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Geology, soils and climate of the Margaret River wine region

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Western Australia.*

Geology, soils and climate of the Margaret River wine region



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Peter Tille, Angela Stuart-Street and Peter Gardiner

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Cover: Margaret River winery (photo: DPIRD)



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Data sources

Data sources for this report:

- soil-landscape mapping, data and soil classifications, soil profile photographs and vineyard location information was provided by DPIRD
- geological mapping information was provided by Geological Survey of Western Australia
- digital elevation model mapping underlay and elevation mapping was provided by Landgate
- climate indices were derived from SILO patched point data (Queensland Government) and Bureau of Meteorology (BoM) records.

Notes for map users

The maps in this report are generated from the best currently available information. Databases maintained by DPIRD and other state government agencies are the primary source. The soil-landscape maps and other features reliant on it are designed for use at publication scales, in this case 1:100 000. The scale and method of linework capture influences the uniformity of a map unit and the accuracy of the lines.

1 Introduction

This report is an extract from the broader description and analysis of the geology, soils and climate of all the wine regions of Western Australia currently being developed by DPIRD (Tille et al. in press). It expands on the brief descriptions in the second edition of *Viticulture* (Coombe & Dry 2004) concerning the soils and landscapes of Western Australia's main wine growing regions.

We have tailored this report extract to the specific needs of the Margaret River wine region. It contains local soil names and soil-landscape zones and systems maps.

The wine industry recognises the importance of giving customers an understanding of the vines' environment and how that may influence wine character and quality. This allows growers to tell the story of their wine and their label to form direct connections between the wine producer and the consumer. This story has become even more important in the 21st century when, in addition to direct cellar sales, a good online presence is essential. The information in this report will support that story and underpin it with the most current geology, soil and climatic data:

- Section 2 describes the location, varieties and production, including the main towns; the latitude, longitude and elevation; a brief history of viticulture in the region; the most recently available data on the area planted, common varieties and tonnes of grapes produced.
- Section 3 details the geology, physiography and elevation, with broad descriptions of the dominant rocks underlying the region as well as the geological history and how this influences the shape of the land.
- Section 4 provides soil-landscape zone and system mapping and descriptions.
- Section 5 gives a summary and map of the main soils in the region. It also provides the proportion and qualities of the main soil types currently supporting viticulture.
- Section 6 contains a summary and maps of the climate, including rainfall, temperature and other important climate parameters for viticulture, such as mean January temperature, average diurnal temperatures and average rainfall for selected time periods.
- Section 7 contains maps of the distribution of the main soils and photos of typical soil profiles in the Margaret River region.

2 Margaret River region

The Margaret River wine region lies to the west of the Geopraphe Region in the extreme south-western tip of the Australian continent (Figure 2.1). It covers about 212 000 hectares (ha), with the eastern boundary following the line of longitude 115°18' E. This line, running southwards from the township of Vasse to the Southern Ocean east of East Augusta, is known as the 'Gladstones Line', having been suggested by John Gladstones.

About 40% of the region remains cloaked in native vegetation, including forests and woodlands of the iconic jarrah (*Eucalyptus marginata*), marri (*Corymbia calophylla*) and karri trees (*E. diversicolor*) which create a pleasing setting for many wineries. Towns within this region include Margaret River, Dunsborough, Augusta and Vasse, with smaller settlements at Yallingup, Witchcliffe, Karridale and Cowaramup.

Although there are some early records of wine production at Margaret River in the 1850s and 4ha of Doradillo grapes being planted at Yallingup in 1914 (Beeston 2002), widespread interest in viticulture did not develop until John Gladstones (1965, 1966) identified the potential of the district for wine grapes.

His work encouraged commercial plantings by Dr Tom Cullity at Vasse Felix in Wilyabrup in 1967. In 1970, Dr Bill Pannell began planting his property Moss Wood, followed by Dr Kevin Cullen and his wife Di who established their commercial vineyard in 1971.¹ In 1978, the region, led by Dr Cullen, was among the first in Australia to adopt a regional certification of wines (Beeston 2002).

By the late 1980s, there were around 350ha of vines and because of major expansion during the 1990s, the Margaret River region production swelled to yield more than 40% of Western Australia's wine grape tonnage (Dry *et al.* 2004). The 2018 vintage shows that Margaret River now easily surpasses the previously dominant Swan Valley, and contributes over 60% of the state's wine grape tonnage. Current estimates of vineyard areas show they have expanded to cover about 6000ha (Figure 2.1).

In 2018, almost 22 000 tonnes of white grapes and about 15 400 tonnes of red grapes were harvested. The dominant white varieties grown were Sauvignon Blanc, Semillon and Chardonnay. The dominant red varieties grown were Cabernet Sauvignon, Shiraz and Merlot.

¹ A trial planting by the Cullen's on a neighbour's property dated back to 1966.

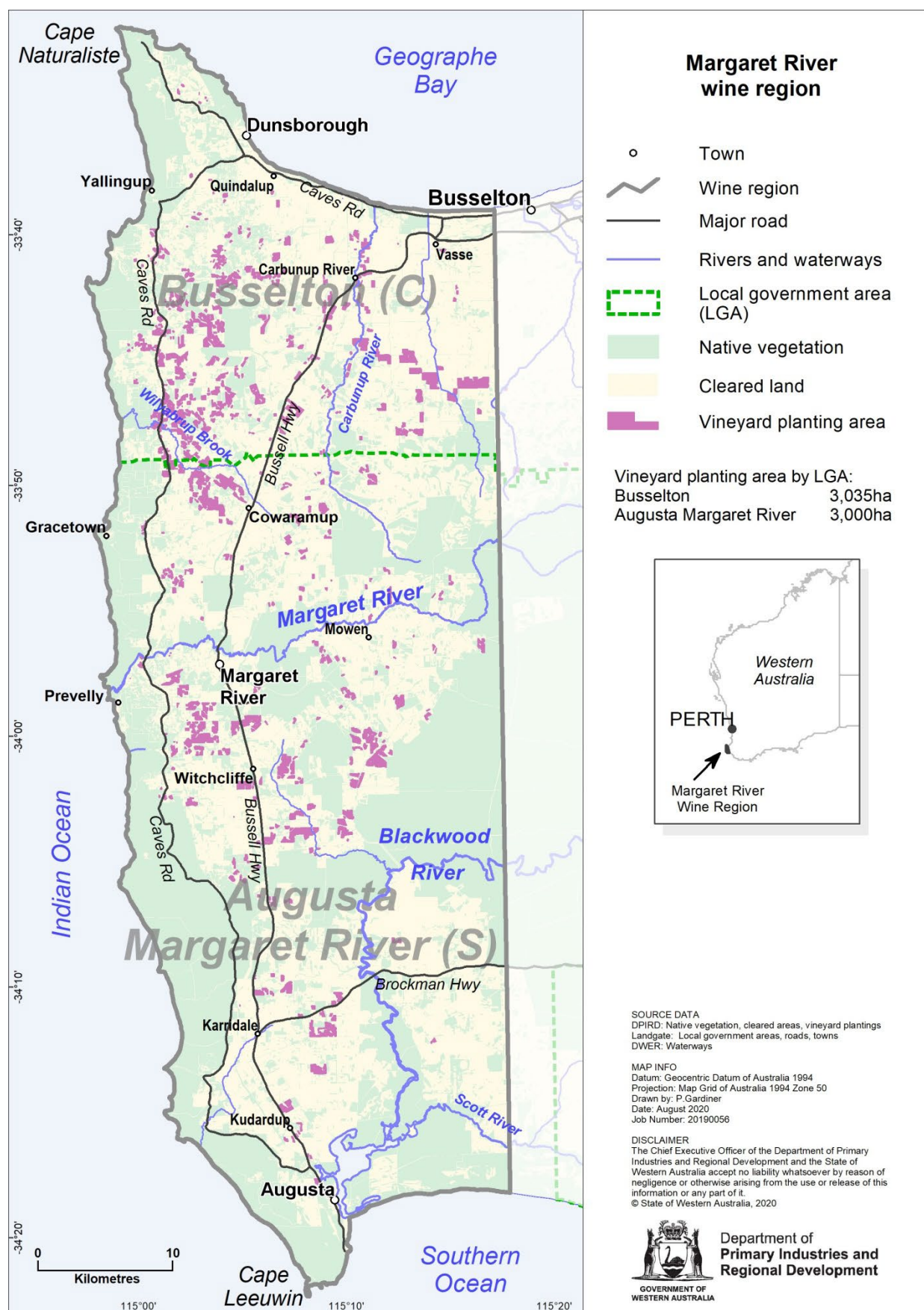


Figure 2.1 Margaret River wine region

3 Geology and landforms

The Margaret River region has two dominant geological formations influencing its landscape and its soils: the crystalline rocks of the Leeuwin Complex in the western half (about 83 000ha), and the sedimentary rocks of the Perth Basin in the east. The Dunsborough Fault, which runs from Dunsborough to Augusta and passes inland of Margaret River, separates the Leeuwin Complex from the Perth Basin (Figure 3.1). The diversity of landforms and elevations across the region reflects the influence of different erosional and depositional processes (Figure 3.2).

Almost two-thirds of Margaret River's vines are planted over the Leeuwin Complex, which is made up of intensely deformed granite and gneiss rocks (mainly granitic orthogneiss). They are comprised of felsic gneisses, plagioclase-hornblende gneiss and mafic gneiss rocks, all with a similar geochemistry (Janssen et al. 2003).

The precise age of the rocks of the Leeuwin Complex is unclear because of the scarcity of measurements. Myers et al. (1994) reports two samples as aged at around 1130 and 1600 million years old. This is similar in age to the younger crystalline rocks of the Albany Fraser Orogen (underlying the Great Southern, Pemberton and Manjimup wine regions), but considerably younger than the rocks of the Yilgarn Craton (beneath the Blackwood, Geographe, Peel and Perth Hills wine regions).

Collins (2003) has dated some of the gneiss to around 750 million years old and granite/amphibolite to around 520 million years old. These are similar ages to some of the older rocks under the wine regions of South Africa, but probably predate the oldest geology of the viticultural areas of Europe.

The Leeuwin Complex corresponds to the Leeuwin Soil-landscape Zone in DPIRD's mapping (Section 4, Figure 4.1). An iron-enriched lateritic plateau has formed over the crystalline rocks of this complex, with up to 10 metres (m) of weathered mantle overlying the basement rock. This plateau, identified and mapped as the Cowaramup Uplands Soil-landscape System (Tille & Lantzke 1990a) rises gently from an elevation of 20m on the Australian Height Datum (mAHD) at Augusta to 140mAHD near Dunsborough (Section 4, Figure 4.2).

Several rivers and streams have dissected the plateau to form the relatively shallow Wilyabrup Valleys Soil-landscape System (Section 4, Figure 4.2). It is in these valleys, found between Cape Naturaliste and Augusta and along the coastline, that the rocks of the Leeuwin Complex are most exposed.

Deposits of deep windswept sands underlain by Tamala limestone cloak the western fringe of the Leeuwin Complex. This is the Gracetown Ridge Soil-landscape System, comprised of sand dunes extending from Cape Naturaliste to Cape Leeuwin and rising to heights of 140 to 210mAHD; it is generally not used for viticulture.

The breakup of Gondwanaland led to the separation of Australia and Greater India in the Permian to Early Cretaceous periods. This resulted in the formation of a deep, linear trough of sedimentary rocks known as the Perth Basin, lying to the east of the Dunsborough Fault and to the west of the Darling Fault, which is outside of the Margaret River region.

Within the region, the central portion of the Perth Basin is the Donnybrook Sunkland, represented by the Donnybrook Sunkland Soil-landscape Zone in DPIRD's mapping (Section 4, Figure 4.1). This elevated terrain formed about 150 million years ago on sedimentary rocks — mainly sandstones, siltstones and shale — mostly obscured by a mantle of deeply weathered laterite.² This zone contains almost a quarter of the vines within the region.

The Donnybrook Sunkland Zone has three distinct systems (Section 4, Figure 4.2). Firstly, the Whicher Soil-landscape System begins at the northern boundary of the zone which marks a curved ancient shoreline rising abruptly from the Swan Coastal Plain. The gently inclined Yelverton Shelf sits at about 60mAHd (Figure 3.1). The Whicher Scarp, an older marine escarpment that gently climbs to 90mAHd, is located to the south of this shelf.

The second system is south of the Whicher Scarp, where the zone transforms to the undulating, dissected lateritic plateau of the Treeton Hills Soil-landscape System. This series of ridges and valleys, including those of the Carburnup River, Margaret River and upper Chapman Brook, sits at 40–130mAHd. The Treeton Hills System gradually descends to the winding Blackwood River from where it gives way to the broad flats of the Nillup Plain Soil-landscape System, the third system in the zone.

The Nillup Plain system merges southward into the extensive Quaternary deposits of the Scott Coastal Plain. Defined by the Scott Coastal Soil-landscape Zone (Section 4, Figure 4.1), this flat, swampy terrain terminates at the prominent D'Entrecasteaux dunes fringing the waters of the Southern Ocean east of Augusta.

North of the Donnybrook Sunkland Zone is the relatively flat Swan Coastal Plain, reaching only 40mAHd. The shape of the plain evolved as the rocks of the Perth Basin were stripped by marine erosion and buried by more-recent (10–20 million years of age) marine and terrestrial sediments. The plain has a series of subdued dune systems mirroring the shoreline. The first of these is within the Perth Coastal Soil-landscape Zone (Section 4, Figure 4.2), which extends from this area northward up the coast to Jurien Bay. It includes calcareous and quartz dune ridges and estuarine deposits underlain by Tamala limestone typical all along the west coast. Further inland, a discontinuous arc of older low quartz dunes runs parallel to the coast — the Bassendean Soil-landscape Zone — marking the location of an ancient shoreline (Figure 3.2).

A sequence of alluvial deposits makes up the remainder of the coastal plain. This is the flat Abba Soil-landscape System — part of the Pinjarra Soil-landscape Zone — the better-drained portions of which contain the remaining 14% of the region's vines.

The elevation of the region ranges from 0 to 231mAHd, with vineyard plantings located between 3 and 139mAHd. On the Leeuwin Zone, vineyards are situated mostly at elevations between 40 and 100mAHd, while those on the Donnybrook Sunkland Zone are usually at 40–80mAHd. Around Carburnup and Jindong on the Swan Coastal Plain, vineyard elevations are 3–40mAHd (Figure 3.2).

² Despite its name, the Donnybrook Sunkland is elevated. The name derives from the fact that the sedimentary rocks were formed in a trough and lie at a lower level than the rocks of the Yilgarn Craton. These rise up above the Sunkland to the east of the Darling Fault.

