IBRA SUB_REGIONS IN WA

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In revising some bioregion boundaries, and in identifying sub-regional boundaries, we have relied on a recently published update on geological unit boundaries (Geological Survey of Western Australia 1999. *Western Australian Atlas of Mineral Deposits and Petrolium Fields.* Department of Minerals and Energy, Perth), and a contemporary floristic study of the Irwin-Carnarvon boundary (Gibson, N., Burbidge, A.H., Keighery, G.J. and Lyons, M.N. 2000. The temperate to arid transition of the Irwin-Carnarvon phytogeographic boundary, Western Australia. *Records of the W.A. Museum* Supplement).

Victoria/Bonaparte (VB)

1. Arafura: marine plains with sporobolus grasslands, mound springs with monsoon forest, and, on seaward periphery, mangrove creeks and coastal dunes with vine thicket.
2. South: Red- and black-soil plains with savanna woodlands, emergent quartz-sandstone ranges with tree-steppe over hummock grassland and limestone ranges with open-savanna vine thickets.

North Kimberley (NK)

1. Mitchell: high rainfall (1100 – 1500 mm annually) with diverse array of exposed basement strata dissected by rivers, and each with a variety of vegetation-types. Rugged sunken coastline deeply embayed with large mangles, Eucalypt woodlands and hummock grasslands on skeletal sandy soils incompletely mantling sandstone boulder country, woodlands and tussock/cane grasslands on heavier volcanic and dolerite soils. Areas of lateritised upland with open forests. Alluvial floors along major river valleys.
2. Berkeley: medium rainfall, less dissected, upland of mainly Pentecost sandstones more continuously mantled by (sandy) soils, and dominated by open savanna woodland; vine thickets confined to coast.

Central Kimberley (CK)

1. Pentecost: Predominantly middle pentecosts sandstone, with King Leopold and Warton sandstone ranges along its southern peripheries. Large areas are mantled by Cainozoic soils. Moderate dissection by several rivers (Durack, Chamberlain and Fitzroy). This is the Central Kimberley. Rainfall averages 1000 - 750 mm annually. Savannah woodlands (eucalypts over *Triodia*).
2. Hart: Dominated by Hart Dolerite exposed along the eastern edge of the Kimberley Craton, where its basement members are folded and exposed. Rugged topograply. Basement rocks are volcanics, plutonics and sedmentary rocks. Driest part of Central Kimberley (600mm – 700mm). Savannah

woodland over Triodia and/or bunch grasses. Headwaters of Ord, Denham and Fitzroy Rivers.

3. Mount Eliza: South-western periphery of Kimberley Craton. Intense folding, exposure of basement strata, very rugged. Shades, granites, sandstones, dolerites, volcanics. Rainfall 800mm. Savannah woodlands – scattered vine thickets towards western end.

Ord-Victoria Plains (OVP) in WA

1. Ord: Major river system draining low lying plains and hilly tracts northwards (Ord River). Average rainfall between 500 and 800 mm annually. Phanerozoic strata of the Ord Basin strata have been well exposed, including sandstones, limestones and volcanics.
2. South Kimberley Interzone: In the east, it comprises a gently undulating, elevated erosional plain, drained southward into the desert by Sturt and Wolfe Creeks, and separated from the dissected valley of the Ord River by steep breakaways. Much of the plateau is covered by cracking clay plains developed over Antrim Plateau Volcanics, although large areas a covered by thick laterite that has been partly dissected to form mesas, and is mainly covered by extensive desert sandplains. More dissected at the western end, which is drained westwards by the headwaters of Christmas Creek, a tributary of the Fitzroy River. Lower rainfall than either the Ord or Fitzroy Sub-regions.

Dampier Land (DL)

1. Fitzroy Trough: The semi-arid northern periphery of Canning Basin. Middle and lower catchment of the Fitzroy River. Includes the alluvial plains associated with this river (mainly erosional products from Central Kimberley, but also from the South Kimberley Interzone via Christmas Creek), and areas of sandplain and eroded dune surfaces derived from the Canning Basin. Extensive coastal mud flats are associated with the Fitzroy delta. Devonian limestone barrier reef structures are preserved along its northern and eastern peripheries. woodlands of Pindan, Boab and Eucalyptus, rainforest patches and hummock grassland on limestone, riverine vegetation. Rainfall averages 500 – 800 mm anually.
2. Pindanland: Sandplains of the Dampier Peninsular and western part of Dampier Land, including the hinterland of the Eighty Mile Beach. Fine-textured sand-sheet with subdued dunes and includes paleodelta of Fitzroy River. Pindan vegetation. This is the coastal, semi-arid, north-western margin of the Canning Basin (450 – 700 mm annual rainfall) receives slightly lower rainfall than the Fitzroy Trough Sub-region..

Tanami (TAN) in WA

No divisions in WA.

Great Sandy Desert (GSD) in WA

1. McLarty: Influences by monsoon. Morning fogs in dry season. Includes the Mandora Paleoriver System. Red-brown dunefields with finer texture than further south. Includes gravelly surfaces of Anketell Ridge along its northern

margin. Owenia reticulata savannas and mafer prop n bunch grasses. Sub-humid component in flora and fauna.

