VEGETATION MAPPING OF THE
PORT PHILLIP & WESTERNPORT
REGION

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Arthur Rylah Institute for Environmental Research
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SUMMARY

The Port Phillip region has significant remnant vegetation that is continually under threat by an expanding population and pressures of urban and industrial development. Threats to remnant vegetation in this region have been intensified by the lack of broad scale mapping of extant vegetation that would otherwise enable a more scientific approach to conservation and management. This project represents a milestone for the conservation of remnant vegetation in the Port Phillip and Westernport area. Whilst there have been numerous small studies on the native vegetation of localized areas throughout the study area, it has never been mapped so extensively, including all private and public land. The mapping completed for this project now represents the most accurate, broad-scale mapping of remnant vegetation in the Port Phillip and Westernport region. In addition, pre-1750 mapping provides a glimpse of the vegetation that blanketed the landscape over 250 years ago. In combination, the mapping of remnant and pre-1750 vegetation allows issues of conservation and management to be negotiated in the context of past and present distribution.

The EVC mapping of extant vegetation of the Port Phillip and Westernport region is based on detailed interpretation of aerial photograph images and extensive fieldwork. It is hoped that all land managers, including local government agencies and staff of Parks Victoria, use this resource as a basis for future conservation and management decisions. These maps will provide a valuable resource for development of planning scheme overlays, assist land managers in protecting the remaining flora and fauna sites of significance and guide local efforts to plant suitable indigenous vegetation within the region.
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INTRODUCTION

Ecological Vegetation Class (EVC) mapping was implemented as part of the Regional Forest Agreements (RFAs), driven by a need to determine a Forest Reserve System. However, due to the scale of vegetation mapping produced, a wide application for a variety of other purposes has arisen, including conservation and management of native flora. EVC mapping constitutes baseline data for planning decisions at all levels of government and is invaluable data for the conservation and management of remnant vegetation and for the development of revegetation programs. It has become one of the key data sets used in terrestrial biodiversity management.

RFA mapping has been completed for over two-thirds of Victoria, including public and private land. Victorian RFAs include the Central Highlands, the West and the North-East of the state, Gippsland and East Gippsland. Prior to this study, the main areas in Victoria that had been excluded from EVC mapping were the Wimmera/Little Desert areas, the Northern Plains, inner Melbourne, the Mornington Peninsula and surrounds of Westernport. However, the significance of remnant vegetation in the Port Phillip and Westernport region has necessitated mapping for conservation and management purposes.

Whilst EVC mapping throughout Victoria represents a milestone for the conservation of native vegetation, it is nonetheless a first draft. Future mapping of remnant vegetation, at a finer scale than 1:25 000 (the scale at which remnant vegetation was mapped in Port Phillip and Westernport) will continue to improve this first draft. EVC mapping has been completed at a higher resolution for some areas, for example, Phillip Island, and the Hurstbridge township.

The aims of this project were threefold.

1. To map all existing native vegetation, regardless of land tenure, to Ecological Vegetation Class at a scale of 1:25,000.
2. To model pre-1750 (pre-European settlement) vegetation at a scale of 1:100,000.
3. To provide a brief report detailing the methods used and descriptions of the EVCs mapped.

Maps will be incorporated into the NRE Corporate Geographical Data Library.
STUDY AREA

LOCATION & BOUNDARY

The Port Phillip and Westernport study area is approximately 10 000 km². Figure 1 (p.4) shows the boundary of the study area in relation to Local Government Areas. In the north-west the study area includes the entire Melbourne tile and is bounded by the existing West Regional Forest Agreement (RFA) EVC mapping. In the north-east, the study area includes the entire Ringwood 1:100 000 tile and is bounded by the existing Central Highlands RFA EVC mapping. In the south-east it includes the western half of the Warragul 1:100 000 tile and the north-west quarter of the Wonthaggi 1:100 000 tile and is bounded by the existing Gippsland EVC mapping. The study area also includes the entire Westernport and Woolamai 1:100 000 tiles. The high water mark of the Mornington Peninsula, within the Sorrento 1:100 000 tile marks the south-western boundary of the study area.

The study area encompasses 34 local government areas (LGAs) in the Port Phillip and Westernport catchment, from Wyndham and Melton in the west, to Bass Coast in the east. Local Government Areas within the boundary of the study area include those within inner Melbourne (Brimbank, Boroondara, Bayside, Banyule, Darebin, Greater Dandenong, Glen Eira, Hobsons Bay, Kingston, Knox, Monash, Maribyrnong, Maroondah, Manningham, Melbourne, Moreland, Moonee Valley, Port Phillip, Stonnington, Whitehorse and Yarra) and outer Melbourne (Bass Coast, Cardinia, Casey, Frankston, Greater Geelong, Hume, Melton, Moorabool, Mornington Peninsula, Nillumbik, Whittlesea, Wyndham and Yarra Ranges) (Fig. 1). French Island was also mapped in this study and is not part of a local government area.

ENVIRONMENTAL CHARACTERISTICS OF THE STUDY AREA

This study area has a distinctive geological history. In particular three distinctive geological formations in inner Melbourne merge. These three formations are the Volcanic Plains (‘Werribee Plains’) of the west, the Silurian-derived sedimentary hills in the east and north-east and the Tertiary sands that extend from central Melbourne through the south-east to Frankston and inland to Springvale and Cranbourne.

Distinctive environmental variation across the Port Phillip and Westernport region is also strongly influenced by climate, which in turn is associated with altitude. The hills in the east and north-east have a higher rainfall than the Volcanic Plains of the west and north-west. In addition to the distinctive merging of geology and climate on a broad scale within the inner Melbourne area, the complex of environmental characteristics throughout Mornington Peninsula and Westernport contribute significantly to the uniqueness of coastal and near coastal areas.
The following summaries of geology and climate provide a brief overview of the differences across the study area. More detailed information is available in a range of publications (e.g. Society for Growing Australian Plants Maroondah, Inc., 1991; Land Conservation Council, 1973; Tickell, 1992; Spencer-Jones et al 1975 and Jenkin, 1962).
Figure 1. Study Area in relation to Local Government Areas
Geology and a Brief Comment on Soil and Plant Associations

There are three predominant geological formations in the study area. These are the Tertiary and Quaternary Volcanic Plains (‘Werribee Plains’) of the west; the Silurian-derived sedimentary hills in the east and north-east, and the Tertiary sediments that extend from central Melbourne to Cape Schanck in the south-east and inland to Springvale and Cranbourne. In addition to the main geological formations, several others occupy smaller parts of the study area including Ordovician marine sediments in the north-west and Mornington Peninsula, Cambrian volcanics and marine sediments (predominantly in the north-east and east) and Cretaceous sediments in the south-east. A summary of the main geological events that have shaped the present-day landform, including the distribution of geology, soil types, and topography, is given in Table 1 (pp.6-7). Additional discussion of geology and brief comment on soil and vegetation associations is provided below. The discussion is divided on the basis of seven broad regions. These regions are the Melbourne 1:100 000 tile, the Ringwood 1:100 000 tile, Mornington Peninsula, the northern half of Westernport, the Cardinia Shire on the Warragul 1:100 000 tile, Phillip Island and French Island. The following discussion is drawn from several sources including EVC mapping of extant vegetation, maps by the Geological Society of Victoria, Society for Growing Australian Plants Maroondah (1991) and Quinn and Lacey (1999).