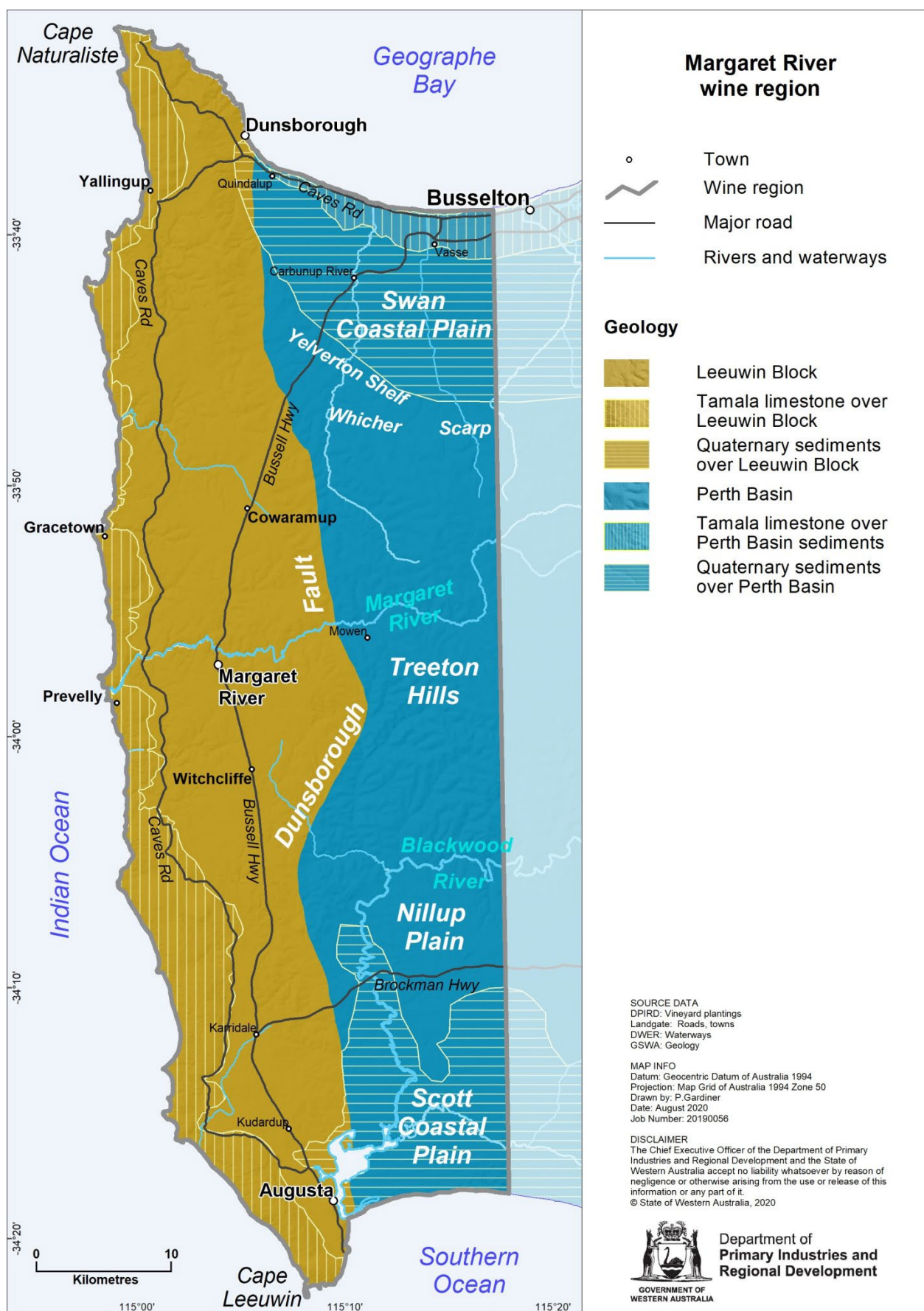


Figure 3.1 Simplified geology and physiography of the Margaret River wine region

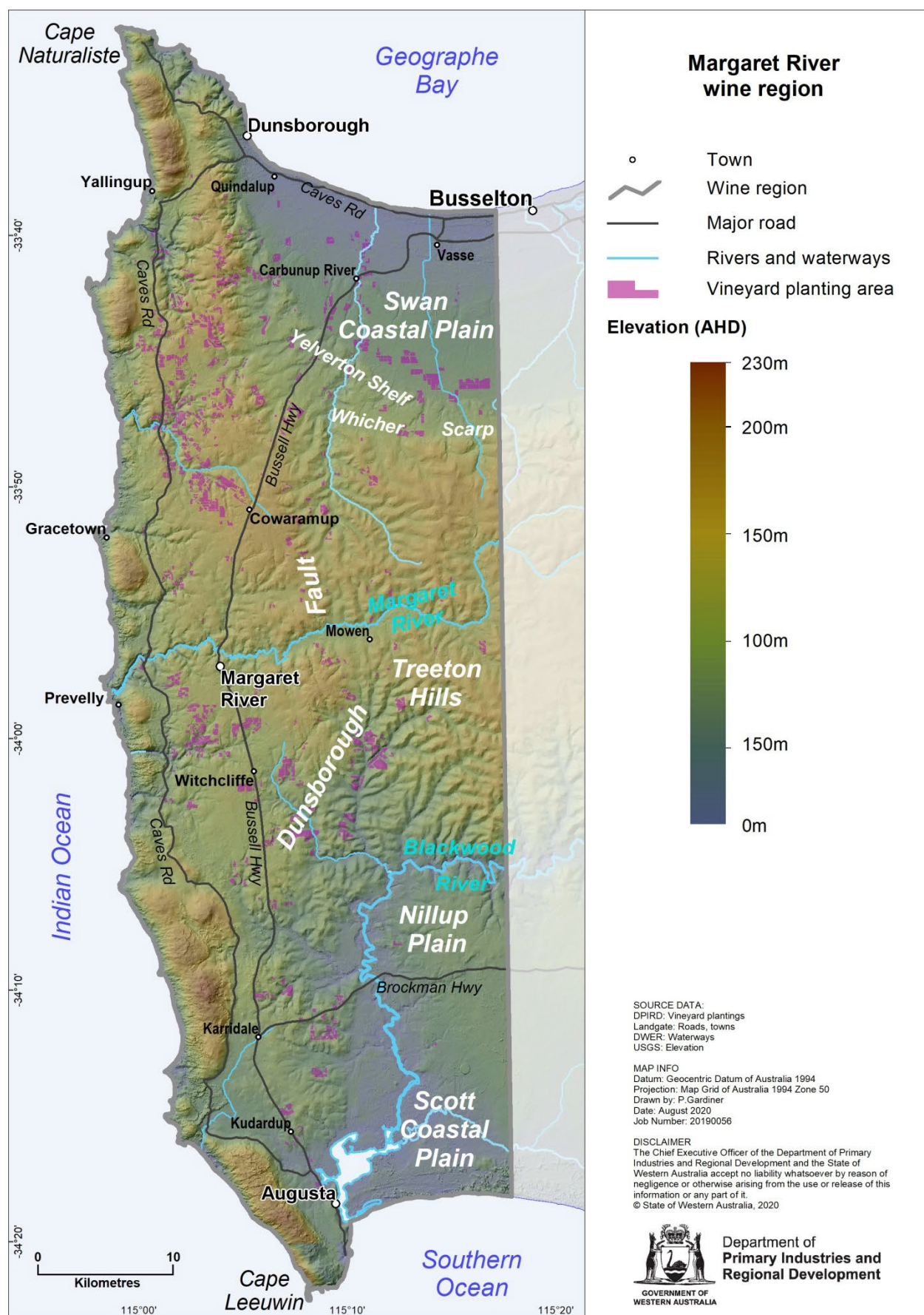


Figure 3.2 Elevation of the Margaret River wine region

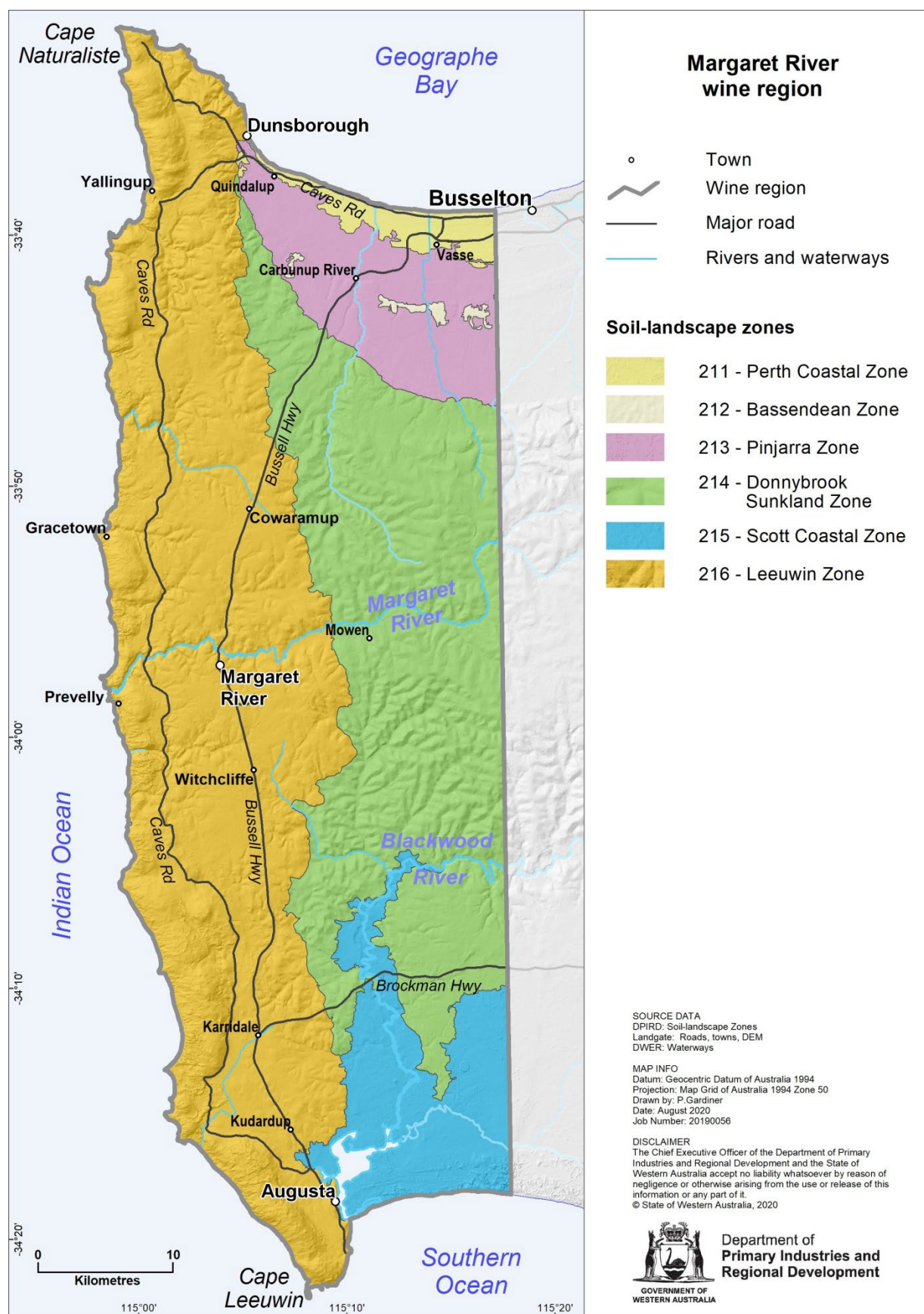
4 Soil-landscapes

A soil-landscape is an identified area of land with repeating patterns of landscapes and associated soils (Schoknecht et al. 2004). They are mapped and presented at different scales and varying levels of complexity in both landscape and soil patterns depending on the needs of the user. The broadest scale shown here is the soil-landscape zones, which reflect the geology, geomorphology and relief of an area. Table 4.1 describes the six zones in the Margaret River region and Figure 4.1 shows their location and extent.

Table 4.1 Description of the soil-landscape zones in the Margaret River region

Zone name & code	Area (ha)	Description
Perth Coastal Zone (211)	4 007	Coastal sand dunes and swamps on Tamala limestone over Quaternary sediments over Perth Basin sedimentary rocks. Waterlogged soils with Calcareous sands and Spearwood sands. Mixed coastal scrub/heath and tuart forest/woodland.
Bassendean Zone (212)	659	Sand dunes, swamps and sandplain on unconsolidated Quaternary sediments over Perth Basin sedimentary rocks. Bleached sands dominant. Banksia–paperbark woodlands and mixed heaths.
Pinjarra Zone (213)	16 652	Coastal plain with swamps on unconsolidated Quaternary sediments over Perth Basin sedimentary rocks. Busselton and Abba soils (often waterlogged) dominant, with minor Bleached sands and Marybrook soils. Jarrah–marri–wandoo–paperbark forest/woodland.
Donnybrook Sunkland Zone (214)	68 236	Moderately dissected lateritic plateau on deeply weathered mantle and colluvium Quaternary sediments over Perth Basin sedimentary rocks. Forest Grove and Mungite soils (sometimes waterlogged) co-dominant. Jarrah–marri forest and woodland.
Scott Coastal Zone (215)	19 698	Coastal sand dunes and plain with swamps on limestone and unconsolidated Quaternary sediments over Perth Basin sedimentary rocks. Waterlogged sands with some Bleached sands and Spearwood and other yellow sands. Mixed coastal scrub/heath, jarrah–marri–peppermint–paperbark woodland, swampy heaths and sedgeland.
Leeuwin Zone (216)	102 754	Coastal sand dunes and moderately dissected lateritic plateau on limestone and deeply weathered mantle over Leeuwin Block crystalline rocks. Forest Grove soils with Mungite soils (sometimes waterlogged) and Spearwood sands. Mixed coastal scrub/heath, peppermint woodland and jarrah–marri–karri forest.

Note: Figure 4.1 shows the location and extent of the soil-landscape zones.



Note: Table 4.1 describes the soil-landscape zones shown on this map.