2. Mackay: Tropical inland 'red-center' desert. Includes 'Percival' and 'Auld' palaeoriver systems.

Gibson Desert (GD)

1. Lateritic Plain – Psolitic gravelly sandplains and laterite breakaways on Cretaceous sediments of Gunbarrel Basin.
2. Dune Field – red dune fields mantling Permian strata of Gunbarrel Basin.

Little Sandy Desert (LSD)

1. Rudall: The Rudall Complex, Throssell Group and Lamil Group of the Patterson Orogen. Proterozoic hill country of Throssel, Mount Sears, Broadhurst and Harbutt Ranges. Includes headwaters and course of Rudall River. Extensive areas of tussock grass are associated with footslopes. River Gums communities along drainage.
2. Trainor: 'Red centre' desert on Neoproterozoic sedimentary basement (Officer Basin).

Central Ranges (CR)

No divisions in WA, but now extended to include a strip of sandplain to the south that is on the proterzoic basements that characterise this bioregion.

Great Victoria Desert (GVD) in WA

1. Shield: western end is underlain by Yilgarn Craton. Higher proportion of sandplains and predominance of Mallee's (Eucalyptus kingsmilli, E. youngiana etc.
2. Central: underlain by Permian sediments of Gunbarrel Basin, dune fields extensive.
3. Eastern: underlain by Devonian sediments of Gunbarrel Basin. Sandplains extensive.

Nullabor (NUL) in WA

1. Northern band - (Carlisle Plain) deeper soil profiles with high proportion of red sand mixed with loams and calcaveous clays. Low woodlands of Myall over bluebush – inland desert climate.
2. Central band – shallow calcaveous soils, thinly mantling massive lifetare scrublands. Temperate arid. Saltbush and Bluebush low open shrubland.

Pilbara (PIL) Does not include Barrow Island, the Monte Bello Islands and the Lowendal Islands.

1. Chichester - Northern section of the Pilbara Craton. Undulating Archaen granite and basalt plains supporting shrub steppe characterised by Acacia pyrifolia over Triodia pungens hummock grasslands. Snappy Gum tree steppes occur on ranges. Semi-desert-tropical (300mm); drainage to north via numerous rivers (e.g. De Grey, Oakover).

2. Fortescue – Alluvial plains and Fortescue River frontages. Salt marsh, mulga – bunch grass, and short grass communities on alluvial plains. River Gum woodlands fringe the drainage lines. Scrub steppe on sandstone. Semi desert tropical (300mm). Drainage to north-west.
3. Hamersley – Southern section of the Pilbara Craton. Mountainous area of Proterozoic sedimentary ranges and plateaux, dissected by gorges (basalt, shale and dolerite). Mulga low woodland over bunch grasses on fine textured soils, and Snappy Gum over *Triodia brizoides* on skeletal sandy soils of the ranges. Semi-desert tropical 300mm.
4. Roebourne: Quaternary alluvial coastal and sub-coastal plains with a grass savanna of mixed bunch and hummock grasses, and dwarf shrub steppe of *Acacia translucens* over *Triodia pungens*. Samphire, *Sporobolus* and mangal occur on marine alluvial flats and river deltas. Arid (semi-desert) tropical with summer rain (300mm).

Gascoyne (GAS)

1. Ashburton: mountainous range country associated with Ashburton River Catchment. of the Ashburton Basin (shales, sandstones and conglomerates), and the north-western part of Bangemall Basin (sandstone, shale, carbonates). Mulga/Snakewood low woodlands. Low mixed shrublands on hills. Areas of Triodia. Arid (desert) climate with bimodal (winter and summer) rainfall, tropical monsoon influences its western periphery.
2. Carnegie: Underlain by the Eraheedy Basin of the Capricorn Orogen (Proterzoic) and the south-eastern extension of the Bangemall Basin. Extensive samphire and saltbush steppes are associated with the extensive salt lake systems. Low Mulga communities occur on hills and plains. Desert climate, with bimodal rainfall.
3. Augustus: Southern and inland sections of the Bangemall Basin (shales, sandstone and carbonates). Also includes the Narryera Complex and Bryah Basin of the Proterozoic Capricorn Orogen (on northern margin of the Yilgarn Craton), as well as the Archaean Marymia and Sylvania Inliers. Although the Gascoyne River System provides the main drainage of this sub-region, it is also the headwaters of the Ashburton and Fortescue Rivers. There are extensive areas of alluvial valley-fill deposits. Mulga woodland with *Triodia* occur on rises, while the plains are covered by Mulga parkland. A desert climate with biomodal rainfall.