Melbourne 1:100 000 tile

Landform of the northern and western regions of Melbourne, within the Melbourne 1:100 000 tile, has been strongly influenced by volcanic activity during the late Quaternary and early Tertiary periods (Table 1). Volcanic activity during these periods formed expansive, low-lying and undulating basalt plains, along with occasional rocky outcrops of earlier geological origins (Society for Growing Australian Plants Maroondah 1991). The soil derived from the basalt plains is mainly fertile, poorly drained, heavy cracking clays. These heavy clay soils, low rainfall and strong winds are ideal in promoting the formation of grasslands and grassy wetlands. Hence, the Basalt Plains of the west are home to the grasslands and grassy wetlands which once extensively covered this region. Whilst the basalt plains dominate, Quaternary and Recent sediments occur around Werribee, Port Melbourne and through the north-west. Tertiary sands from the south-east and Silurian sediments from the east merge in the Melbourne CBD.

Ringwood 1:100 000 tile

The predominant feature to the east and north-east of Melbourne is the merging of the basalt plains of the north and west with Silurian sediments from the east and Tertiary sands from the south.
Table 1. A Summary of the Geological History of the Study Area, taken from LCC (1973).

<table>
<thead>
<tr>
<th>Era</th>
<th>Period</th>
<th>Time</th>
<th>Summary of Geological Events within the Study Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quaternary</td>
<td>Today</td>
<td></td>
<td><strong>Pleistocene Epoch</strong>&lt;br&gt; Late Pleistocene— Ice Age (approx. 20 000 years before present).&lt;br&gt;The close of the ice age (approx. 18 000 years before present) resulted in an increase in sea level causing Port Phillip and Westernport sunklands to flood and separating Tasmania from Victoria.&lt;br&gt;Sedimentation in the Werribee and Yarra deltas, in the Carrum and Kooweerup swamps, and in Port Phillip reflects the influence of sea level changes during the ice ages.</td>
</tr>
<tr>
<td></td>
<td>1.8 Ma</td>
<td></td>
<td><strong>Middle Pleistocene</strong>— developing drainage systems dissected the Pliocene sediments and volcanics. Wide valleys were eroded along the main streams and thin veneers of alluvial sediments deposited.</td>
</tr>
<tr>
<td>Tertiary</td>
<td>1.8 Ma</td>
<td></td>
<td><strong>Pliocene Epoch</strong>&lt;br&gt;Differential erosion of hard and soft rock responsible for present landscape.</td>
</tr>
<tr>
<td></td>
<td>5 Ma</td>
<td></td>
<td><strong>Miocene Epoch</strong>&lt;br&gt; Late Miocene— basalt (newer volcanics) flows formed extensive sheets of the Werribee Plains. Extrusions of new volcanics (Quaternary in origin) were mostly restricted to relatively small areas. Extrusions occurred from a larger number of small vents, many of which are still preserved as low hills throughout the plains.</td>
</tr>
<tr>
<td></td>
<td>23 Ma</td>
<td></td>
<td>Continued extrusion of older volcanics that began during the early Tertiary period.</td>
</tr>
<tr>
<td></td>
<td>38 Ma</td>
<td></td>
<td><strong>Oligocene Epoch</strong>&lt;br&gt; Late Oligocene— slow subsidence began marking the onset of marine deposition in the southern part of the study area. At the same time, a uniform sequence of silt and silty clay was deposited in the western basin.</td>
</tr>
<tr>
<td></td>
<td>54 Ma</td>
<td></td>
<td>Continued extrusion of older volcanics that began during the Palaeocene.</td>
</tr>
<tr>
<td></td>
<td>54 Ma</td>
<td></td>
<td><strong>Palaeocene Epoch</strong>&lt;br&gt; Beginning of older volcanic extrusion that continued through to the Miocene period. In some cases the volcanics formed thick piles in downfaulted basins, as on Mornington Peninsula.&lt;br&gt;Phase of terrestrial sedimentation with intermittent volcanic activity. Sediments from this phase include sand, silt, gravel and brown coal and are represented in the Port Phillip and Westernport basins. The coal seams are mined in four locations around Victoria including Bacchus Marsh. These sediments are of Palaeocene to perhaps Oligocene age.</td>
</tr>
<tr>
<td></td>
<td>65 Ma</td>
<td></td>
<td>Note: Cenozoic sedimentation described above was mainly confined to three main basins including the Port Phillip sunkland and the Westernport basin, both within the study area.</td>
</tr>
</tbody>
</table>
### Table 1 cont.

<table>
<thead>
<tr>
<th>Eras</th>
<th>Periods</th>
<th>Time(^a) (Ma)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>65 Ma</td>
<td>By the close of the Cretaceous period, the fundamental topography of the study area was formed. An east-west chain of lakes and swamps formed across southern Victoria and rapidly filled with sediments. Block faulting lifted these sediments to form, among others, the Barrabool Hills.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>146 Ma</td>
<td></td>
</tr>
<tr>
<td>Cretaceous</td>
<td></td>
<td>146 Ma</td>
<td>A long east-west trough was formed in southern Victoria and was rapidly filled with a thick sequence of sandstone containing feldspar and andesitic rock fragments mudstone and conglomerates.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>208 Ma</td>
<td>A period of long and continued erosion.</td>
</tr>
<tr>
<td>Jurassic</td>
<td></td>
<td>208 Ma</td>
<td>Long and continuous erosion occurred during this time forming a landscape of low relief.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>245 Ma</td>
<td></td>
</tr>
<tr>
<td>Triassic</td>
<td></td>
<td>208 Ma</td>
<td>Long and continuous erosion occurred during this time forming a landscape of low relief.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>245 Ma</td>
<td></td>
</tr>
<tr>
<td>Permian</td>
<td></td>
<td>245 Ma</td>
<td>Beginning of a lengthy period of slow erosion continued through the Triassic and Jurassic periods. Widespread deposits of sandstone and siltstone during this period were subsequently removed by erosion in the majority of areas.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>286 Ma</td>
<td></td>
</tr>
<tr>
<td>Carboniferous</td>
<td></td>
<td>286 Ma</td>
<td>Thick sediments widespread as a result of prior marine sedimentation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>360 Ma</td>
<td></td>
</tr>
<tr>
<td>Devonian</td>
<td></td>
<td>360 Ma</td>
<td>Upper Devonian - Intrusions and flows of acid igneous rocks into or over folded marine sediments occurred in many areas. Thick piles of volcanics were extruded into dish-shaped basins called cauldron subidences. Conglomerates, sandstones, and siltstones laid down in river and lake systems precede the volcanics. Examples of cauldron subidences occur in Dandenong. Many other granitic intrusions occurred during this period. The most notable examples in the study area include Arthurs Seat, Mount Martha, and Mount Eliza. Middle Devonian - A period where marine sediments deposited during early Palaeozoic era were lifted and folded along axes tending north-south. The resultant folding caused tight folding of Ordovician marine sediments, although marine sediments near Melbourne (Silurian and Devonian) were more open. Intrusions of granitic rocks beneath the surface. Thick flows of acid volcanics occurred in some places and formed the bedrock of the study area. Lower Devonian - Marine sedimentation continues from the Cambrian period into the early Devonian - Lower Devonian sediments north-east of Melbourne approx. 4 300 Ma).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>410 Ma</td>
<td></td>
</tr>
<tr>
<td>Silurian</td>
<td></td>
<td>410 Ma</td>
<td>Marine sedimentation continues from the Cambrian period - Silurian sediments west of Melbourne.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>440 Ma</td>
<td></td>
</tr>
<tr>
<td>Ordovician</td>
<td></td>
<td>440 Ma</td>
<td>Marine sedimentation continues from the Cambrian period.</td>
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<td></td>
<td>508 Ma</td>
<td></td>
</tr>
<tr>
<td>Cambrian</td>
<td></td>
<td>508 Ma</td>
<td>Extrusions of submarine volcanics followed by marine sedimentation consisting of interbedded sandstone and siltstone and black shale. The area stayed beneath the sea for much of this period.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>544 Ma</td>
<td></td>
</tr>
</tbody>
</table>