Figure 4.1 Location and extent of the soil-landscape zones in the Margaret River region

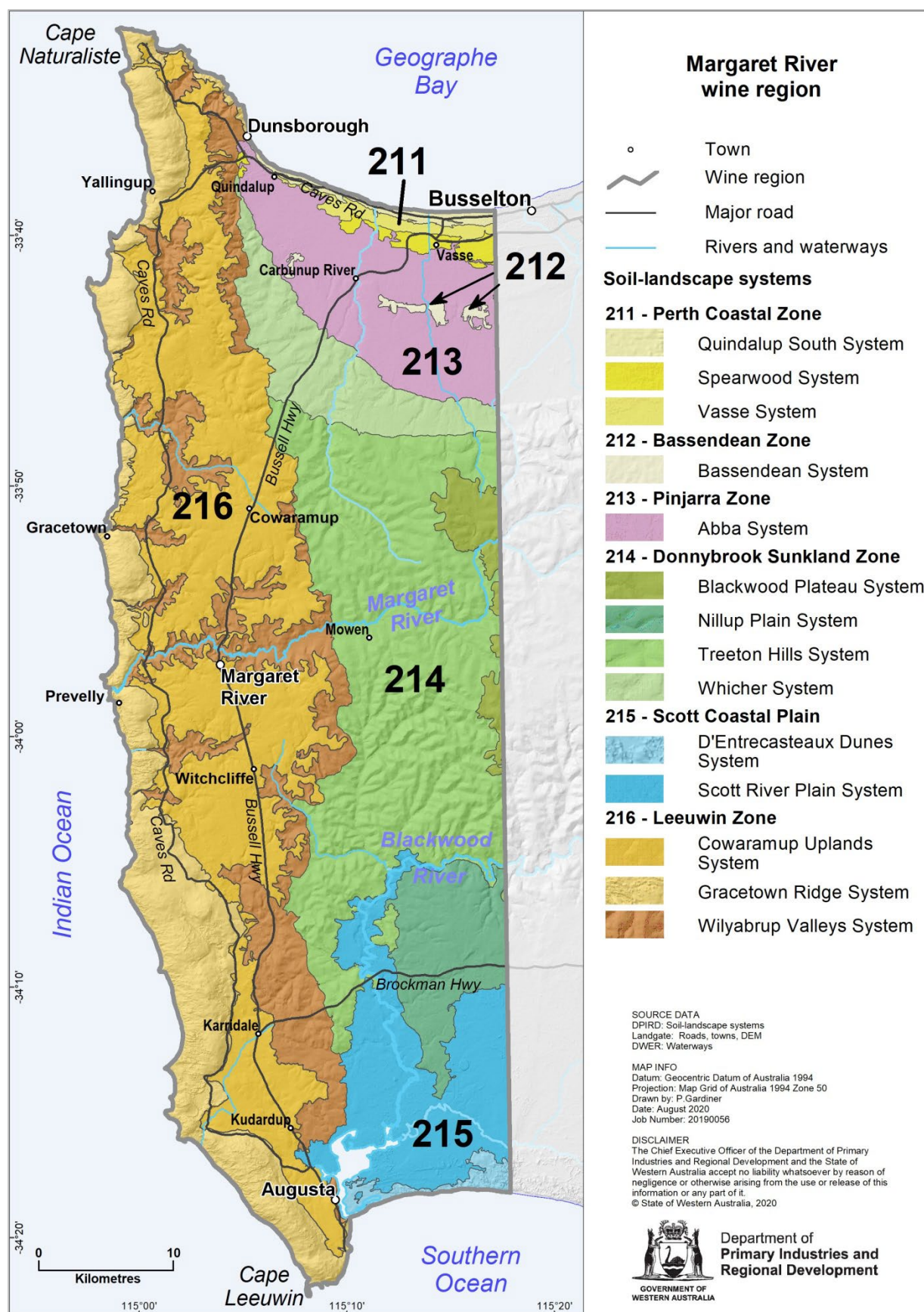
4.1 Soil-landscape systems

Soil-landscape systems are subdivisions of the soil-landscape zones. They provide more detail about the relief, landform pattern, main soils and their parent materials. Fourteen systems are in the region, described in Table 4.2 and shown in Figure 4.2.

Table 4.2 Description of the soil-landscape systems in the Margaret River region

System name & code	Area (ha)	Description
Quindalup South System (211Qu)	1 231	Coastal dunes with sand flats on aeolian sand over sedimentary rocks. Calcareous sands dominant. Mixed coastal scrub.
Spearwood System (211Sp)	1 437	Sand dunes and plains on aeolian sand and limestone over sedimentary rocks. Spearwood sands dominant. Tuart-marri forest and woodland in south, heath and open woodland in north.
Vasse System (211Va)	1 340	Estuaries, swampy depressions and poorly drained flats on alluvium over sedimentary rocks. Waterlogged soils dominant. Samphire flats and paperbark woodlands.
Bassendean System (212Bs)	659	Sand dunes, swamps and sandplain on unconsolidated sediments over sedimentary rocks. Bleached sands dominant. Banksia-paperbark woodlands and mixed heaths.
Abba System (213Ab)	16 652	Coastal plain with swamps on unconsolidated sediments over sedimentary rocks. Busselton and Abba soils (often waterlogged) dominant, with minor Bleached sands and Marybrook soils. Jarrah-marri-wandoo-paperbark forest/woodland.
Blackwood Plateau System (214Bp)	3 265	Lateritic plateau with broad swampy depressions on deeply weathered mantle over sedimentary rocks. Forest Grove soils dominant. Jarrah-marri forest.
Nillup Plain System (214Np)	9 238	Plain with broad swampy depressions on deeply weathered mantle over sedimentary rocks. Mungite soils (often waterlogged) with some Bleached sands. Jarrah-marri-paperbark woodland.
Treeton Hills System (214Th)	44 728	Undulating terrain on deeply weathered mantle and colluvium over sedimentary rocks. Mungite soils and Forest Grove soils co-dominant, with minor Waterlogged soils. Jarrah-marri forest and woodland.
Whicher System (214Ws)	10 049	Low scarp slopes and terrace on laterite, colluvium and alluvium over sedimentary rocks. Forest Grove soils and Mungite soils (sometimes waterlogged). Jarrah-marri forest and woodland.
D'Entrecasteaux Dunes System (215Dx)	1 905	Coastal dunes on aeolian sand and limestone over sedimentary rocks. Major Calcareous sands, with some Bleached sands. Mixed coastal scrub and peppermint-jarrah-marri woodland.
Scott River Plain System (215Sr)	17 794	Poorly drained coastal plain with dunes and swamps on Quaternary deposits over Perth Basin sediments. Waterlogged soils with some Bleached sands and Yellow sands. Heaths, sedgelands and jarrah-marri-paperbark woodland.
Cowaramup Uplands System (216Co)	51 429	Lateritic plateau with broad swampy depressions on weathered mantle over granitic rocks. Forest Grove soils with Mungite soils (sometimes waterlogged) and Bleached sands. Jarrah-marri forest.
Gracetown Ridge System (216Gr)	26 980	Dunes and rocky coast on aeolian sand and limestone over granitic rocks. Spearwood sands and Calcareous sands co-dominant. Mixed coastal scrub, peppermint woodland and jarrah-marri-karri forest.
Wilyabrup Valleys System (216Wv)	24 345	Major valleys on colluvium over granitic rocks. Forest Grove soils dominant, with some Keenan soils and Mungite soils. Jarrah-marri-karri forest.

Note: Figure 4.2 shows the location and extent of the soil-landscape systems.



Note: Table 4.2 describes the soil-landscape systems shown on this map.

Figure 4.2 Location and extent of the soil-landscape systems in the Margaret River region

5 Soils

5.1 Main soils

The soil and mapping information in this report is adapted from the department's broad-scale soil-landscape mapping that can be viewed on [NRInfo](#) on DPIRD's website. This mapping uses the Western Australian Soil Groups classification (WA Soil Groups; Schoknecht & Pathan 2013).

It is important to note that very few map units are composed of a single soil type or one combination of soil and landscape position. At the scale of mapping presented, these maps represent not one, but several, soil and landscape combinations presented as a proportion of each area mapped (Schoknecht et al. 2004).

Here we have used local soil names for the Margaret River region — see Tille and Lantzke (1990b) for more specific details about these soils — because these names (shown in bold below) are well established and understood across the region. The way they relate to soils described in the other wine regions in Western Australia (Tille et al. in press) is in the following manner:

- **Forest Grove soils** = Ironstone gravelly soils: sandy or loamy topsoils that contain more than 20% ferruginous nodules, over clay or a hard layer at depth
- **Mungite, Busselton and Abba soils** = Sandy duplex soils: topsoil layers are typically sandy with a sudden increase to clay layers at depth; some soils have a more gradual change to clay
- **Spearwood and Yellow sands** = Coloured deep sands: yellow, brown or red coloured sand which extends beyond 80cm
- **Bleached sands** = Pale deep sands: grey or pale yellow–brown coloured sand which extends beyond 80cm
- **Calcareous sands** = Alkaline soils: here these soils are the strongly alkaline deep sands of the coastal dune systems
- **Keenan soils** = Red–brown loams: typically a reddish-brown sandy loam to clay loam soil with less than 20% ferruginous nodules; they are commonly associated with freshly weathered rock in valleys and often contains fragments of rock or quartz
- **Marybrook soils** = Alluvial sands and loams: often a highly variable mix of soils found along major rivers; includes coloured sands and reddish-brown sandy loam to clay loam soils.

Section 7 contains distribution maps of each of these groups of local soils, with photos showing examples of typical soil profiles.

The remaining soil names used here are the same as those described for the other wine regions. One of these other groupings of soils is **Difficult soils**, which are typically areas with seasonally high watertables or shallow rock. Our analysis suggests that there are some vineyards planted on Difficult soils. Some of the Difficult soils have been altered — for example, mounded, drained or rocks removed — to allow cultivation to wine grapes. These analyses were based on reasonably accurate mapping of the vineyards combined with broad-scale (1:100 000) soil-landscape mapping. As described above, this mapping is not detailed enough to reflect all the intricate changes in soil type across the landscape. As most map units contain a combination of

favourable and unfavourable soils, the unsuitable soils will naturally be avoided and the better soils preferentially selected where possible.

Figure 5.1 compares the proportion of the main soils (in pale green) occurring across the Margaret River region. Forest Grove soils are the most common overall, followed by a mixture of Mungite, Busselton and Abba soils. To indicate the preferred soils for viticulture, we included the proportion of the main soils planted to vines (in dark green). More details about the soils are in the following sections and Appendix A.

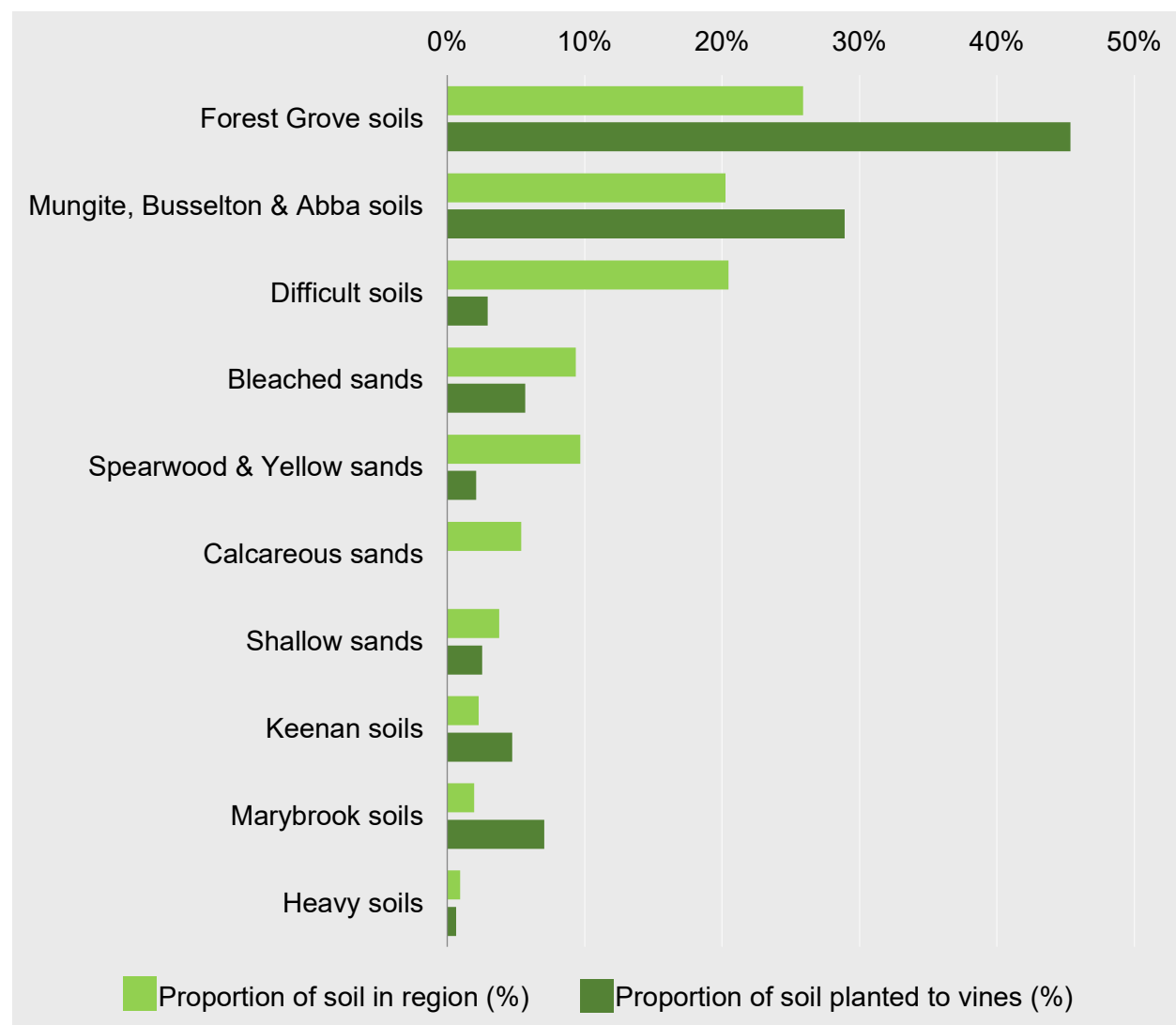


Figure 5.1 Proportion of main soils across the Margaret River region compared with main soils used for viticulture

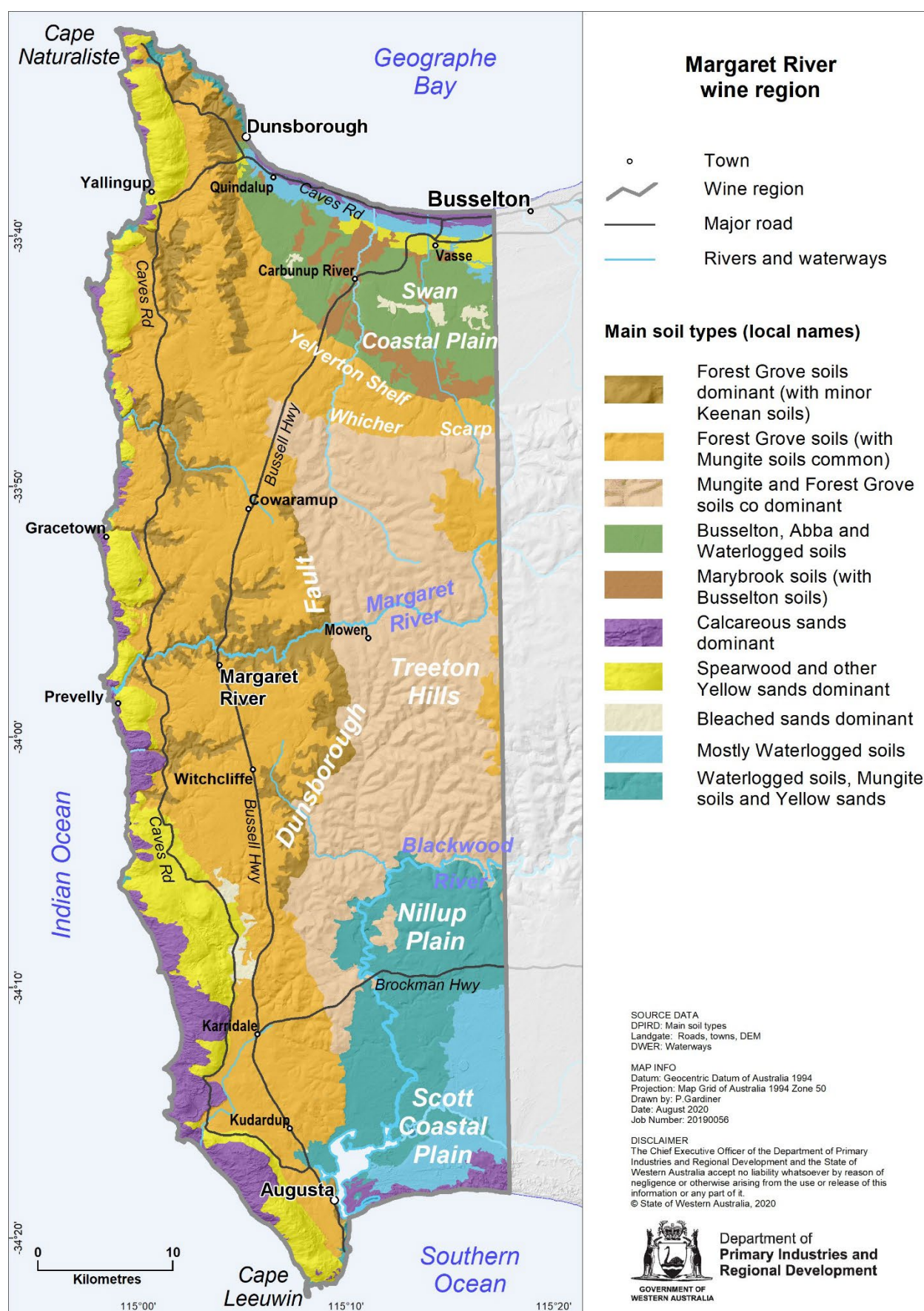
5.2 Distribution of the main soils

Figure 5.1 shows the distribution of main soils (using the local names) across the Margaret River region. As discussed previously, each map unit contain a mix of soils. The map legend only refers to the most common soil types in each unit. Table 5.1 provides descriptions of the legend entry for each map unit.

