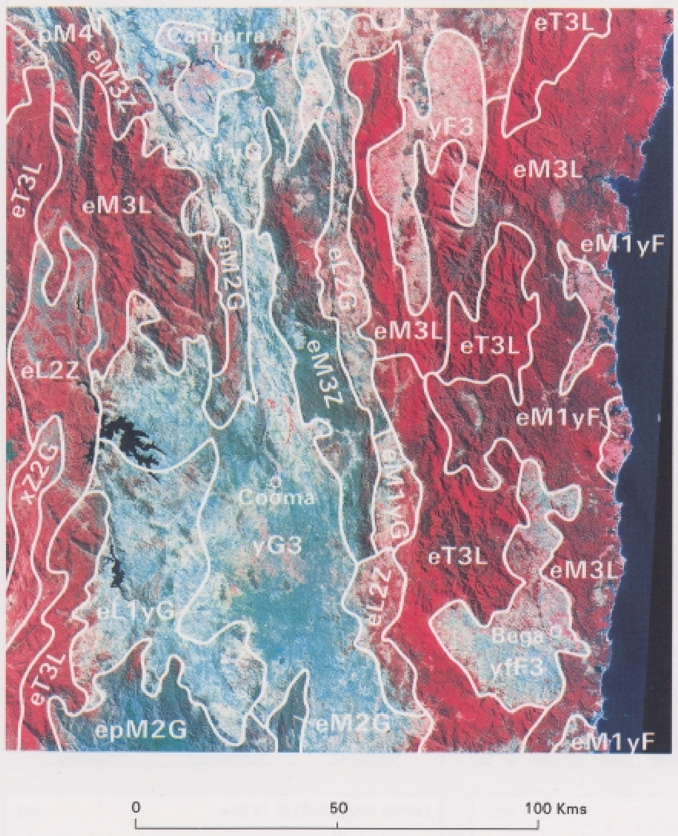
# Mapping a continent's vegetation




**Rainforests and canelands**
*The sugar cane growing areas of the lowlands around Ingham on the northern Qld coast, coded as* **vG4**, *stand out in strong contrast to the solid red signal of the rainforests of the coastal ranges* (**xM4**). *The eucalypt open forest on Hinchinbrook Island* (**eM3L**) *contains many patches of rainforest and therefore has a similar bright red signal. The sparse, dry season cover of the open woodlands* (**eM1yG**) *has a patchy white and blue signal, mainly attributable to the underlying soil and rock outcrops. Between the rainforests and the open woodlands is a narrow transitional zone of eucalypt open forest* (**eM3G**).


**The Channel Country**
*This image shows Cooper Creek, south-western Qld, near where it swings westward into SA. The floodplain appears as a broad blue band crossed by a network of channels. The open grassland coding* (**yG2**) *describes the average condition of the vegetation of the Channel Country, which fluctuates markedly in response to the passing of floodwaters. This can be seen by the red areas, which indicate localised flushes of dense ephemeral plants. The low hills of the rolling downs, here a greenish-yellow, carry a sparse shrubland* (**wS1yG, wZ1**) *and sparse grasses, while the plains* (**aG2**) *represent the southern arid extensions of the Mitchell grass country.*




**The Monaro**
*The NSW Southern Tablelands town of Cooma is at the centre of this image, with the Canberra urban area at the top and Bega at the bottom right. The naturally treeless Monaro plains* (**yG3**), *south of Cooma, appear light blue, as do other grassland areas further north. Pastures along the coast are pink, primarily as a result of higher rainfall. There are distinct boundaries between the natural forests, which appear red, and the cleared lands. The bulk of the Eucalyptus forests are in the* **eM3L** *category, while the bulk of the tall forests* (**eT3L**) *have the brightest signal. The drier forests* (**eM3Z**) *and the woodlands* (**eM2G**) *appear blue-brown.*

The mapping of Australia's present vegetation at 1:5 million scale, on which this volume is based, was made possible by the rapid improvements in earth resources satellite technology over the last decade.

When the first multispectral scanner (MSS) imagery was received from the ERTS-1 (later renamed Landsat 1) satellite, launched in 1972, its potential for identifying the present boundaries of vegetation and land clearance was soon realised. But it was not until Australia established its own Landsat receiving station at Alice Springs in 1979 that suitable satellite imagery became readily available and easily selected. Subsequent improvements in image processing and the standardisation of false colour transparency production made possible a simple methodology for mapping vegetation boundaries over the entire continent.

## Compiling the maps

### *Present Vegetation*

The 1:5 million scale map of present vegetation shows the state of Australia's plant cover in the mid-1980s for both native and exotic species. Such mapping in effect freezes a dynamic situation because plant cover in many areas is constantly changing in response to climatic factors and human activities. Therefore, all that can be done is to indicate the 'average' condition of the vegetation over a period of several years.

Compilation of the map was based on standard false-colour composite transparencies of Landsat imagery at 1:1 million scale. The multispectral scanner on board the satellite records spectral reflectance values received from the earth's surface in several discrete wavelength bands. As the major terrestrial influences on the total reflectance in these bands are vegetation, soils and rock, so spatial differences in such features are visibly distinct on the imagery.