\(a\): Approximate time (Ma - Million years ago, unless otherwise stated) of the beginning of the era and period.
Flanking the Silurian sediments to the north, east and south-east are Devonian sediments of siltstone with inter-bedded sandstone. In the east occurs a complex of Silurian sediments, granite through the Dandenong Ranges, granodiorite through Lysterfield Reservoir and Cardinia Creek, older basalts east and north-east of the Silvan Reservoir and Recent river alluvium (sand, silt, clay and minor gravel) associated with many of the main tributaries.

The undulating basalt plains of the west are adjacent to a wide band of Silurian sediments forming mountainous topography (i.e. Kinglake National Park and the surrounding area). The soils derived from these geological formations are generally light grey loams over clay. Within the drainage lines of these areas, darker loams overlie clays and sand. These profiles tend to be moist in winter, tending to dry out during summer. Darker loams, containing a greater proportion of organic matter, tend to be moister in winter than the grey loams. Typical of the dacite origin of the area around the Dandenong Ranges, the soils are coarse textured. Light grey loams, and in some areas red loams, overlie clay, whilst red loams predominate on the eastern face of the Dandenong Ranges. Originating from Tertiary sediments, the soils along the eastern side of Port Phillip Bay vary from dark loams, clays and local sands and dark grey sands over clay, to light grey loams over clay and deep sands.

Along with a change in geology from the expansive Basalt Plains to a more complex and diverse landscape of the eastern sediments, in conjunction with a significant increase in rainfall, is a significant change in plant communities and species diversity. Open woodland is located on undulating hills, while the steeper slopes are densely forested. The variation in surface and sub-surface soil profiles of the Tertiary sands is mirrored by a large diversity of plant communities. In addition, this region supports species-poor, but nonetheless significant vegetation communities such as Swamp Scrub, and a variety of woodland and forest ecosystems.

**Mornington Peninsula**

Mornington Peninsula has a complex geological history described in detail by Tickell (1992). Calcareous sands and dune limestone from the Pleistocene Epoch extend from Point Nepean to Rye on the north coast and south-east to the southern end of Main Creek. Siliceous sands from the same period cover much of the area east of the calcareous sand from the southern end of Main Creek to Rosebud. East of these sands, Arthurs Seat and Red Hill are located on Devonian granite. North of the granite are alluvium and gravel and extending north of these sediments, south of Mt Martha, is a pocket of Devonian hornblende dacite. South-east of Arthurs Seat is an extensive region of Eocene basalts that extend north-east to the edge of Merricks Creek. Dissected through the basalt and beyond, the creeks and other tributaries are lined with Quaternary alluvium, gravel and sand. North of the basalt, following the Devilbend Faultline to just north of Devilbend Reservoir and west to Balcombe is
a dissected band of Ordovician sandstone, slate and chert. An extensive band of Tertiary sandstone, known as Baxter sandstone, extends from Somers and Balnarring north to Somerville and Olivers Hill, south of Frankston. These Tertiary sediments are dissected by several patches of Silurian mudstone, claystone, sandstone and hornfels, in addition to Quaternary sands along drainage lines, and Devonian granite and aplite around Mount Eliza. North of the Baxter Sandstone, are Quaternary sands and a continuation of patches of Silurian sediments from further south. Along the western side of Mornington Peninsula, recent swamp and lagoonal deposits line the coast. The distribution of geology, soil types and plant communities in the Mornington Peninsula varies from extensively uniform to more complex associations. For example, calcareous sands almost exclusively support widespread and relatively uniform expanses of Coastal Alkaline Scrub. In contrast, there are more complex associations on the more fertile loams derived from granites in the Arthurs Seat National Park.

Siliceous sands east of Point Nepean support a complex of species-rich plant communities including Damp Heathland and Damp Sands Herb-rich Woodland, among several other vegetation types. Sandy loams derived from Tertiary basalts also support forest and woodland communities, while the alluvium along creek beds support vegetation types such as Swampy Riparian Woodland and Swamp Scrub.

**Northern half of Westernport 1:100 000 tile**

This section of the study area extends from Frankston, Langwarrin and Pearcedale, along the northern boundary of the Mornington Peninsula and extends north to Mordialloc, north-east to Upper Beaconsfield and east to Koo-Wee-Rup. From the Mornington Peninsula, the complex of Silurian sediments (mudstone, claystone, sandstone and hornfels) among Quaternary sand and limestone extends to south of Cranbourne where it comes into contact with a band of Tertiary basalt in and around Cranbourne. Surrounding the basalt is a large expanse of Tertiary sediments (sandstone, sandy clay and ligneous clay) that extends in discontinuous sheets from as far south as Stony Point on the Mornington Peninsula. Silurian sediments, Devonian granite and Tertiary basalts also occur in the north-east corner of the tile from Hallam through to Beaconsfield and Pakenham. However, the most prominent feature of this area is the extensive sheets of Quaternary sediments of stream alluvium, sand, silt, clay, gravel and limestone. In the north-east, these sediments extend from Sweetwater Creek, south of Frankston, north to Mordialloc and east to Lyndhurst. Whilst not uncommon through Mornington Peninsula and Westernport, the alluvial sediments are confined to drainage lines amongst Tertiary sands elsewhere on the Westernport tile. The swamp and lagoonal deposits extend to the south coast, while along the Bay the coast is lined with Quaternary dunes, aeolian siliceous sand sheets, estuarine sands and shell beds.
The swamp deposits along the north coast of Westernport Bay support EVCs such as Mangrove Shrubland, Coastal Saltmarsh, Swampy Woodland, Swamp Scrub, Damp Heathland and Damp Sands Herb-rich Woodland. North of the coast, now almost completely cleared of its original vegetation, the swampy sediments would have supported Plains Grassy Woodland/Plains Grassland with riparian communities along drainage lines, evidenced by the few small remnant patches. The complex of more fertile loam and clay sediments derived from Tertiary, Silurian and Devonian sediments support forest communities, such as Grassy Forest and Lowland Forest, with riparian vegetation such as Swampy Riparian Complex on Quaternary sands along drainage lines.