Table 5.1 Description of the main soil types in the Margaret River region

Main soil types	Description
Forest Grove soils dominant (with minor Keenan soils)	Ironstone gravelly soils occur across more than half of these areas and about a quarter of the soils are Red–brown loams
Forest Grove soils (with Mungite soils common)	Ironstone gravel soils are prominent, with up to a third of the soils being Sandy duplex
Mungite and Forest Grove soils co-dominant	Sandy duplex and Ironstone gravel soils are equally common
Busselton, Abba and Waterlogged soils	Sandy duplex and seasonally wet soils are equally common
Marybrook soils (with Busselton soils)	Mainly Alluvial sands and loams with some Sandy duplex soils
Spearwood and other yellow sands dominant	Coloured sands are dominant
Bleached sands dominant	Pale deep sands make up most of the soils
Calcareous sands dominant	Calcareous (Alkaline) sands make up most of the soils
Mostly Waterlogged soils	Most of the soils are affected by seasonally high watertables and other wet areas
Waterlogged soils, Mungite soils and Yellow sands	Waterlogged soils mixed with areas of Sandy duplex and Yellow deep sands

Note: Figure 5.2 shows the location and extent of the main soils.



Note: Table 5.1 describes the main soil types shown on this map.

Figure 5.2 Main soil types in the Margaret River region

The lateritic mantle covering the crystalline rocks of the Leeuwin Complex and the sedimentary rocks of the Perth Basin have given rise to the Forest Grove soils. These soils cover over a quarter of the land in the Margaret River region (Figure 5.1, Table A1 in Appendix A).

West of the Dunsborough Fault, they are the dominant soils of the Wilyabrup Valleys Soil-landscape System and cover almost half of the Cowaramup Uplands System (Table 4.2, Figure 4.2). On the Cowaramup Uplands System, they are particularly common on gently sloping terrain and the broad crests.

East of the Dunsborough Fault, the Forest Grove soils cover almost a third of the Treeton Hills System and a quarter of the Yelverton Shelf (part of the Whicher Scarp System). They are dominant on broad ridge crests, but are more commonly found in a mix with Mungite soils on sloping land below the crests and broad flats. Forest Grove soils are very minor on the coastal plains.

Mungite, Busselton and Abba soils are the next most common soils in the region, covering almost a quarter of the cleared land. The Mungite soils are frequently found in a mix with Forest Grove soils. They cover almost a third of the Treeton Hills System, mainly on the undulating valley slopes. They are also present on the broad flats and depressions of the Yelverton Shelf and the Nillup Plain.

West of the Dunsborough Fault, Mungite soils are found on the broad flats and depressions of the lateritic plateau, covering almost 30% of the Cowaramup Uplands System, usually in combination with Forest Grove soils.

Busselton and Abba soils are restricted to older alluvial deposits on the Swan Coastal Plain, on low rises and in depressions.

Spearwood and other yellow deep sands are found in about 10% of the region, but only about half of these are on land cleared for agriculture. They are prominent on the Gracetown Ridge System along the coast between Cape Naturaliste and Cape Leeuwin. This discontinuous ridge of sand dunes has a core of Tamala limestone. Spearwood sands are also dominant in the band of low coastal dunes over Tamala limestone (Spearwood dunes) on the Swan Coastal Plain. Broad areas of yellow deep sands are found on flats flanking the Blackwood and lower Scott rivers.

Bleached sands occur in patches covering about 10% of the region. They dominate the Bassendean System on the Swan Coastal Plain and are prominent on low dunes and flats on the Scott River Plain and D'Entrecasteaux dunes of the south coast. Bleached sands also occur along the inland margin of the Gracetown Ridge. They are scattered across the remainder of the Whicher, Abba, Cowaramup, Treeton and Nillup systems.

Keenan soils and Marybrook soils are not such common soils, both found on only about 3% of the cleared land in the region. Keenan soils are associated mainly with exposures of the freshly weathered crystalline bedrock in the Wilyabrup Valleys and Cowaramup Uplands systems.

Marybrook soils are most prominent on the Swan Coastal Plain. They are associated with younger alluvial deposits on the better-drained alluvial fans and river terraces of the Abba System (around Jindong and Caribunup). They are also on well-drained flats flanking watercourses and at the base of the Yelverton Shelf where fine, fertile

sediments are deposited from short drainage lines descending from the upland plateau. Away from the Swan Coastal Plain, other well-drained river and stream flats also feature these soils, including along Margaret River, Chapman Brook and the Blackwood and Scott rivers.

Calcareous sands are minor soils closely associated with the region's coastal fringes and are typically not cleared. These are mainly windswept calcareous dunes and beach ridges of the Quindalup, Gracetown and D'Entrecasteaux systems.

Shallow sands are also minor, most prominently associated with Tamala limestone on the coastal Spearwood and Gracetown systems. Pockets of shallow sands over cemented ironstone are scattered across the Leeuwin and Donnybrook Sunkland zones.

The small areas of Heavy soils are mostly associated with poorly drained areas in the Nillup Plains and Abba systems and adjoining the lower Blackwood River in the Scott River Plain System.

We grouped together as Difficult soils the areas where productivity may be affected by land dominated by seasonally high watertables; or valley floors, swamps and lakes; or where exposed or shallow rock or cemented laterite or stony soils are prevalent. Particularly frequent on the coastal plains, most of these areas remain uncleared, making up about a fifth of the region.

Soil-landscape mapping covering this entire region is published in the Busselton – Margaret River – Augusta survey (Tille & Lantzke 1990a).

5.3 Main viticultural soils

The sites selected for grape growing by the pioneers of the modern Margaret River wine industry were on **Forest Grove** soils³ in the valley formed by Wilyabrup Brook. These were the soils supporting 'a predominance and good growth of redgum'⁴ that Gladstones (1966) recommended as being most suitable.

Forest Grove soils are the most common in these valley landscapes found across the Leeuwin Complex, and the preference for them continues. Despite covering just over a quarter of the land in the Margaret River region (Figure 5.1), they are the most widely planted type of soils, supporting more than 40% of the region's vines (Figure 5.3, Table A2 in Appendix A).

Forest Grove soils typically consist of lateritic colluvium sitting over clay derived from the deeply weathered mantle. The topsoil is typically a yellowish-brown loamy sand to sandy loam with up to 60% rounded ironstone gravels. This overlies mottled yellow clay at about 50cm. In the WA Soil Groups, they are mainly *Duplex sandy gravels* and *Loamy gravels*.⁵ *Deep sandy gravels*, where the sandy topsoil extends to over 80cm in depth, and *Shallow gravels*, where ironstone duricrust overlies the clay subsoil, are planted to a lesser extent.

³ First described by Smith (1951).

⁴ Redgum is the common name for Marri (*Corymbia calophylla*).

⁵ Schoknecht and Pathan (2013) describe the WA Soil Groups (shown in italics).

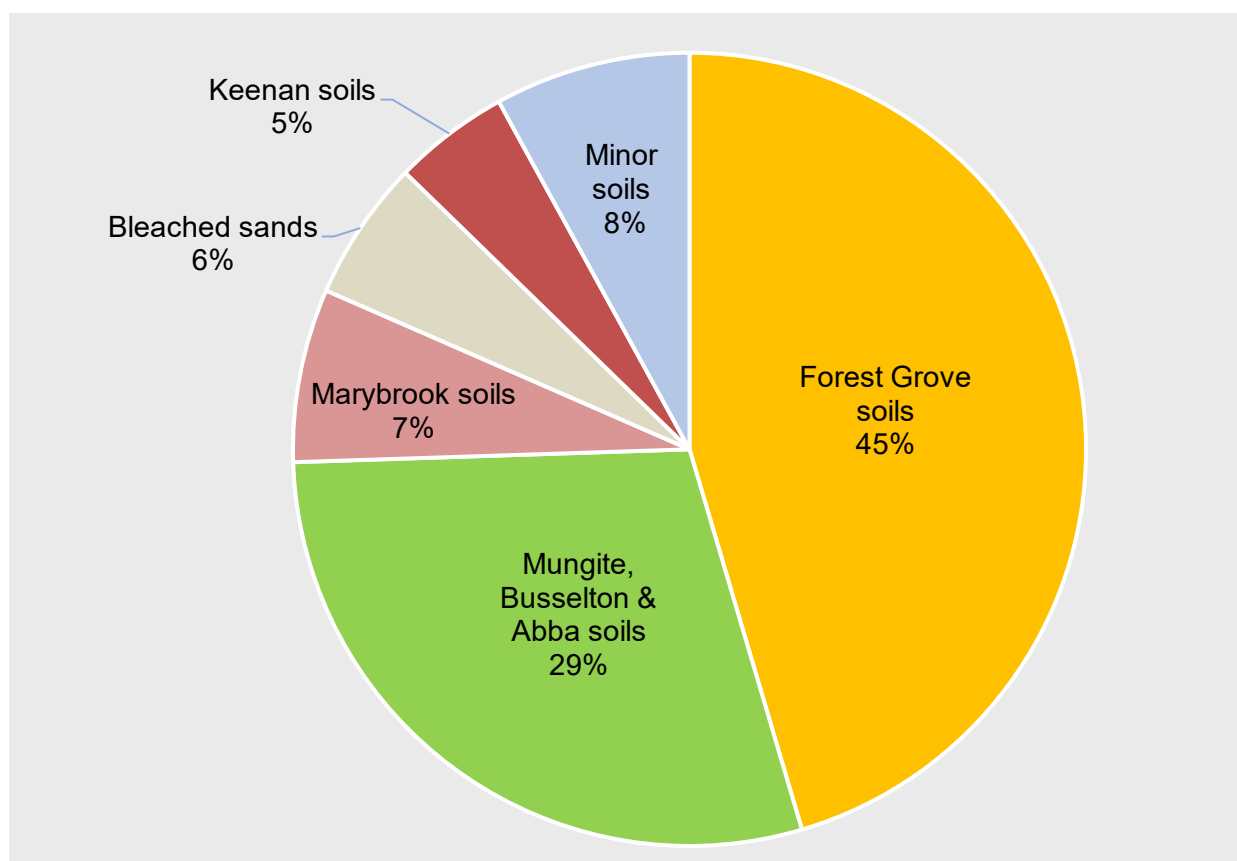


Figure 5.3 Proportions of the main soils used for viticulture in the Margaret River region

Almost a quarter of the region's vines are growing in the Wilyabrup Valleys System (Figure 4.2), with at least 60% planted on Forest Grove soils. The loamy topsoils recommended for plantings by Gladstones (1966) are most common in these valleys because there is greater influence from freshly weathered bedrock here than other areas. It is also around the fresh rock that red–brown colours are more likely to be found.

Plantings on the Cowaramup Uplands System are now more widespread, accounting for around 40% of the region's vines. In this system, at least half of the vines grow on Forest Grove soils.

Over the sedimentary rocks of the Perth Basin (Figure 3.1), the main areas of Forest Grove soils planted to vines are on the Treeton Hills System and the Yelverton Shelf. The Forest Grove soils have a similar appearance to those formed over the crystalline rocks of the Leeuwin Complex. However, there is a higher proportion of *Duplex sandy gravels*, with fewer *Loamy gravels* being encountered.

On the Cowaramup Uplands System, Treeton Hills System and the Yelverton Shelf, plantings are often established on a mix of Forest Grove and **Mungite soils**.⁶ The Mungite soils have a grey–brown sandy to loamy topsoil over a pale-grey, mottled clay subsoil at around 50cm. Sometimes there is a texture contrast between the topsoil and subsoil, but there is often a gradual boundary. In both cases, the subsoil restricts profile

⁶ Mungite soils were first described by Smith (1951). In terms of the main soils described by Tille et al. (in press), they mostly fall into the Sandy duplex grouping, even though many have a gradational profile and some have a loamy topsoil.

drainage. In the WA Soil Groups, Mungite soils are mainly *Pale sandy earths*, *Grey deep sandy duplexes* and *Semi-wet soils*.⁷ Waterlogging can be an issue on these soils, but with winter rainfall decreasing and with soil amelioration (mounding and drainage), the area of plantings has increased, possibly supporting up to quarter of the region's vines. Sloping ground is preferred for vines and subsoil drainage may need to be installed.

Around 7% of the region's vines grow on **Marybrook soils**⁸ located mainly around Jindong on the Abba System (Figure 4.2). These soils have formed in relatively young, well-drained alluvium and have red fine sand to loam topsoils, sometimes grading to a clay with depth. In the WA Soil Groups, they are mainly *Red deep sands*, *Red sandy earths* and *Friable red-brown loamy earths*. There are also some Marybrook soils planted on the flats adjacent to the Margaret River and upper Chapman Brook.

Associated with the Marybrook soils on the Swan Coastal Plain, areas of better-drained **Busselton soils**⁹ have been planted. These typically consist of a grey-brown fine loamy sand grading into a mottled sandy clay with depth. In the WA Soil Groups, they are mainly *Pale sandy earths* and *Pale deep sands*. They are like some of the Mungite soils and have also been more widely planted as winter rainfall has decreased. About 4% of the vines in the region grow on these soils.