The transparencies used were selected from images recorded over the period 1980–85. The boundaries of spectral features visible on each image were plotted on to overlays and then transferred to a base map at 1:1 million scale. At this stage many of the smaller units were grouped according to other information on the vegetation of each area and were generalised so that only those likely to survive reduction to the publication scale of 1:5 million were retained.

Over much of Australia where plant cover is sparse, vegetation contributes only a small part to the total reflectance signal. The map units distinguished in these areas are in fact terrain patterns, the reflectance of which may be related to landforms, soil or rock, as well as vegetation. A premise of this project, therefore, was that there is a general spatial correlation between the physical features of the environment (such as topography and soil) and natural vegetation.

Where European land use has supplanted tracts of natural vegetation, there are large differences in reflectance between the natural and modified land cover. These abrupt changes in reflectance are significant vegetation boundaries. In addition, some widespread natural vegetation types were found to be consistently associated with distinctive spectral signatures on Landsat. Notable among these were the rainforests and open forests, and the *Acacia* and mallee shrublands.

Reflectance patterns may suggest the nature of vegetation in many areas, but comprehensive information from the ground is required to draw meaningful boundaries. It was necessary to collect and evaluate all available information about the vegetation within each of the mapped units. This included published and unpublished maps of vegetation, soils, land use and land systems, together with associated texts and other relevant reports.

Information on crops and pastures was taken from the statistical reports of the Agricultural Data Dissemination Service (ADDS), based on annual agricultural censuses (Australian Bureau of Statistics 1982–85). Interpretation of some areas was aided by examining topographic maps and aerial photographs, and by field studies.

With this information in hand, decisions were made on the vegetation type within each plotted unit, and this was translated into a code within the structural and floristic terms of the classification.

## Mapping from space

Satellite imagery, with its regular and up-to-date coverage of the entire continent, proved to be the most logical and economical means of mapping Australia's present vegetation. The Landsat MSS has spectral bands designed to detect vegetation, and the resolution of its images is ideally suited to small scale mapping. The width of the scanning path of Landsat is 185 km and each full image covers more than 30 000 $km^2$. Even so, with a continental area of 7.68 million $km^2$, the Present Vegetation map proved to be a major undertaking and about 450 images were required for total coverage of Australia.

Six examples of Landsat MSS false-colour images used as the primary mapping source for present vegetation are given to show the diversity of land cover patterns encountered across the continent. These im-

***Natural Vegetation***

The 1:5 million map of the natural vegetation is a reconstruction of the probable state of Australia's plant cover immediately before European settlement began in 1788. The Present Vegetation map was used as the starting point and it was then necessary to examine all available sources of information that might give a lead to the nature of the pre-settlement vegetation. These included historical records, maps based on original vegetation, and soil maps of cleared areas. One major source was the map Natural Vegetation in the second series of this atlas (Carnahan 1976). This earlier attempt at reconstructing natural vegetation had used all known source materials then available.

An important supplement to the 1976 map was the considerable amount of new mapping of reconstructed natural vegetation that has since become available for various sections of the country. Much of this new information was obtained from government and other authorities involved in environmental surveying and mapping, and the quality and coverage of the more recent work enabled a more accurate picture of the vegetation than was possible with the earlier map.

## Generalisation

Spatial patterns in nature are never entirely uniform and it is therefore difficult to describe vegetation by a single classification code at any scale of observation. For a map at 1:5 million scale, where the smallest areas that can readily be distinguished are about 30 000 ha, the problems of generalisation for both codes and boundaries become more acute.

The compilation of the maps presented many of the general problems associated with vegetation mapping. Firstly, it is difficult to establish precise boundaries because vegetation types often merge into each other. Secondly, it is difficult to define the vegetation of a site where there are marked fluctuations in structure or composition, for example in response to runs of wet or dry years and to fires. As a result, it is necessary to generalise over both time and space by defining the 'average' condition of the vegetation of a given area over a period of several years.

The constraints of scale also made it necessary to map mosaics of vegetation types in terms of the spatially predominant type, though certain kinds of mosaic have been specially treated. Probably the most widespread vegetation mosaic is that associated with dunefields in inland Australia. Here, the vegetation on the crests may be different from that on the interdune areas and slopes. The areally dominant vegetation, that of the interdunes and stable lower dune slopes, is given in the coding (e.g. **<u>wS1tH</u>**), which is underlined to indicate that it is within a dunefield mosaic.