**Cardinia Shire on the Warragul 1:100 000 tile**

Quaternary sediments extend from Bass Coast Shire north into Cardinia Shire, largely in association with the Heath Hill Fault. Eocene sediments of basalt are along the southern margin of the fault and Tertiary sand, silt and gravel along the northern margin. Upper Devonian granite occurs north of the Quaternary sediments, roughly from Nar Nar Goon to Tynong and Garfield. Quaternary gravel, sand, silt and swamp deposits, that cover much of the Cardinia Shire within the Warragul tile, predominantly support Swampy Riparian Woodland and Swamp Scrub. A mosaic of Plains Grassy Woodland and Plains Grassland would have occurred on the flat country in the Pakenham to Beaconsfield area, with Grassy Woodland in the northern section going into the Upper Devonian granite. Further into the more nutrient-rich soil derived from granite is a complex of woodland and forest communities.

**Bass Coast Shire**

The distribution of different geological features of Bass Coast Shire is broadly associated with fault lines that cut through the landscape in a south-west to north-easterly direction. The most complex associations occur in an area in the southern part of Bass Coast Shire. This area consists of a complex of sediments including fluvial sand and silt, and aeolian dune deposits of sand and clay. Cretaceous sediments of fluvial sandstone and siltstone, and coal, and a small area (approx. 2km²) of Silurian mudstone and sandstone of marine origin situated south of Wonthaggi. Fluvial gravel, sand and silt extend from this area through the basin of the Powlett River. South of the river is a wide expanse of Tertiary sand, silt and gravel. North of the river between the Kongwak Monocline and the Heath Hill Fault, a broad band of Cretaceous sandstone, siltstone, minor conglomerate and coal extends beyond the boundary of the study area. The Bass river north-west of the Heath Hill Fault, like that of the Powlett River, lies within a basin of Quaternary sediments. Tertiary sediment lines the Heath Hill Fault and north of this is a large expanse of Quaternary swamp and lagoon deposits. These deposits extend through to the western-most extent of Bass Coast Shire, whilst Tertiary basalt and sandstone occurs in the north-west corner to Settlement Point. Quaternary sediments around Wonthaggi, that are
largely nutrient-poor, support a complex of woodlands, the heathlands south of Wonthaggi and riparian vegetation along the Powlett River. Cretaceous sediments support Lowland Forest on the northern edge of the coastal plain and Damp Forest further north and north-east as rainfall increases toward the Strzelecki Range.

The Recent Quaternary sediments through the basin of the Bass River support Riparian Forest. Over the large expanse of Quaternary lagoonal and swamp deposits, there is a complex of Grassy Woodland, Swampy Woodland and Swampy Riparian Woodland. Plains Grassy Woodland and Damp Sands Herb-rich Woodland occur on the Tertiary basalt and sandstone.

**Phillip Island**

Basalt from the older volcanics of the Eocene era covers the majority of Phillip Island. Other formations include Quaternary alluvial sediments that follow the main tributaries, a few isolated patches of other Quaternary sediments (dunes, aeolian siliceous sand sheets, raised beaches, estuarine sands and shell beds) and Devonian granite at Cape Woolamai.

Soils derived from the extensive sheets of basalt on Phillip Island are either dark brownish grey clay loams or very fine sandy clay loams that overlie similarly textured soils beneath which are medium to heavy clays. These soils mainly support Plains Grassy Woodland. Alluvial sediments along tributaries support Swamp Scrub and the exposed granite outcrop at Cape Woolamai supports a severely pruned Coastal Headland Scrub. Behind the granite tip is basalt mantled by a recent deposit of sand. This area also supports Plains Grassy Woodland. An inlet at Rhyll in the north-east corner of the Island supports estuarine communities including Coastal Salt Marsh and *Estuarine* Brackish Wetland.

**French Island**

The geological formations of French Island consist predominantly of Tertiary gravels, sands and clay and Quaternary sediments. The Quaternary sediments are mainly Pleistocene sand ridges and sheets with extensive swamp deposits in depressions through the Quaternary sediments and sand clay and silt in the north and south-east. A few small patches of older Tertiary basalt and Devonian granite and granordiorite are distributed predominantly along the southern coastline. Saltmarsh and mangroves flank the northern and north-western coastline.

French Island has extensive heathlands overlying Quaternary sediment. Intermittent among the heathland is open forest on Tertiary sediments and wetlands in peaty sand and clay depressions of
Quaternary origin. The more fertile basalts and granites in the south support Plains Grassy Woodland with isolated pockets of Herb-rich Foothill Forest along the steep, sheltered coastal cliffs.
Climate

The Port Phillip and Westernport study area, like much of Australia, has a Mediterranean climate (Dallman 1998). Rainfall has significant spatial variation across the study area. The mean monthly rainfall for Melbourne (Bureau of Meteorology, Melbourne Regional Office, Elevation: 31m, 1885 to 2001) is 657 mm, with an average of 147 days of rainfall per year (Figures. 2b and 2c, p.14). The Volcanic Plains to the west of Melbourne have the lowest rainfall in the study area (Fig. 2c, p.14). For example, the mean annual rainfall for Laverton (Bureau of Meteorology, Laverton RAAF Station, Elevation: 16.0 m, 1941 to 2001) is 557 mm, although the number of rainfall days is similar to that in inner Melbourne. Rainfall increases significantly from west to east. Mean annual rainfall is 899 mm in Scoresby (Bureau of Meteorology, Scoresby Research Institute, Elevation: 104m, 1948 to 2001, Fig. 2c) over 168 days of rain per year. As altitude rises into the Dandenong Ranges (Bureau of Meteorology, Mt Dandenong GTV9, Elevation: 620m, 1968 to 2001) the long-term rainfall averages increased to 1202 mm, almost twice that of inner Melbourne, with, on average, an additional 40 days of rain each year in comparison to inner Melbourne (Fig. 2b).

The south-eastern extent of the study area incorporates the Mornington Peninsula, French and Phillip Islands and Bass Coast Shire. Mornington Peninsula (Bureau of Meteorology, Mornington, Elevation: 46 m, 1868 to 2001) and Phillip Island (Bureau of Meteorology, Cowes, Elevation: 12 m, 1882 to 1978) have similar mean annual rainfall averages, 740 and 765 mm respectively, Mornington Peninsula has fewer days of rain, 137 and 153 respectively. Finally, the mean annual rainfall of the most south-easterly region of the study area, Bass Coast Shire, (Bureau of Meteorology, Wonthaggi, Elevation: 52 m, 1911 to 2001) is 937 mm.