About 5% of the region's vines grow on **Bleached sands** — *Pale deep sand* and *Gravelly pale deep sand* in the WA Soil Groups. The sands are generally pale grey and extend more than 80cm in depth. Sometimes they contain ironstone gravels below a sandy topsoil and in some cases, a clay layer can be found at more than 80cm below the sandy surface. These soils are generally not preferred for planting, but often occur as small pockets among the better soils in vineyards.

About 4% of the plantings grow on **Keenan soils**¹⁰ derived from freshly weathered crystalline basement rock of the Leeuwin Complex, mostly in the Wilyabrup Valleys System. They tend to have brown, or occasionally red, loamy topsoils over clay subsoil. These well-structured soils are typically a mixture of *Brown loamy earth*, *Brown deep loamy duplex* and *Friable red-brown loamy earths* (WA Soil Groups). They are often found in combination with the loamy Forest Grove soils and areas of rock outcrop (often as granite boulders) and stony soils.

Although suitable for vines, only a very small area of **Spearwood sands** (*Yellow deep sands* and some *Red deep sands* around Boranup) is planted in the region. On the Swan Coastal Plain, urban development has reduced the area available, and between Cape Leeuwin and Cape Naturaliste, much of these soils are in the Leeuwin Naturaliste National Park. **Other yellow sands** (*Yellow deep sands* in the WA Soil Groups) have been planted mainly on the Yelverton Shelf and Treeton Hills System, but these support only about 2% of the region's vines.

⁷ Some of the loamy variants of the Mungite soils do not sit comfortably into any of the WA Soil Groups.

⁸ First described by McArthur and Bettenay (1958).

⁹ First described by McArthur and Bettenay (1958).

¹⁰ First described by O'Donnell and Lockhart (1945).

6 Climate

The climate of the Margaret River area first drew John Gladstones to its potential for viticulture. He felt it had distinct advantages over all other wine districts in Australia (Gladstones 1965). Oceans form the north, west and southern borders of the region, creating a strong maritime influence over its climate, with low temperature variability.

The average annual rainfall (1989–2018) across the region is 977 millimetres (mm), ranging from almost 800mm at Cape Naturaliste in the north to over 1120mm in the south-east. Most of the rainfall occurs during the winter and spring months (Table 6.1, Figure 6.1). All other climate data is based on the period 1989–2019.

Table 6.1 Rainfall statistics for the Margaret River region, 1989–2018

Statistic	Annual rainfall (mm)	Growing season (October–April) rainfall (mm)
Minimum	732	143
Maximum	1123	261
Average	977	214

The region's average annual relative humidity (using the more-central Witchcliffe BoM weather station data) is about 72% in the morning (9 am reading) and 58% in the afternoon (3 pm reading), which results in ideal growing conditions, but carries a moderate risk of fungal disease. In seasons where rainfall arrives early in autumn, there is a moderate risk of bunch rot in susceptible varieties.

Because of the proximity to the ocean, temperature variability is low and spring frosts are uncommon. Mean minimum temperatures in the coldest months (July and August) near Augusta are as high as 11°C, while mean daily July temperatures at Margaret River are 12.8°C. The warmest and driest conditions are found around Jindong and Carburnup on the Swan Coastal Plain in the north-east (Beeston 2002). This area is relatively sheltered from southerly and westerly winds by the Leeuwin Naturaliste Ridge and the Whicher Scarp, but is exposed to warm, dry winds from the north-east.

There is a downward gradient of temperature and sunshine hours from the north to the south of the region, with temperatures marginally increasing again south of Karridale. An abrupt increase in cloudiness south of Witchcliffe is a common summer feature. South of this point, the warm northerly winds have limited effect. The main climatic influence is the moderating coastal winds from the Indian and Southern oceans.

Because of the coastal influences and relatively low elevations, spring frosts are uncommon in the region, with an overall lower risk around the coastal areas, increasing slightly for inland valley locations. Temperatures below 2°C may occasionally occur after budburst in August and September.

Margaret River, like most Western Australian coastal locations, is a windy region, particularly in spring and summer where the typical pattern brings cool afternoon sea breezes with high relative humidity. While this brings relief from the heat and aridity in summer, it can be detrimental to vine growth and development in spring because

exposure to strong ocean winds can damage new shoots and flowers, thus reducing fruit set.

In spring, the predominant winds come from the east and south-east in the morning and from the south in the afternoon, with 20% of the wind being stronger than 40 kilometres per hour (km/h).

The overall average 3 pm wind speed at Witchcliffe is 19km/h. Wind speeds are higher at the prominent capes to the north and south of the region, rising to an average of 25km/h at Cape Leeuwin and up to 29km/h at Cape Naturaliste.

6.1 Climate parameters for viticulture

Table 6.2 gives an overview of the temperature statistics significant for viticulture in the Margaret River region. They include:

- mean January temperature, which represents the month of the highest annual temperature
- growing season (October to April) mean temperature
- growing degree days, which is a summation of heat for vines over the growing season (October to April), using the base 10 method (Hall & Jones 2010)
- diurnal temperatures, which are the ranges between minimum average daily and maximum average daily temperatures.

Hall and Jones (2010) and Dry and Coombe (2004) provide more details about these parameters.

Table 6.2 Temperature statistics for the Margaret River region, 1989–2019

Measurement	Value
Mean January temperature (°C)	20.6
Growing season (October–April) minimum mean temperature (°C)	18.2
Growing season (October–April) maximum mean temperature (°C)	19.5
Mean growing degree days (October–April)	1939
Minimum average diurnal temperature (°C)	5.7
Maximum average diurnal temperature (°C)	12.0
Average diurnal temperature (°C)	10.1

The following maps show important climatic parameters for viticulture across the Margaret River region:

- average annual rainfall, 1989–2018 (Figure 6.1)
- average growing season (October to April) temperature (Figure 6.2)
- average rainfall for selected seasonal time periods (Figure 6.3)
- average diurnal temperature variability from October to April (Figure 6.4). These temperatures are the differences between the average daily minimum and maximum temperatures and indicates the extent of overnight cooling

- average seasonal growing degree days, using the base 10 method (Figure 6.5). This provides an estimation of the useful heat for vines, using daily mean temperature higher than 10°C over the growing season (October to April)
- average seasonal biologically effective growing degree days from September to March (Figure 6.6) and from October to April (Figure 6.7). This is an estimation of the heat affecting the vine growth and development during the growing season for early-ripening varieties (Figure 6.6) and for late-ripening varieties (Figure 6.7). These maps are calculated by adjusting degree days (Figure 6.5) for latitude / daylength for the selected time period.

Hall and Jones (2010) and Dry and Coombe (2004) provide more details about these parameters.