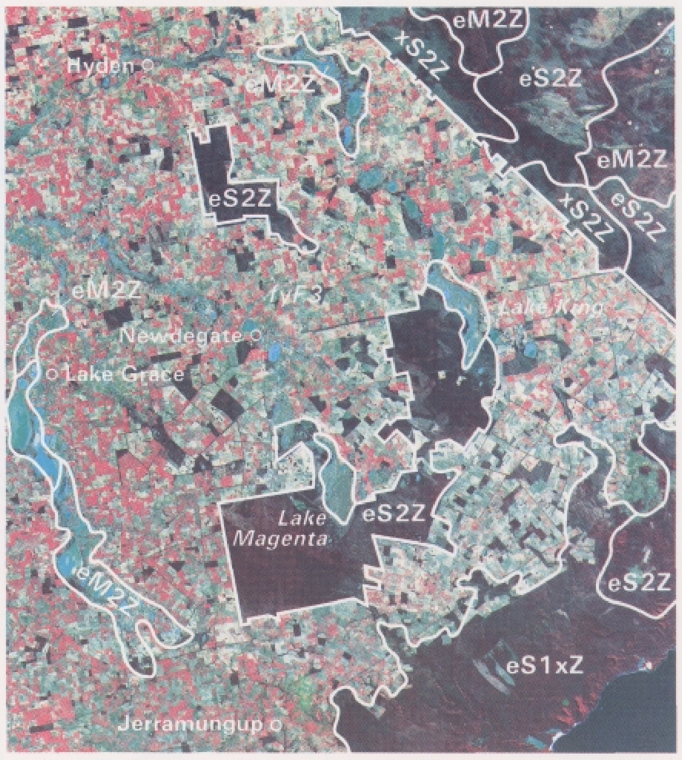
Intertidal mosaics of mangrove stands, low shrublands, herbaceous communities and bare salt flats occur at many places along the Australian coast. They cannot readily be separated in terms of predominant structural and floristic elements at 1:5 million scale and are therefore mapped and described as a 'littoral complex'. Urban and horticultural areas, with their varied cultural vegetation components, are also mapped as complexes. On the other hand, there is no separate treatment of certain other special environmental situations, such as wetland and alpine habitats; these are referred to in the descriptions of the different structural forms that occur in these habitats.

Mappable areas of rainforest are shown as either mixed closed forest (**xT4**, **xM4**) or *Nothofagus* closed forest (**nM4**), but smaller patches of rainforest frequently occur within open forest areas. Because of the current public and scientific interest in rainforest, the location of patches too small to map separately (but locally covering 500 ha or more) is indicated by symbols.

Except in relatively limited areas, seasonal cropping is conducted in association with livestock grazing and the vegetation consists of a mosaic of crop and pasture paddocks. Since the seasonal crops constitute a very distinctive kind of vegetation, being sown and harvested each year, the problem of mapping this mosiac has been overcome by using overprinted symbols. Crop symbols are area-related (1 per 10 000 ha) and are divided into summer (triangles) and winter (circles) crops. Their placement is based primarily on ADDS reports.

ages are produced by representing the reflectance values of three of the four spectral bands by the primary photographic colours of blue, green and red.

The high chlorophyll reflectance in the near-infrared part of the spectrum appears as red on the images, so areas of dense, vigorously growing vegetation show up as bright red. Dense sclerophyll vegetation often appears dark brown, largely because the bright signal of the underlying soil in the other bands is masked out by branches, leaves and litter. Fertilised and irrigated pasture appears as bright pink, while dry grassland is more often a pale blue colour. Exposed clay-based soils usually appear blue to white, while those formed on sand are more yellow, though both will appear much darker if they are wet. Imagery from early in the dry season generally gives the greatest contrast between the signals of the different vegetation types.




**Western Australian wheatbelt**
*This image shows the eastern margin of the wheatbelt in WA. The most striking feature is the sharp boundary between the cleared cropland, with its distinctive patchwork pattern of fields, and the uncleared bush, mainly mallee shrubland (**eS2Z**, **eS1xZ**). This image post-dates that used to compile the 1:5 million map and since then the boundaries of land clearance have moved further into former bushland areas. The chains of salt lakes with intervening areas of woodland are coded as **eM2Z**. The larger lake beds (Lake Grace, Lake Magenta and Lake King) are bare. Fire scars are visible as paler areas within the dark natural vegetation.*


**Lake Mackay**
*The mosaic of different aged fire scars, exposing varying amounts of the underlying soil, creates a patchy signal on Landsat imagery and is typical of wide areas of desert sandplain and dunefield in inland Australia. This pattern of dark and light areas indicates mostly transient differences in vegetation cover, which is constantly changing with regrowth after fires. The major mapped units are the dunefields, with visible linear dunes, and sandplains (**wS1tH**). The vegetation of both is similar: open shrublands, with Acacia dominant, over hummock grasses. The underlined codes indicate the vegetation of the stable interdune areas.*



**Cobourg Peninsula**
*The dominant vegetation is open forest (**eM3L**), which has a uniform red-brown signal. After burning it appears more blue or black. Woodlands (**eM2G**) generally occur further inland and are a lighter blue-brown colour. The rocky outcrops of the northern tip of the Arnhem Land escarpment show up as pale blue areas along the eastern side of the scene. The seasonally inundated floodplains of the major rivers are vegetated primarily by dense sedgelands (**gG4**). The large littoral area on the peninsula demonstrates the variety of cover types within this complex, with both dense mangrove forest (red areas) and bare mud flats (pale blue) occurring together.*