Temperature, unlike rainfall, is fairly uniform across the study area (Fig. 2a, p.14). For example, the mean daily maximum temperatures of Laverton, Melbourne, Mornington, Cowes, and Wonthaggi are 19.6°C, 19.8°C, 18.9°C, 17.9°C and 18.7°C respectively. Mean daily minimum temperatures are also similar. The greatest deviation of temperature from these figures is the Dandenong Ranges where mean daily maximum and minimum temperatures are a couple of degrees lower than surrounding areas.
Figures 2a-c. Mean Daily Temperature, Mean Number of Rain Days and Mean Monthly Rainfall.
**TERMINOLOGY**

The following definitions derive from Tumino and Roberts (1998)

**ECOLOGICAL VEGETATION CLASS (EVC)**

An Ecological Vegetation Class (EVC) is a basic vegetation mapping unit used for conservation assessment and planning (Commonwealth and Victorian RFA Steering Committee, 1999). It represents the highest level in the hierarchical vegetation typology used across the state of Victoria. An EVC consists of one or more floristic communities that exist under a common regime of ecological processes within a particular environment at a regional, state or continental scale (Woodgate *et al.* 1994). The homogeneity of floristic communities within an EVC is manifested in analogous life forms, genera, families, vegetation structure and landscape position (Woodgate *et al.* 1994). Floristic community differences within EVCs are often geographically or geologically driven.

**FLORISTIC COMMUNITY (FC)**

A ‘Floristic Community’ is a group of species that are similar in terms of structure and response to major environmental variables such as landform, geology, soil, altitude, aspect, slope and rainfall (Muir *et al.* 1995, Woodgate *et al.* 1994). A combination of these variables provides suitable habitat for species that are characteristic of a Floristic Community. Consequently, where a combination of variables is repeated in the landscape at a local scale and broadscale, a particular Floristic Community can occur.

**CHARACTER SPECIES**

A ‘Character Species’ is a species that consistently and frequently occurs in a particular Floristic Community. These species can be ubiquitous across the study area and therefore may be shared with other Floristic Communities.

**INDICATOR SPECIES**

An ‘Indicator Species’ is a species that is generally specific to an EVC, or a Floristic Community. These species tend to have more specific habitat requirements and consequently occur in fewer communities. When comparing two Floristic Communities, indicator species help to delineate the boundary or ecotone between communities. For example, *Amphibromus* spp. are restricted to perennially or seasonally swampy land, thus most of their distribution lies within Plains Grassy Wetland throughout the study area.
COMPLEX (in relation to EVCs)

The term ‘complex’ is used to identify a mapping unit that cannot be identified as a single EVC due to the presence of character species associated with at least two EVCs. For example, Floodplain Wetland Complex can consist of character species from a number of wetland EVCs.

MOSAIC (in relation to EVCs)

The term ‘mosaic’ is used to identify a polygon within which at least two EVCs have been identified, although the size of the polygon (scale of mapping) prevents the delineation of these EVCs within the polygon. Individual patches of each EVC are clearly identified on the ground but are too small to isolate as individual polygons at the scale of mapping. Therefore, the polygon is labelled as a mosaic of the EVCs it contains. For example, Grassy Woodland/Damp Sands Herb-rich Woodland Mosaic consists of these two component EVCs.

NOMENCLATURE

Plant nomenclature follows the NRE Flora Information System (FIS 2001), managed by the Biodiversity Information Management Section. Information stored in the FIS is based on the Flora of Victoria, Volumes II, III & IV (Walsh & Entwistle, 1994, 1996 & 1999) and the Victorian Census (Ross, 2000).

METHOD

EXTANT VEGETATION (1:25 000)

The method employed to map extant vegetation at EVC classification in Port Phillip and Westernport (excluding inner Melbourne, see ARCUE’s methodology below) is similar to the methods employed to map EVCs in Gippsland (Davies et al., in prep). The major difference employed in this project was the use of digital aerial photography, where available, to capture native vegetation polygons, which was used for approximately one-third of the study area. For the remainder of the study area, polygons were captured using aerial photograph interpretation (API, see below for details). The differences between these two methods will be described, firstly as a brief summary, followed by a more detailed description of each stage that leads to the final production of colour-coded maps.

Mapping EVCs in Port Phillip and Westernport involved several stages, beginning with the analysis of floristic data and the capture of native vegetation polygons. Analysis of all available floristic data enables identification of the majority of EVCs present in the study area, and definition of EVCs based on character species. The capture of native vegetation polygons was completed either by aerial photograph interpretation (API, see definition below), or by digitising aerial images using ‘ARCVIEW™’, a mapping software package. The next stage was extensive field assessment via all
accessible roads. Field assessments enable polygons to be labelled and the typology of EVCs to be developed in relation to vegetation structure, composition and canopy pattern as shown on aerial images (hard copy aerals and digital images), as well as environmental characteristics such as geology, soil type, aspect and topography. Polygons were edited as required as a result of field assessments. For the digital aerial photography, Land Information and Cartography Services (LICS) edited the polygons on-screen. Polygons on the hard copy aerial photograph overlays were transferred to base-maps. These base maps were then digitized by LICS. The final phase of mapping, which involved final edits of polygons, labels, colour coding and formatting of the colour-coded key of EVCs, was carried out by the Land Information Group (LIG), NRE and Spatial Vision. Each of the stages is described in more detail below.

**Floristic Analysis**

Data on the distribution and abundance of flora species have been collated from many sources and consolidated into a statewide database known as the ‘Victorian Flora Information System’ (FIS). The Information Management Section of Parks, Flora and Fauna (PFF) of the Department of Natural Resources and Environment (NRE) manages the FIS. Currently, the FIS contains approximately 35000 entries of quadrat data for localities throughout Victoria. Over 7000 of these entries are from localities within the study area. These data were used as the basis of a floristic analysis to assign vegetation to EVCs and identify EVCs present in the study area.

Quadrat data were extracted from the FIS and the range standardised median cover-abundance data using PATN software package (Belbin 1987). Each quadrat was compared to all others, and a dissimilarity matrix was calculated using the Bray-Curtis co-efficient. The hierarchical agglomerative clustering strategy, Unweighted Pair Group Mean Averaging (UPGMA, $b=0.1$) was applied to the dissimilarity matrix to produce a dendrogram. The dendrogram provides a visual display of the relationships among data. Controlling the clustering of groups according to a priori estimation of the number of EVCs within the study area results in the dendrogram isolating EVCs.

From this analysis, the FIS was used to produce lists of species frequency, tables of character species and location maps. Lists of species frequencies provide an inventory of the occurrence of species among quadrats. Tables of character species provide a list of the most commonly occurring species of a group. In addition to character species, statistics are provided on a range of environmental attributes of groups. Statistical information included the total number of sites sampled, the maximum, minimum and mean altitude, the mean floristic richness per site and the percentage occurrence of weeds. For each group, a map was printed of the distribution of quadrats within the study area.
Data on the FIS requires constant curation to check the validity of data and standardisation of nomenclature. Whilst curation of the data is a continuous process undertaken by a senior botanist, the database is only updated annually. Consequently, the FIS is only as up-to-date as the last annual correction of the database. Floristic analysis of data sets taken from the FIS should therefore be curated prior to analysis to correct problems with nomenclature. In addition, the FIS includes native as well as noxious and environmental weeds.