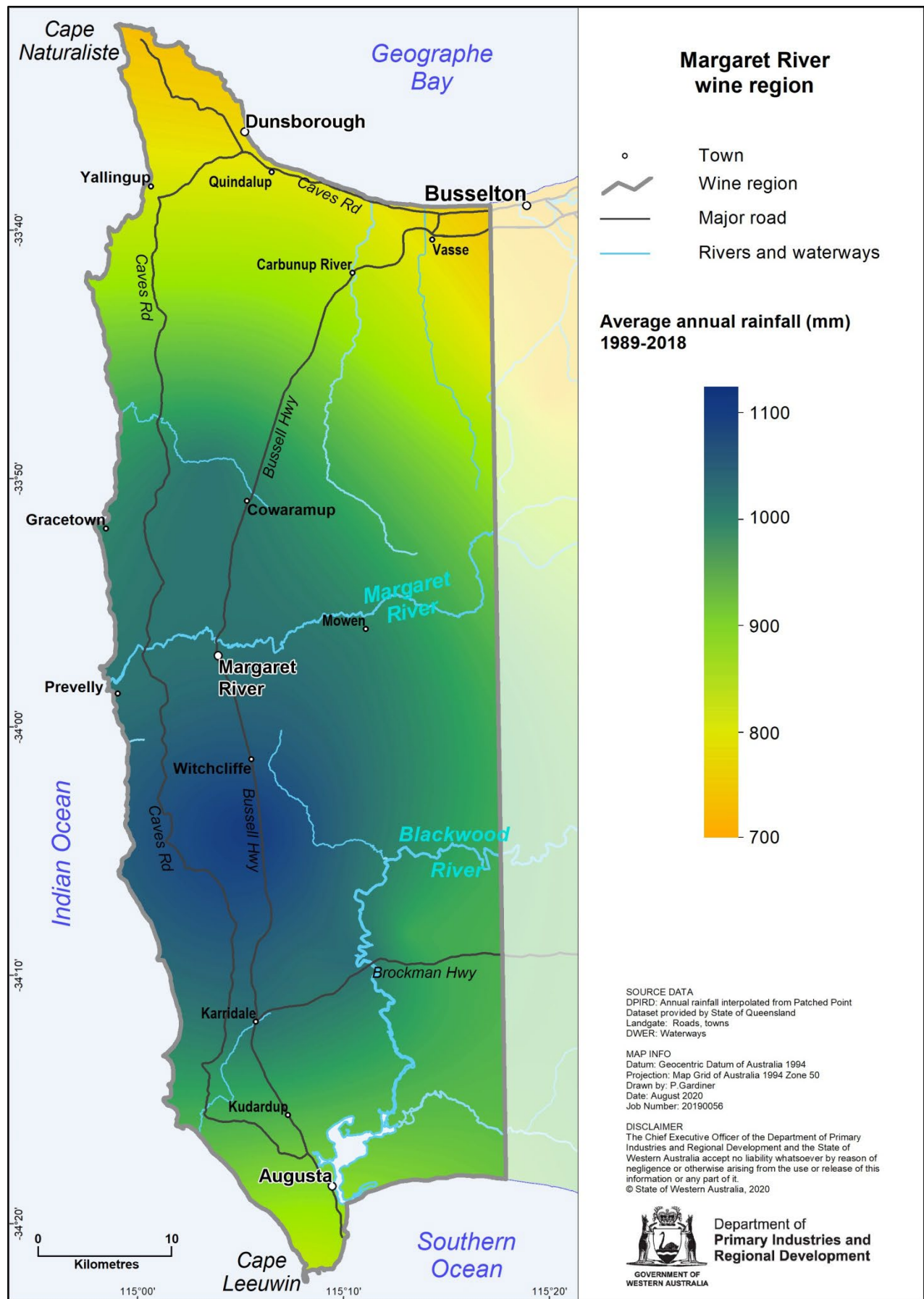


Figure 6.1 Average annual rainfall for the Margaret River region, 1989–2018

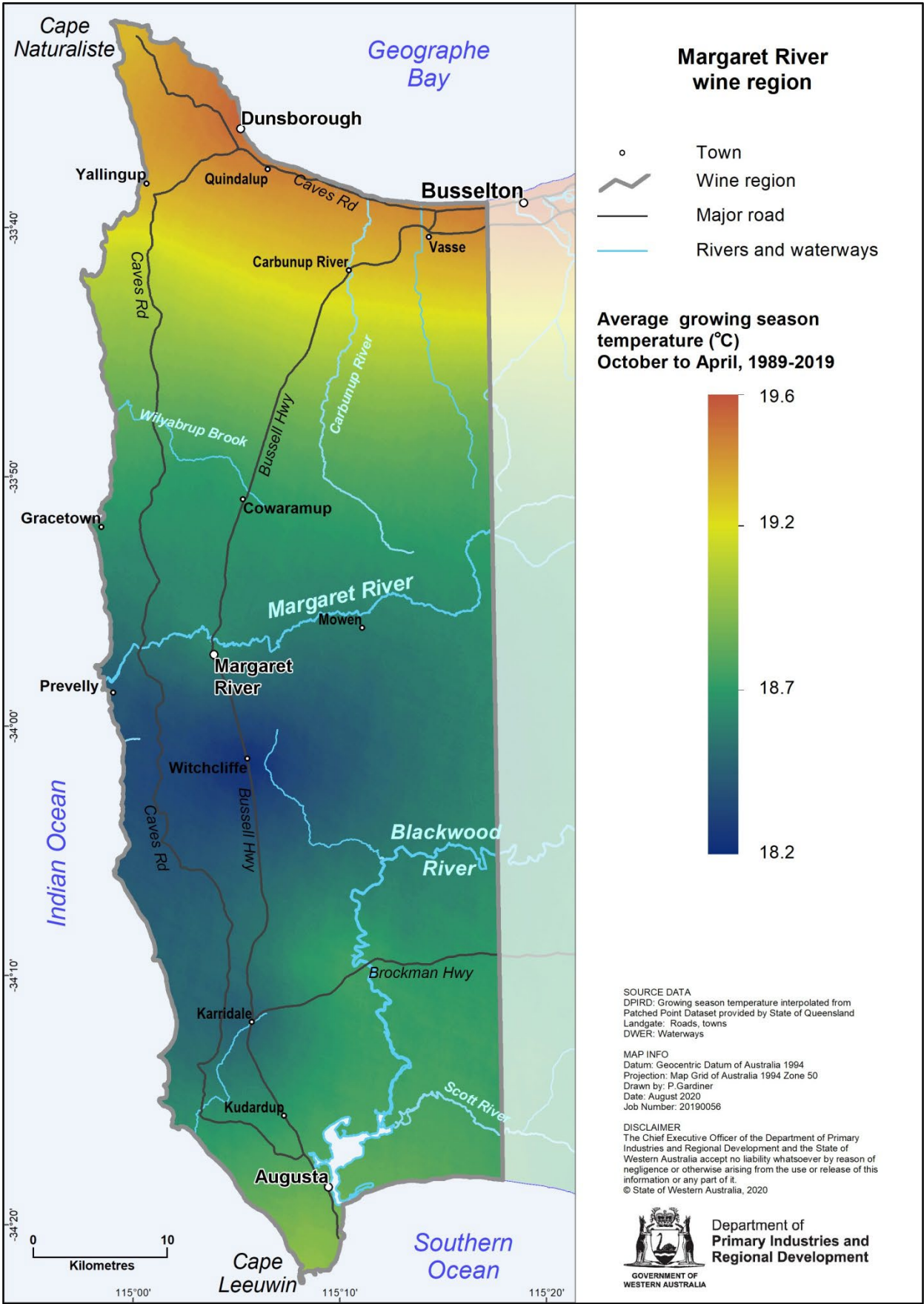


Figure 6.2 Average growing season (October–April) temperature, 1989–2019

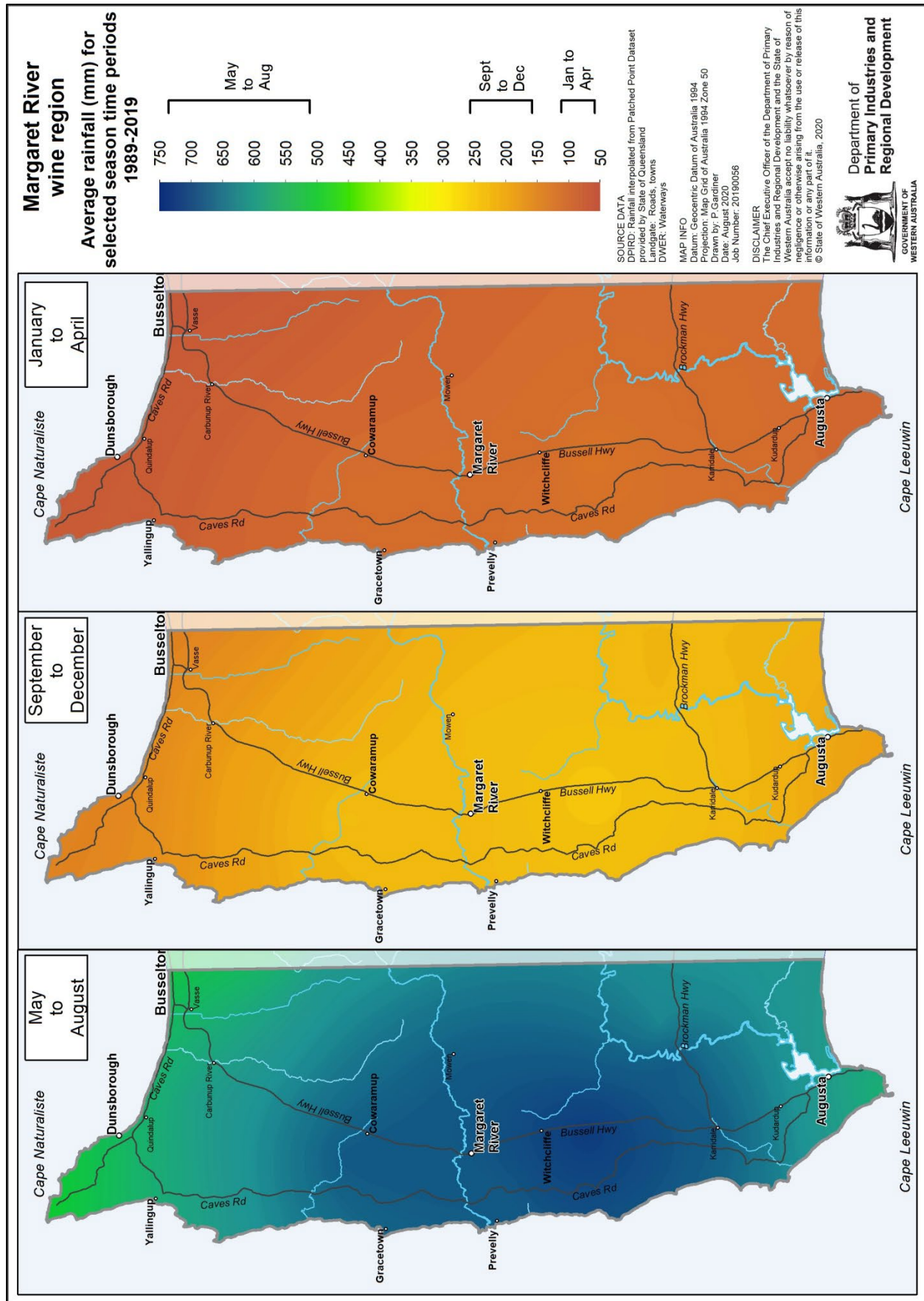


Figure 6.3 Average rainfall for selected seasonal time periods, 1989–2019

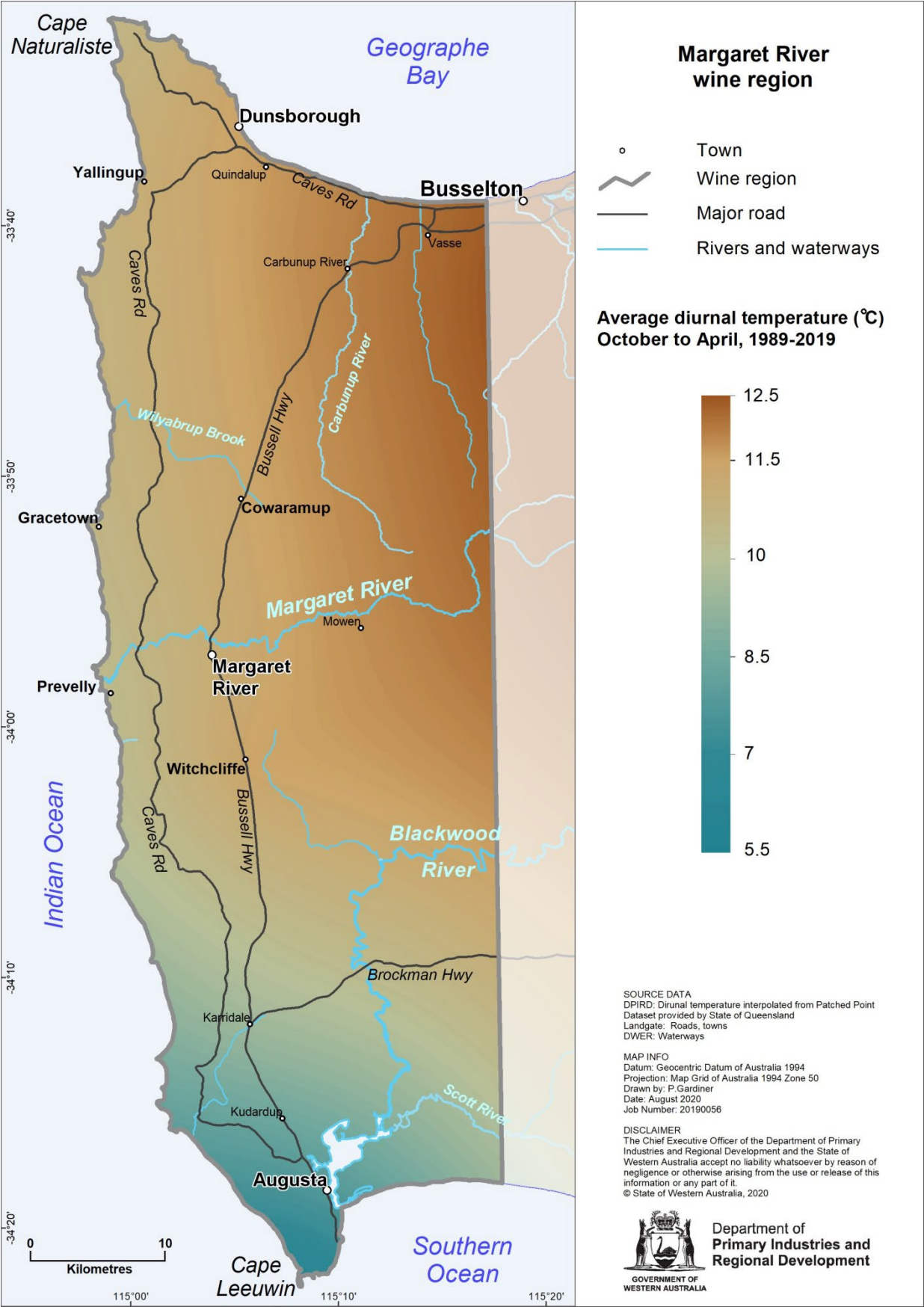


Figure 6.4 Average diurnal temperature variability (October to April), 1989–2019

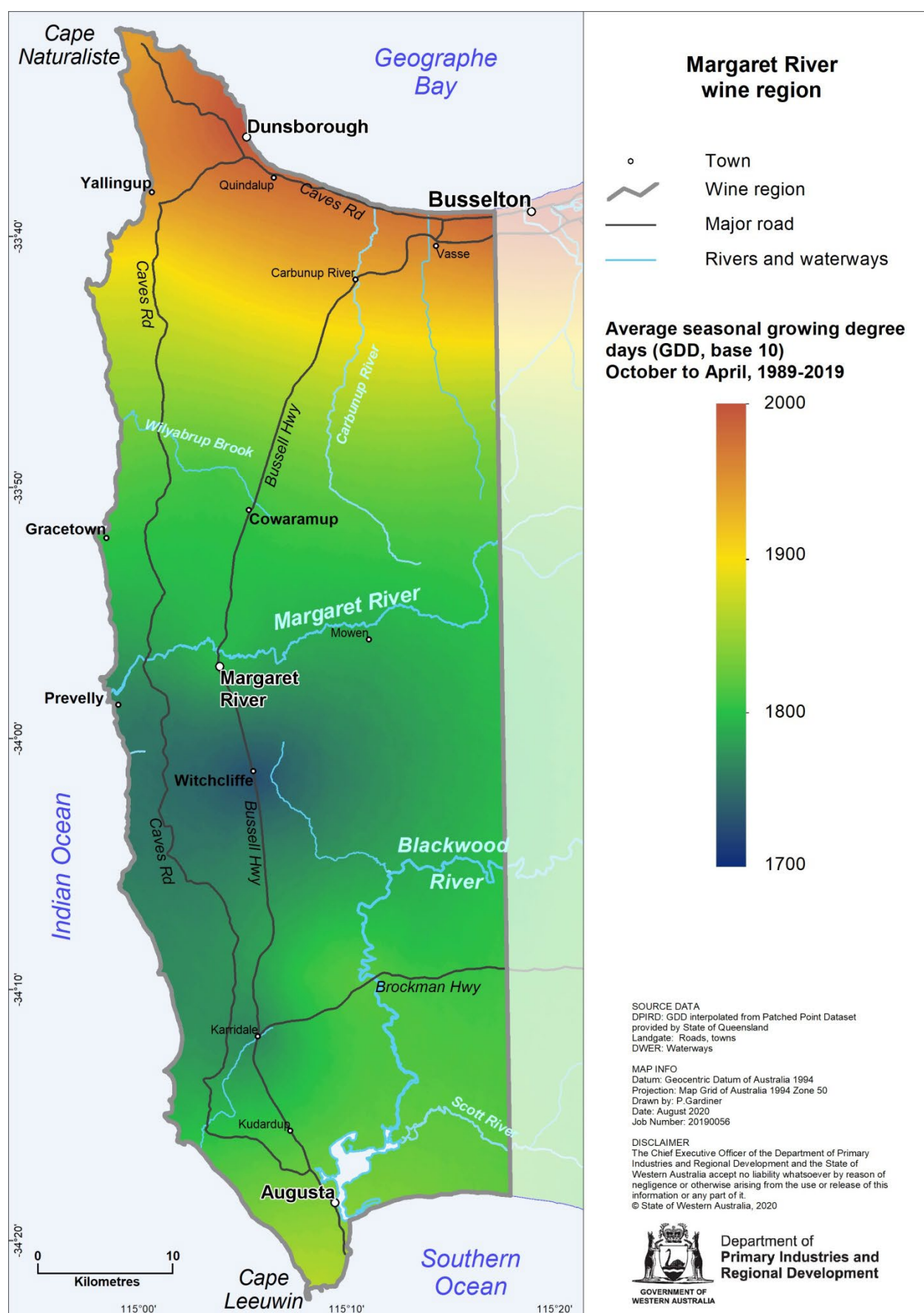


Figure 6.5 Average seasonal growing degree days (October to April), 1989–2019

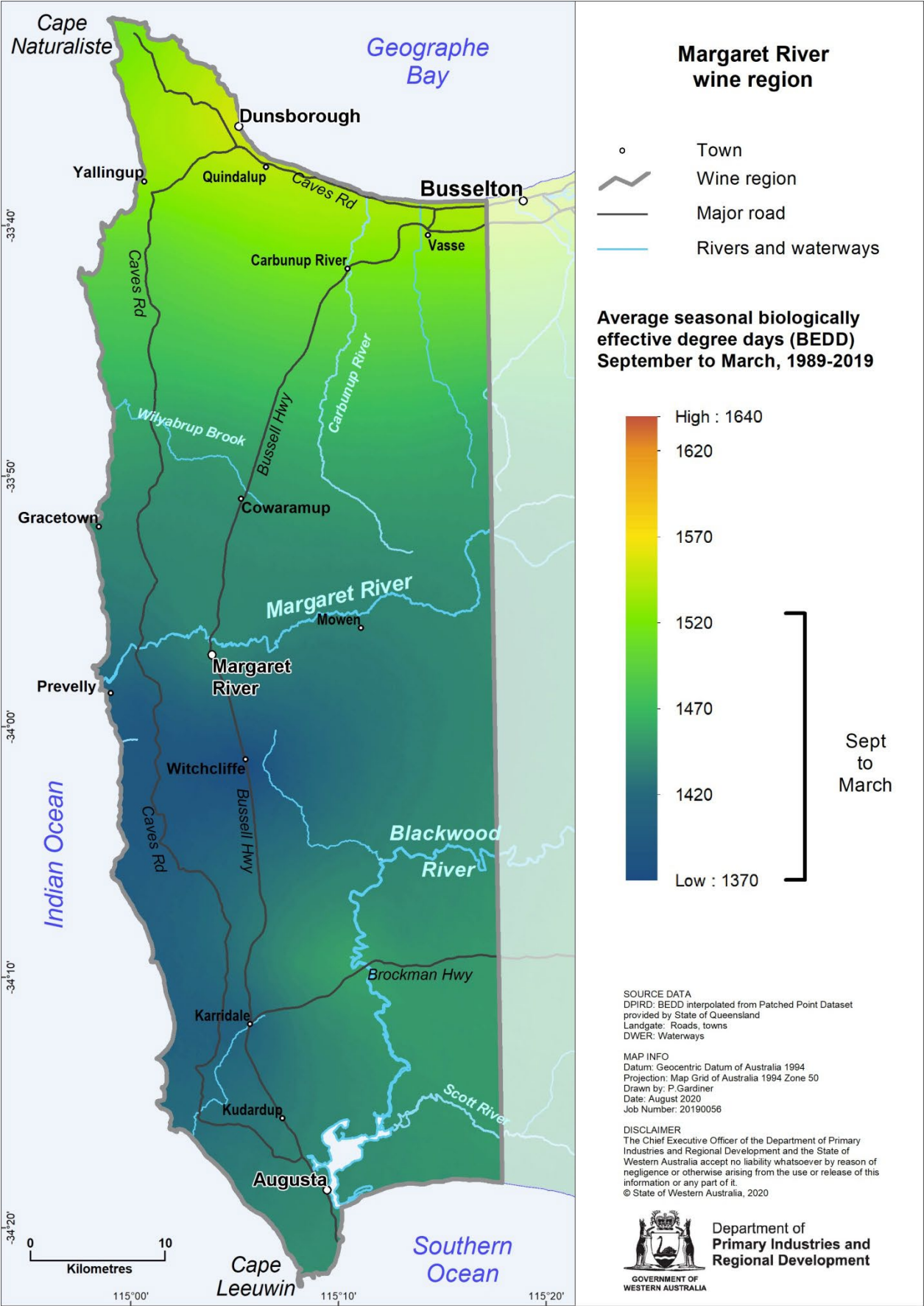


Figure 6.6 Average seasonal biologically effective growing degree days (September to March), 1989–2019

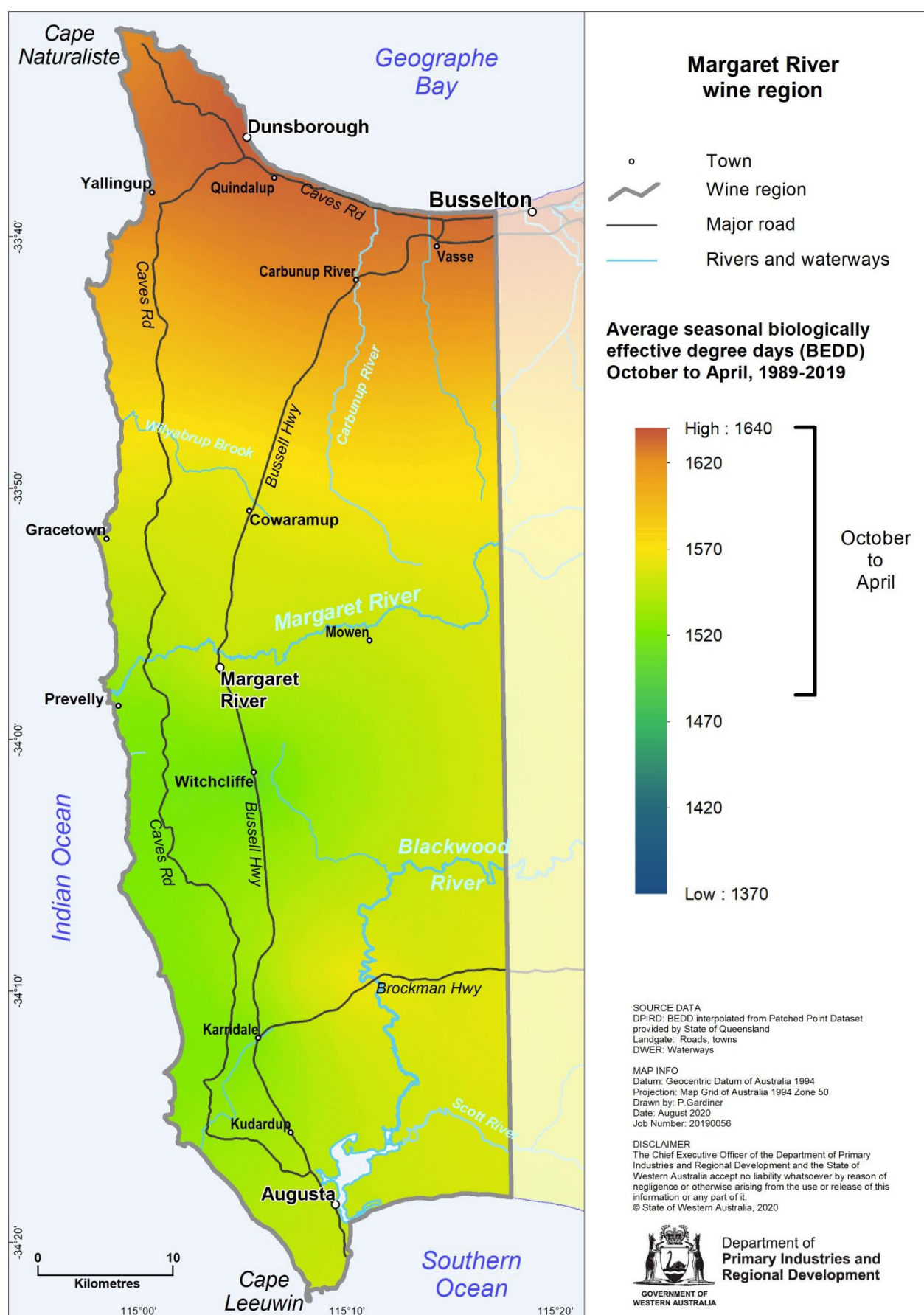
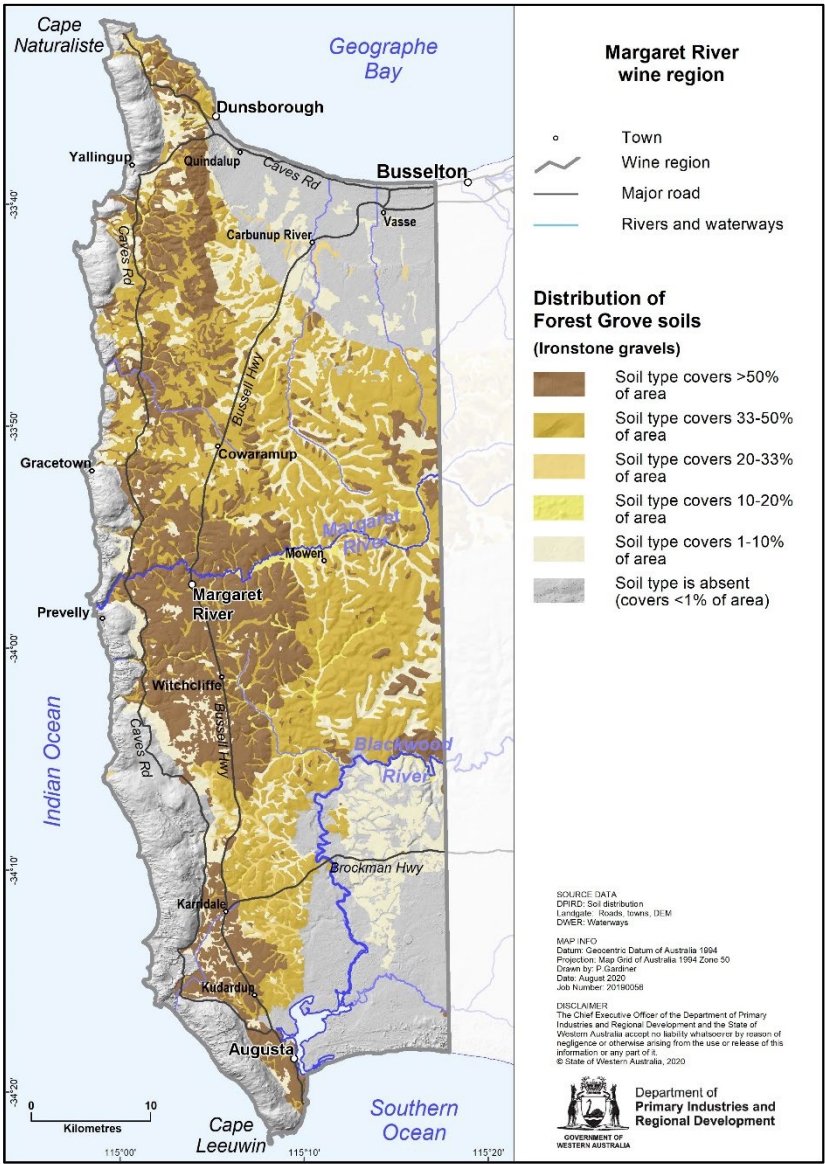


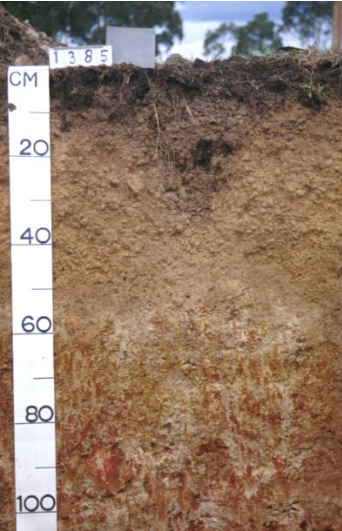
Figure 6.7 Average seasonal biologically effective growing degree days (October to April), 1989–2019

7 Distribution maps and soil profile images of the main soils

Forest Grove soils (Ironstone gravels)



Examples of Forest Grove soils



Duplex sandy gravel



Loamy gravel

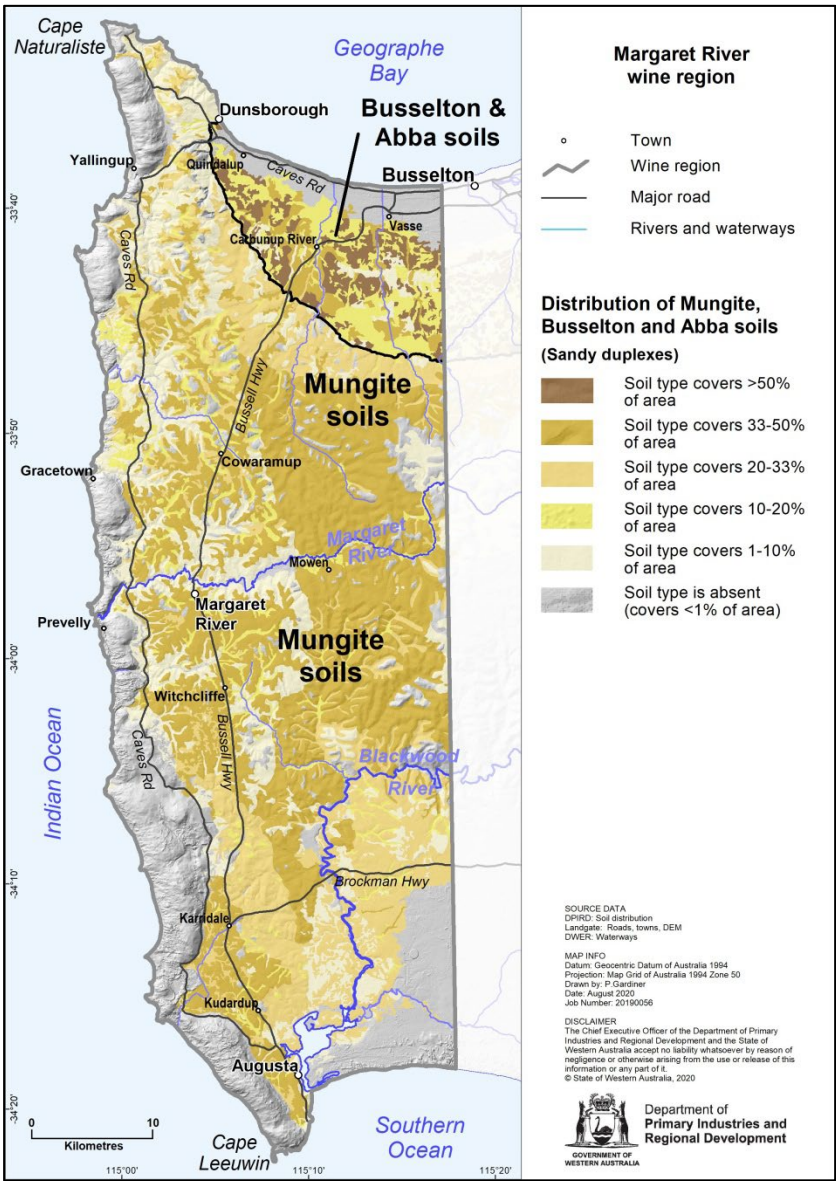


Deep sandy gravel



Shallow gravel

Mungite, Busselton and Abba soils (Sandy duplexes)



Examples of Mungite, Busselton & Abba soils



Pale sandy earth



Yellow-brown deep sandy duplex

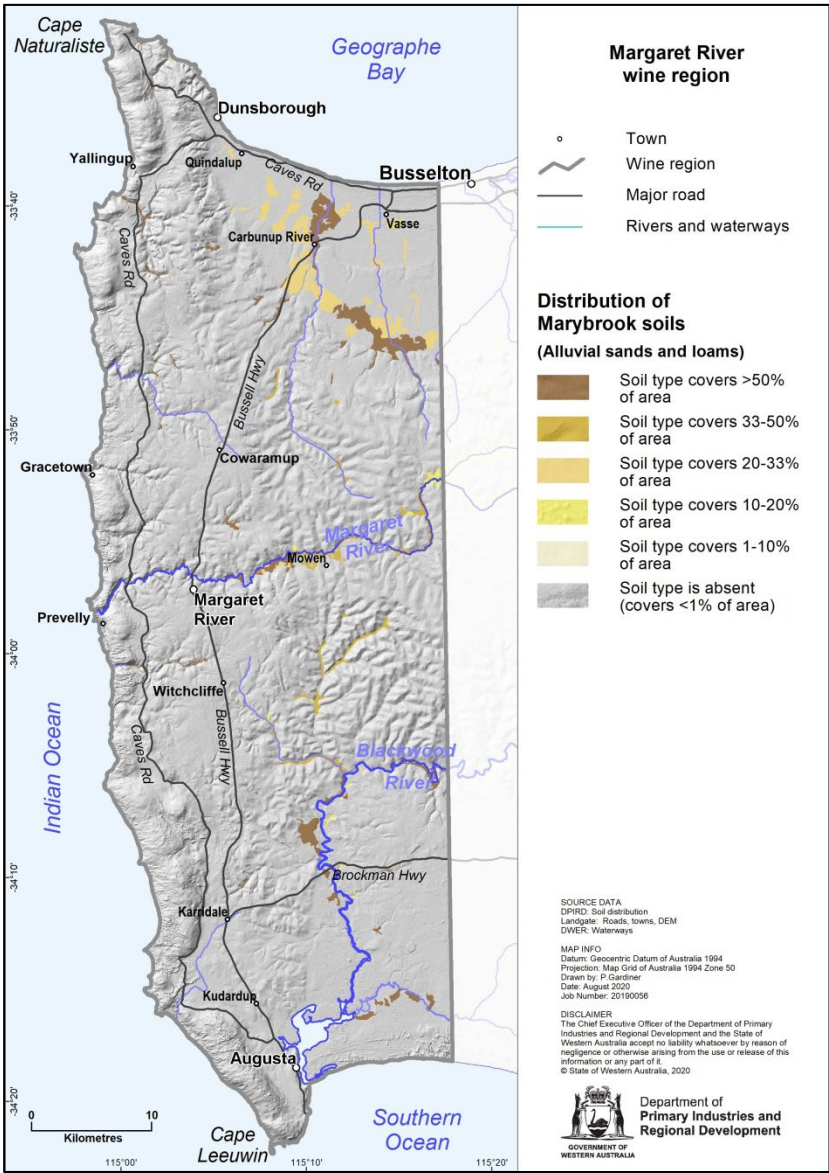


Grey deep sandy duplex



Grey deep sandy duplex

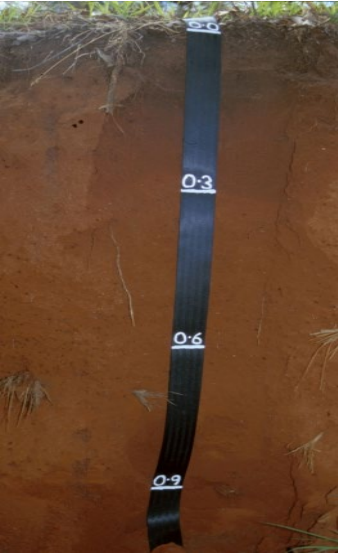
Marybrook soils (Alluvial sands and loams)