Comprehensive curation of the more than 7000 quadrats that were the data set for the floristic analyses was impossible, given the time and budgetary constraints imposed. This did not greatly hamper the analyses and subsequent EVC recognition as there was a large number of appropriately analyzed surveys and other studies completed and published as a basis for this project. In addition, the data set was very large, hence immersing data of unreliable curation. Nevertheless, lack of detailed curation did highlight some problems- namely that the analysis failed to distinguish every EVC mapped in the study area and floristic communities within some EVCs could not be identified and labelled. The former problem also reflects an inadequate base data set, with some EVCs decidedly undersampled.

Weeds occurred in almost all quadrats and vegetation stands and were frequently of such abundance and dominance that they interfered with the natural vegetation patterns and obscured ecological relationships and determinants. Large floristic data sets are required to elucidate ecological relationships in relatively undisturbed vegetation. Considerably more data are required if the vegetation is significantly disturbed, with many vegetation communities effectively locally extinct or so weed-invaded as to be barely recognizable-as is typical in this study area. Consequently, while floristic analyses, as described above, were used to identify and describe most of the EVCs of the study area, these descriptions and analyses are not presented in the report.

**Capture of Botanical and Spatial Data**

**Base-map Scale**

Extant vegetation in the study area was mapped at a scale of 1:25 000. Figure 3 (p.20) shows each of the sixty-nine 1:25 000 tiles in relation to the boundary of the study area. At a scale of 1:25 000, the minimum size of polygons on the final product is approximately 4mm², equating to approximately 2500m² on the ground. In some cases narrow polygons along streams and roadsides were exaggerated in width in order to capture the EVC.
Authorship of 1:25 000 Tiles

The study area was divided into sections and each section allocated to an experienced botanical mapper (see Figure 4, p.21). Alison Oates mapped extant vegetation of Bass Coast Shire, French Island, part of Cardinia Shire and Mornington Peninsula. Kylie Singleton and Maria Taranto assisted Alison in the field. Kylie Singleton mapped Cardinia Shire and the City of Casey with the assistance of Jaimie Brown. David Rankin mapped west and north of Melbourne excluding the inner Melbourne area. Maria Taranto mapped part of Mornington Peninsula with the assistance of Jaimie Brown. Inner Melbourne was mapped by the Australian Research Centre for Urban Ecology. Michelle Tumino, Judy Downe, Doug Frood and Randall Robinson mapped part of the north-east part of the study area. Jeff Yugovic mapped the Mt Eliza area on the Mornington Peninsula.

Interpretation of Aerial Images (hard copy and digital format)

Interpretation of aerial images involves the gathering together of a number of environmental themes (both ecological and structural) to extrapolate polygon development from visited to unvisited areas. The aim is to create an homogeneous and robust extrapolation. The themes may be as permanent as the underlying geology or as temporal as fire frequency. Sometimes, one theme will dominate all others. The following describes some of the environmental themes used for mapping. Certain EVCs are closely aligned with one or more environmental themes.

Examples of environmental themes include:

- relative crown size
- high or low rainfall zones
- topography
- aspect
- relative patch size
- evidence of mining and quarrying
- altitude
- soils
- rain-shadow zones
- canopy density
- tree crown opacity
- underlying geology
- overall forest colour
- tree ferns visible
- presence/absence of overstorey
Figure 3. The study area boundary in relation to 1:25 000 Map Tile Sheets
See Attachment for Figure 4
Development of EVC Mapping Units

Mapping units are derived from models of typology, the latter dependent upon two assumptions. Firstly, that there exists a group of co-habiting species that link the model to an EVC. Secondly, that each typology is based on adequate sampling of an EVC. Confident identification of EVCs using aerial photograph interpretation is achieved as a result of suitable environmental characteristics of both the landscape and of specific EVCs, in addition to access to adequate and reliable data. Examples of factors that contribute to congruent or incongruent resolutions are as follows:

Congruent Resolutions

Typology that is based on sufficient data.
Effective overstorey correlation.
Large homogeneous patch size.
Distinctive contrast between overstorey and understorey.
Correlation between geology and specific EVCs.
Sharp boundaries between EVCs.
EVCs having distinctive canopy density.
EVCs with distinctive topographic associations
Distinctive understorey signature.

Incongruent Resolutions

Insufficient data used to describe typology.
Structural variation with EVCs.
EVCs camouflaged by surrounding EVCs.
EVCs distributed across a variety of ecological niches.
Inability to identify EVCs due to a recent fire event.
Variation in the density of the canopy.
Variable understorey signature.
Inaccurate interpretations based on preconceived ideas.
Indistinct boundaries between EVCs due to an ecotone.
**Aerial Photograph Interpretation (API)**

Aerial photographs were borrowed from Port Phillip Regional Office (NRE, Box Hill), Cardinia Shire and Bass Coast Shire. Photographs covering the Bass Coast were at a scale of 1:25 000. However, photographs covering the remainder of the study area were only available at a resolution greater than 1:25 000, hence transferral of polygons from aerial photographs to base-maps required photo-enlargement. Before using the aerial photographs in the field, the photo-effective area (the central area of a photograph excluding approximately 2cm of the periphery, that when used for API results in minimal temporal distortion of polygons) is determined. The aerial photographs were protected from damage during the API process by plastic overlay film. Cadastral boundaries were marked on each overlay for use when transferring polygons onto base maps. Polygons of native vegetation were identified in stereo vision using pairs of aerial photographs (where available), the covers of which were overlapping and polygons were scribed onto plastic overlays. Some polygons were labelled prior to field assessment, depending on the familiarity of the botanist with certain EVCs. The validity of polygons labelled prior to field assessment was nonetheless checked in the field. Completed base maps were subsequently digitised.

**Digitising and API**

A geo-corrected, digital layer of aerial photography, covering most of the study area (excluding French Island and the majority of Bass Coast Shire) was purchased from Photo Mapping Services. The aerial photographs were taken at a height of 1:15 000 during March and April of 2000. Photographs were scanned at a resolution of 600 dpi, 24 bit colour and ortho-rectified with accuracy of approximately 10m to the supplied State Cadastral Database. The digital photographs were supplied as fourteen mosaics.

ARCVIEW™ v3.2, a GIS software package, was used to view aerial images and digitise polygons of native vegetation. The resolution at which aerial images were originally scanned allowed digitising to be done at a resolution of 1:5 000. API of hard copy images was used for polygons having either a complex mosaic of EVCs, or less than adequate resolution. Areas of limited resolution were primarily due to environmental factors at the time the aerial photograph was taken (eg. fog and smoke). A printout of each 1:25 000 tile, including digitised polygons and 1km gridlines, was used for field assessments. Polygons were edited as required in accordance with field assessments. Subsequently the edited printout of each tile was used to edit the digital layer and label the polygons.
Field Assessment

EVC Determination
Extensive field assessment was used to determine the EVCs in the study area except for the Cardinia Creek, Silvan, Lysterfield and Kilsyth 1:25 000 map sheets. Time constraints forced this area to be mapped by overlaying extant polygons on the existing pre-1750’s Central Highlands RFA EVC mapping. In the rest of the study area, approximately 2-3 days on average was spent assessing each 1:25 000 tile, by driving on readily accessible roads. Due to time constraints, access to most private land areas was not possible. Binoculars were used, where appropriate, to assess polygons inaccessible by road. Where vegetation could not be observed directly or by using binoculars it was modelled on the basis of aerial photograph patterns in accordance with surrounding EVCs. Navigation in the field was primarily achieved using topographic maps and aerial photographs.