Examples of Marybrook soils

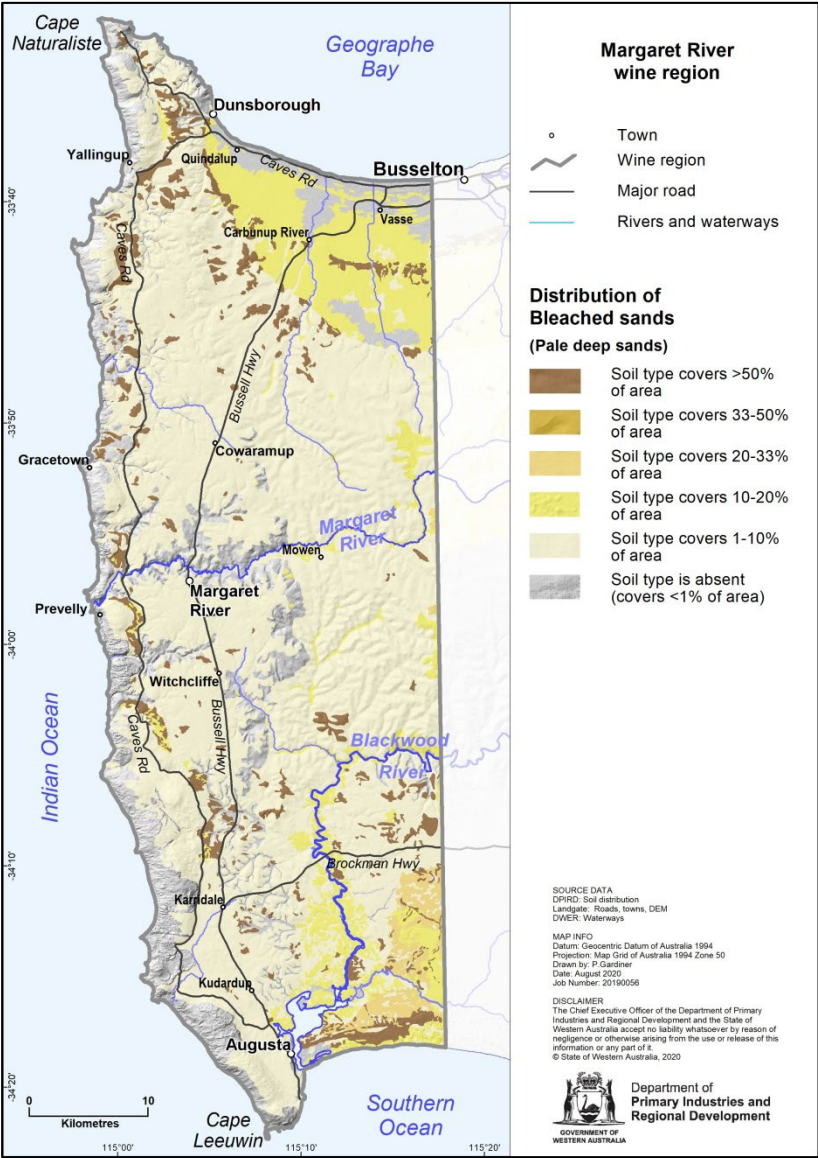


Brown deep sand



Red sandy earth

Bleached sands (Pale deep sands)



Examples of Bleached sands



Pale deep sand (over clay)

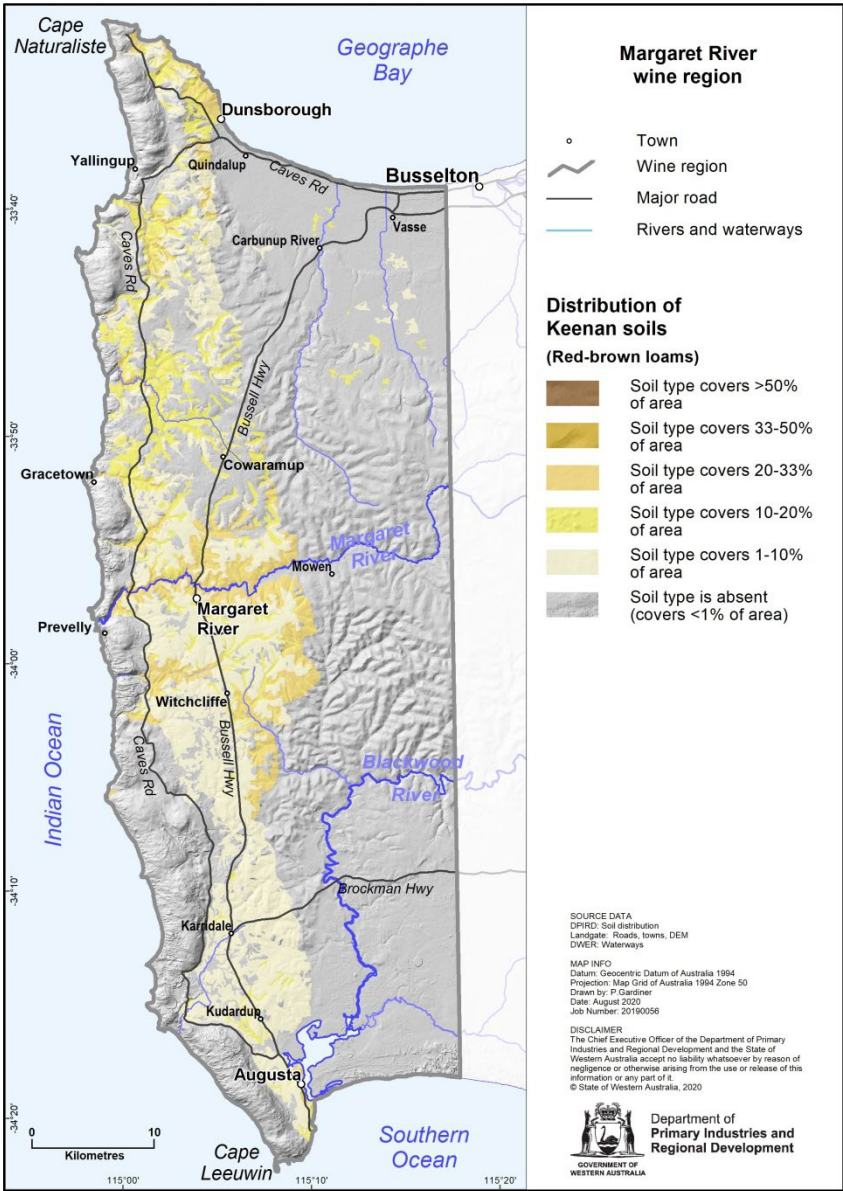


Pale deep sand (over gravel)



Gravelly pale deep sand

Keenan soils (Red-brown loams)



Examples of Keenan soils



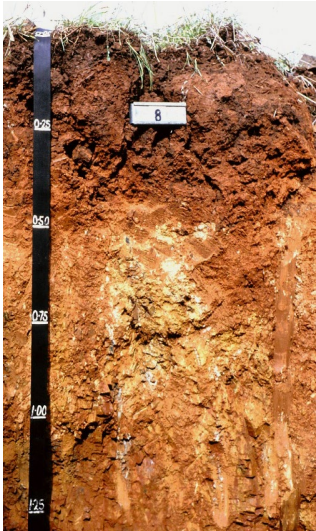
Friable red-brown loamy earth



Brown loamy earth

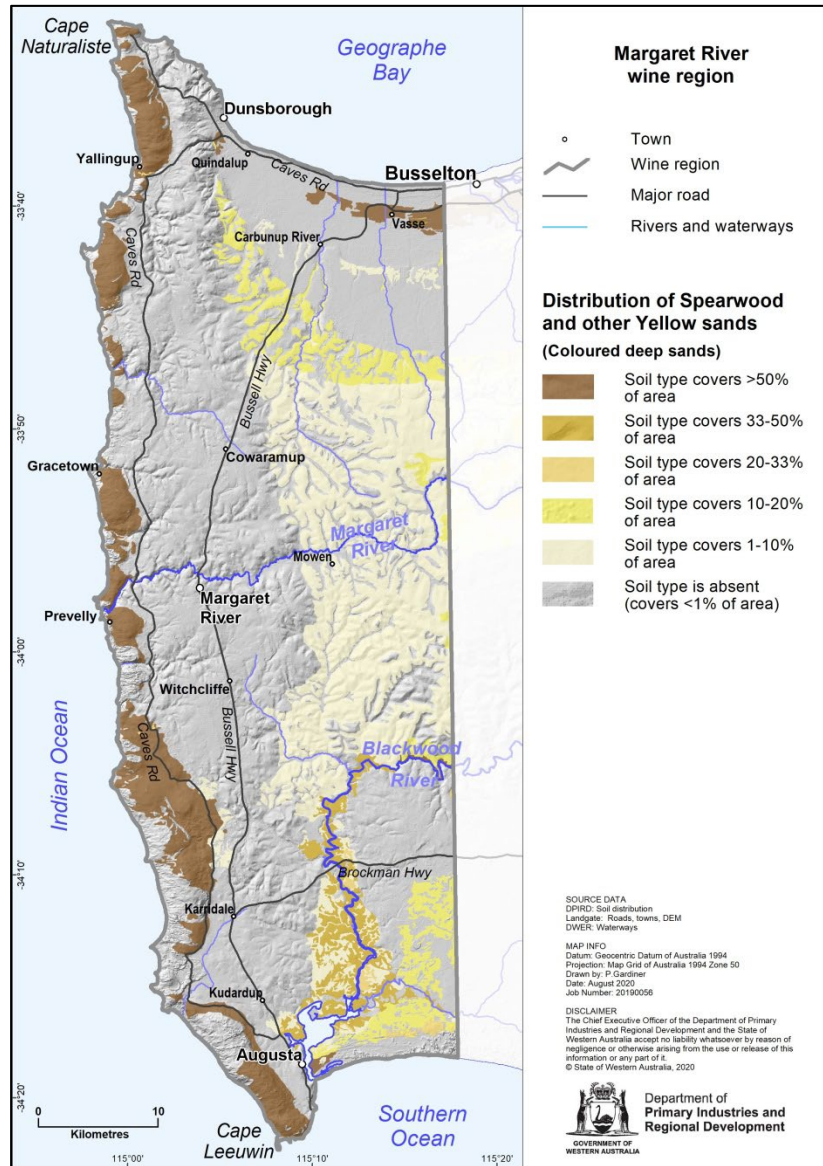


Brown deep loamy duplex



Red deep loamy duplex

Spearwood and other Yellow sands (Coloured deep sands)



Examples of Spearwood and other Yellow sands

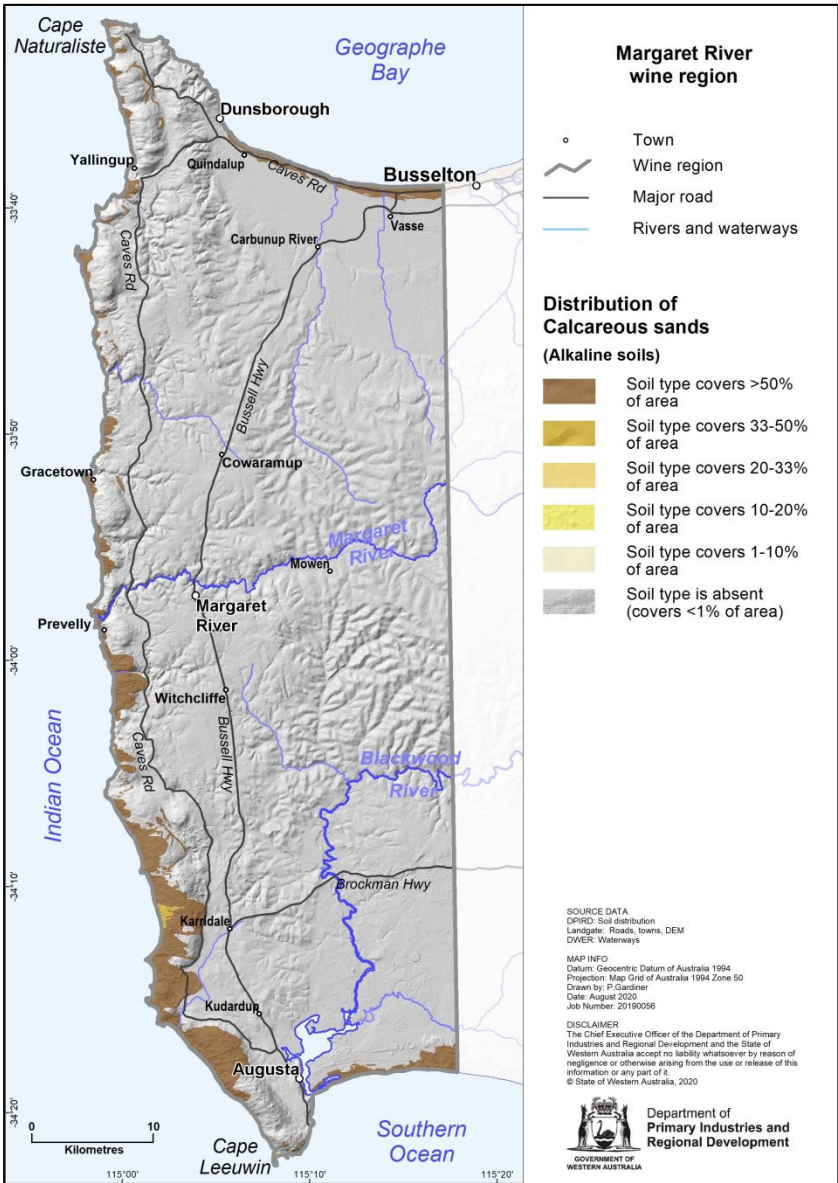


Yellow deep sand



Yellow deep sand

Calcareous sands (Alkaline soils)



Examples of Calcareous sands



Calcareous deep sand



Calcareous deep sand (with limestone gravel)

Appendix A

Table A1 Main soils in the Margaret River region

Soil	Approximate area (ha)	Approximate area (%)
Forest Grove soils	54 884	26
Mungite, Busselton & Abba soils	42 900	20
Difficult soils	43 418	20
Spearwood & Yellow sands	20 562	10
Bleached sands	19 799	9
Calcareous sands	11 378	5
Shallow sands	8 050	4
Marybrook soils	4 132	2
Keenan soils	4 855	2
Heavy soils	2 026	1
Total	212 006	

Table A2: Main soils used for viticulture in the Margaret River region

Soil	Estimated area of vine plantings (ha)	Estimated area of vine plantings (%)
Forest Grove soils	2750	45
Mungite, Busselton & Abba soils	1760	29
Marybrook soils	430	7
Bleached sands	350	6
Keenan soils	290	5
Shallow sands	150	3
Difficult soils	150	2
Spearwood & Yellow sands	130	2
Heavy soils	40	1
Calcareous sands	0	0
Total	6050	

Shortened forms

Short form	Long form
°C	degrees Celsius
AHD	Australian Height Datum
BoM	Bureau of Meteorology
cm	centimetre
DPIRD	Department of Primary Industries and Regional Development
h	hour
ha	hectare
km	kilometre
m	metre
mm	millimetre
WA	Western Australia

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