Polygons can be divided into a number of broad categories according to the ease with which the corresponding EVC can be determined. Examples of these categories are as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Polygon Accessible</th>
<th>Overstorey Largely Intact</th>
<th>Understorey at least partially intact</th>
<th>Photo-pattern Clear</th>
<th>EVC Identifiable</th>
</tr>
</thead>
<tbody>
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<td>X</td>
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<td>X</td>
<td>√</td>
<td>unknown</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Whilst a reliability code has been used in conjunction with EVC labelling of some earlier mapping projects (eg. Tumino and Roberts 1998), such a code was not used for this study due to time restrictions.

Labelling Polygons
Providing the EVC could be determined in the field, polygons (on aerial photographs or printouts of digital aerial images) were labelled with the appropriate EVC number. In some locations, the EVC could not be determined primarily due to unresolved EVC descriptions. In these circumstances, a
comprehensive list of species was compiled from suitable sites, referred to here as ‘sample sites’, for
determination of the EVC at a later date, often with the assistance of expert advice. Species lists from
sample sites will be incorporated into the FIS database.

*Disturbance/Weediness*

For the purposes of EVC mapping of remnant vegetation in the study area, a polygon with a greater
than 50% cover of weeds was generally not included. This label obviously has its limitations and
should be treated with caution as considerable interpretation was involved. For urban areas where
overstorey trees were the only remaining evidence of native vegetation, these polygons were excluded
from the study except for the mapping of inner Melbourne. Revegetated areas were mapped where the
vegetation had reached a stage that resembled the original EVC, both in the overstorey and
understorey layers.

*Methodology for EVC Mapping of Inner Melbourne*

EVC mapping of inner Melbourne was conducted by Nicholas Williams, Emma Leary and Gemma
Phelan of the Australian Research Centre for Urban Ecology, Royal Botanic Gardens, Melbourne.
Subsequent re-assessment of EVC labelling was carried out by Alison Oates and Doug Frood. A high
proportion of vegetation communities mapped in the inner Melbourne area are highly disturbed, with
the majority of sites having >50% cover of weeds. In many instances, only the overstorey of these
communities is intact. As a result, the polygons mapped within the inner Melbourne region have a
greater level of disturbance than those mapped elsewhere in the study area.

*Data Collection Period:*

Most of the source data was collected in 2001, although some were collected at an earlier date.

*Data Sources:*

The EVC polygons were based on a variety of sources including the following:

- GPS surveys.
- Reports undertaken by consultants for local councils or developers, and reports
  commissioned by the Victorian Government.
- Existing digital data sets.
- Aerial photography interpretation.
Data Set Production Methods:

The EVC data set was created using ESRI ARCVIEW\textsuperscript{TM} GIS software and MS Excel. Initially, a separate data set was created for each of 20 individual LGAs within the inner Melbourne study area. Remnant vegetation was identified from reports, consultation with council and other relevant groups, and existing digital data sets. The list of sites was then examined to determine whether sites required field checking. Subsequently one of the following methods was used.

1. Mapping with fieldwork –

Field checking was used to verify the patch boundaries at each site, and also to determine the character species present using lists supplied by NRE. The boundaries of each patch were mapped either by GPS survey, or aerial photograph interpretation (API) in the field, using printouts of digital aerial photography.

2. Mapping without fieldwork –

Field checking was not required if there was enough existing information about the site to provide acceptable EVC and boundary information. The boundaries of each patch were then mapped either by API on-screen or from reports or from existing digital data sets. Where polygon boundaries were identified in the field, polygons were captured in ARCVIEW\textsuperscript{TM}, using on-screen digitising over a digital layer of aerial photography (provided by NRE for use on this project), identical to the printout used in the field.

However, if reports, including maps, were available on sites within the study area, the maps were scanned, the images registered and the polygon boundaries were digitised in ARCVIEW\textsuperscript{TM}. GPS survey data and digital data sets were processed with the appropriate software and incorporated with other digital data in ARCVIEW\textsuperscript{TM}. All EVC polygon boundaries were checked with the aerial photography for appropriate placement.

Attribute information about each polygon in the LGAs was collated in an Excel spreadsheet. These data were subsequently linked to the ARCVIEW\textsuperscript{TM} shapefile. Data sets for each LGA of inner Melbourne were eventually merged into one file and checked for position and attribute accuracy. GPS data collected in the field were accurate to approximately half a metre. However, the accuracy of digital data acquired elsewhere is variable.
Errors due to the conversion process:
Due to the relatively small size of most polygons in inner Melbourne, the error associated with scanning maps from reports would be insignificant in comparison with all other errors associated with the digitising process itself.

Errors due to the manipulation process:
The accuracy of digitising polygons directly on-screen is limited by the accuracy of background data used for reference, in this case aerial photography.

The digital aerial photography, purchased from Photo mapping Services, was accurate to approximately 5 metres. Consequently, the accuracy of the digitised polygons is also approximately 5 metres.

Attribute Accuracy:
Attribute values added to the data set were derived from several different sources. Therefore, the accuracy of these data is dependent entirely on the accuracy of the source. Sites mapped without fieldwork rely on EVC information found in reports. Sites mapped with fieldwork have EVC designations based on staff appraisal of the site and the EVC descriptions. The validity of all attributes was checked.

Mapping and EVC issues:
There were several issues identified in relation to the mapping and EVC determination of vegetation patches. Briefly, these were:

Mapping of revegetation sites:
It was not possible to map revegetation sites in inner Melbourne within the time frame of this project. This was due to the large number of revegetation sites in the study area, most of which are not readily identifiable as native vegetation on aerial photographs. Revegetation sites in urban areas are typically small and have complex boundaries. Mapping these sites would require numerous hours of field validation.

Mapping of private land:
Providing the EVC of vegetation on private land could be identified using aerial photographs, mapping was undertaken without fieldwork (as described in the methodology). However, if the EVC could not be determined from aerial images, the polygons were not mapped.
Mapping overstorey, understorey and disturbed patches

Some vegetation patches are identified as ‘overstorey only’. This indicates they have a continuous overstorey of native vegetation, but are substantially devoid of native understorey species. The opposite is true of patches identified as ‘understorey only’. In addition, some polygons of Sand Heathland and Heathy Woodland are identified as ‘disturbed’, indicating that the EVC could be determined but the vegetation was in an extremely disturbed state. Such disturbance was usually the result of invasion by environmental weeds, such as *Leptospermum laevigatum*.

It was not possible to field check all streets within the inner Melbourne area, consequently, not all remnant patches of vegetation, consisting of overstorey, but devoid of understorey, have been mapped.

Additional Issues Relating to Mapping Vegetation of Inner Melbourne

Comprehensive EVC mapping had already been completed for three LGAs of inner Melbourne at the time of this project. The three LGAs are Yarra, Kingston and Moreland. These data were provided for use on this project and hence no further mapping was undertaken within these LGAs. Biosis Research mapped Yarra City Council and provided the data. Rapid Map and Ecology Australia mapped Kingston City Council and Kingston City Council provided the digital data. These data required some alteration to original polygons and EVC classification, and additional data were added for some areas (e.g. golf courses). The Moreland City Council provided digital data. These data required conversion of the vegetation types recognized to EVC typology.

MODELLING PRE-1750 VEGETATION

Base Mapping Scale

Pre-1750 EVCs of the study area were mapped at a scale of 1:100 000 except for the area mapped by Doug Frood and Jeff Yugovic that was digitized at 1:25 000. At a scale of 1:100 000, the minimum size of polygons on the final product is approximately 2mm², which equates to an area of approximately 200m² on the ground.

Authorship of 1:100 000 Tiles

The study area was divided into sections and each section allocated. Geoff Sutter modelled that part of the study area within the following 1:100 000 tiles: Warragul, Sorrento and Westernport (excluding Phillip and French Islands). David Rankin modelled the Melbourne tile excluding the inner Melbourne area. Alison Oates modelled the Woolamai and Wonthaggi tiles and Phillip and French Islands. Doug Frood modelled the Ringwood 1:100 000 tile and Inner Melbourne (which extends over...
part of the Ringwood and Melbourne tiles) at a scale of 1:25 000. Jeff Yugovic modelled the Frankston 1:25 000 tile.

Method

Pre-1750 EVC mapping was modelled using available data on environmental attributes (in particular, geology, soils, altitude and aspect) some historical information and expert knowledge. However, it should be noted that due to time limitations only scant historical information was used.

Base maps were overlaid on maps of geology, topography and a pre-1750 wetland layer called WETLAND_1788 (Natural Resources and Environment Corporate Geospatial Data Library 2000) and vegetation unit distributions were extrapolated from a map of extant vegetation. The maps were digitized and formatted at a scale of 1:100 000 for inclusion in the Corporate Geographic Data Library.

Comments on Pre-1750s Vegetation Mapping

Pre-1750 vegetation mapping at 1:100 000 depicts broad patterns of vegetation across a landscape rather than precise detail at a specific spot. As a result, smaller mapping units identified in 1:25 000 extant layers may not be represented on 1:100 000 pre-1750 map sheets. Some mapping units identified as specific EVCs in the pre-1750 mapping exercise have been assigned a different EVC in the extant mapping layer due to changes in land management since European settlement, affecting vegetation community structure and composition (e.g. changes in hydrology, fire regimes and land usage). An example of this could be the construction of a drainage system resulting in the establishment of a monoculture of an adventive species such as *Melaleuca ericifolia* that would not have existed previously, or only as a small component of the vegetation community.

EVC MAPPING & THE CORPORATE GEOGRAPHIC DATA LIBRARY

NRE is the principal holder of digital data relating to native vegetation cover and flora and fauna information with a library of digital information called the Corporate Geographic Data Library (CGDL). The CGDL contains information on a wide range of environmental data including EVC Mapping of Victoria, a component that is managed by Parks, Flora and Fauna (PFF). Management of this mapping requires the development of standards relating to EVC typology, accuracy of data collection, presentation and incorporation of additional data into the CGDL. EVC mapping of Port Phillip and Westernport almost completes EVC mapping for Victoria. The only area of Victoria now without EVC mapping is in the north-west of the state in an area south and east of the Mallee and north of the Goldfields, to the Murray River. Parks, Flora and Fauna have, in recent years, made data on the CGDL more accessible to agencies and individuals by negotiating data exchange agreements
with private and public organisations. Maps of extant and pre-1750 vegetation at EVC classification, in addition to other data, are also available in ‘pdf’ format via relevant external web sites.
RESULTS

DESCRIPTION OF THE MAPPING UNITS

63 Ecological Vegetation Classes, 10 Floristic Communities, 29 Mosaics, 8 Complexes and 1 Formation were mapped in the study area. Appendices 1 and 2 provide a numerical and alphabetical listing, respectively, of Ecological Vegetation Classes, Floristic Communities, Mosaics, Complexes and formations located in the study area. Appendix 3 describes the Ecological Vegetation Classes, Floristic Communities, Mosaics, Complexes and Formations detailing geological, topographical, floristic and geographic attributes. These descriptions are subject to change as further sampling enhances the knowledge that has been collected during this and past projects.
RECOMMENDATIONS FOR FUTURE WORK

Developing a typology for statewide flora is a long-term process that requires continual curation with the defining characteristics of each class further refined as statewide EVC mapping progresses. The Port Phillip and Westernport region is a particularly difficult area regarding EVC typology as it is the region where a number of different EVC mapping projects merge. This merger has created problems that will have to be addressed by a future project.

1. There are several inconsistencies that occur between adjacent EVCs along boundaries between previous EVC mapping projects and this project. This has arisen primarily due to the inability to derive consistent typology across Victoria before each area had been studied and therefore was to be expected. Consequently, both the digital data and maps available to the public will need to be corrected in the future when a more consistent typology is developed.

2. Now that most of the state has been mapped at EVC level, EVC descriptions and definitions should be standardised across the state and re-written to remove any ambiguity and confusion. Such ambiguity was encountered during this project making EVC determination difficult in some cases. This problem was accentuated due to the merging of this mapping with several adjacent mapping studies.

3. Due to the occurrence of few species in some wetland EVCs such as Reed Swamp, the use of dominance rather than floristics to define EVCs in such cases should be explored.

4. Ground truthing of the Lysterfield, Cardinia Creek, Silvan and Kilsyth 1:25 000 map sheets was not completed due to time constraints and the EVCs for these tiles were modelled from existing data available on pre-1750s EVC mapping of the RFA area. A re-assessment of these areas is required in the future following more detailed field checking of sites.

5. Pre-1750 EVC mapping should be completed at a finer scale of 1:25 000 rather than 1:100 000 for the Sorrento, Westernport, Warragul, Woolamai and Wonthaggi map sheets, including more extensive research of historical information for use by local governments and community groups in such areas as revegetating of disturbed sites.

6. Additional sampling of threatened EVCs in the study area needs to be carried out where data is lacking. Relevant EVCs include Coastal Alkaline Scrub, Berm Grassy Shrubland, Damp Sands Herb-rich Woodland, wetter forms of Swamp Scrub, Floodplain Riparian Woodland, Creekline Grassy
Woodland, Swampy Riparian Woodland, Swampy Woodland, Shrubby Gully Forest, Sedge Wetland, Creekline Herb-rich Woodland, Reed Swamp, Riparian Woodland, Aquatic Herbland, Sandy Stream Woodland, Damp Heathy Woodland, Spray-zone Coastal Shrubland, Escarpment Shrubland, Coastal Basalt Mosaic, Gully Woodland and Estuarine Flats Grassland. In some instances it will be difficult if not impossible to locate relatively intact remnants within the study area. For some EVCs such as Brackish Grassland and Creekline Grassy Woodland there is no opportunity to collect representative data from the region.
BIBLIOGRAPHY


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Natural Resources and Environment Corporate Geospatial Data Library. 2000. WETLAND_1788 layer. Natural Resources and Environment, Melbourne.


FURTHER READING


EVC Mapping of Port Phillip and Westernport: Extant and pre-1750