Murchison (MUR)

1. Eastern Murchison: The northern parts of the 'Southern Cross' and 'Eastern Goldfields' Terranes of the Yilgarn Cration. Characterised by its internal drainage, and extensive areas of elevated red desert sandplains with minimal dune development. Salt lake systems with areas of saltbush and samphire are associated with the occluded Paleodrainage system. Broad plains of red-brown soils and breakaway complexes support Mulga communities, while red sandplains support *Triodia* hummock grasslands. Arid climate, with mainly winter rainfall (200mm)

2. Western Murchison: Northern part of the 'Murchison' Terranes of the Yilgarn Craton. The headwaters of the Murchison and Wooramel Rivers, which drain the sub-region westwards to the coast. Mulga (usually with bunch grasses) occurs on the on extensive hardpan washplains that dominate and characterise the sub-region, as well as the red-earth plains. Arid climate with bimodal rainfall that usually falls in winter.

Carnarvon (CAR)

1. Cape Range: northern part of Carnarvon Basin. Rugged tertiary limestone ranges, extensive areas of red aeolian dunefield, Quaternary coastal beach dunes and mud flats. Acacia shrublands on limestone and red dunefields, Eucalyptus woodlands on Cape Range. Tidal mudflats of Exmouth Gulf with mangroves. Beach dunes with *Spinifex* communities. Arid, semi-desert to sub-tropical climate, with summer and winter rainfall. **Includes Barrow Island, the Monte Bello Islands and the Lowendal Islands.**
2. Wooramel: Southern and central parts Carnarvon Basin. Alluvial plains associated with downstream sections and deltas of Gascoyne Minilya and Wooramel Rivers. Includes Lake MacLeod and Kennedy Range. Aeolian dunefields are extensive in the north and east as well as on top of Kennedy Range. Permian sediments are common in northern parts. Southern areas comprise limestone plateaux overlain by red sand plains. Acacia shrublands (Mulga, Bowgada, Coriacea) over bunch grasses on red sands. Mangroves confined to small areas around Lake MacLeod and near Carnarvon. Salbush in near-coastal areas. Aseasonal arid climate, tending towards bimodal rainfall.

Yalgoo (YAL)

We have extended this Bioregion westwards to the boundary of the South-west Botanical Province so that it now includes the southern end of the Carnarvon Basin, including the Toolonga Plateau, the sandplain country inland from the Zuytdorp Cliffs (North of Kalbarri), the Edel Peninsula, and Dirk Hartog, Bernier and Dorrie Islands (see Gibson *et al*. 2000). As now defined, the Yalgoo is an interzone between South-western Bioregions, and the Murchison and Carnarvon Bioregions of the Eremean Province.

Two sub-regions are recognised, both with a semi-arid to arid, warm, Mediterranean climate:

1. **Edel: Parts of the southern Carnarvon Basin, it is underlain by Phanerozoic sediments and characterised by proteaceous tree-heaths and *Acacia-Casuarina* thickets on pale red Quaternary sand (white sand on the coast).**
2. **Tallering: Underlain by the north end of the hanerozoic Perth Basin, and by parts of the Western Terraines and the southern end of the Narryer Terraine of the Yilgarn Craton. It is characterised by low woodlands to open woodlands of *Eucalyptus*, *Acacia* and *Callitris* on red sandy plains.**

Geraldton Sandplains (GS)

1. Geraldton Hills: Southern end of Carnarvon Basin and northern end of the Perth Basin, with exposed areas of Permian/Silurian siltstone and Jurassic sandstones,

mostly overlain by sandplains, alluvial plains, coastal limestones. Sand heaths with emergent *Banksia* and *Actinostrobus*, York Gum woodlands on alluvial plains, proteaceous heath and *Acacia* scrubs on limestones depending on depth of coastal-sand mantle, low closed forest of *Acacia rostellifera* (now cleared) on alluvial plains of Irwin River (behind beach dune system south of Geraldton). Also includes the Pinjarra Orogen which is an area of Proterzoic basement. Hill country supports proteaceous shrublands and mallees while valleys support York Gum and 'Jam'. Semi-arid to Mediterranean climate with 400 – 500 mm of rainfall.

2. Lesueur Sandplain: coastal Aeolian and limestones, Jurassic silstones and sandstones (often heavily lateritized) of central Perth Basin. Alluvials associated with drainage systems. There are extensive yellow sandplains in south-eastern parts, especially where the sub-region overlaps the western edge of the Pilbara Craton. Shrub-heaths occur on a mosaic of lateritic mesas, sandplains, coastal sands and limestones. Heath on laterilized sandplains along the sub-region's north-eastern margins. Mediterranean.

Swan Coastal Plain (SWA)

1. Dandaragan Plateau: plateau bordered by Darby and Dandaragan Faults. Cretaceous marine sediments mantled by sands and laterities. Characterised by *Banksia* low woodland, Jarrah - Marri woodland, Marri woodland, and by scrub-heaths on laterite pavement and on gravelly sandplains. Mediterranean (700 mm)
2. Perth: Colluvial and aeolian sands, alluvial river flats, coastal limestone. Heath and/or Tuart woodlands on limestone, *Banksia* and Jarrah-*Banksia* woodlands on Quaternary marine dunes of various ages, Marri on colluvial and alluvials,. Includes a complex series of seasonal wetlands. Mediterranean (1000 – 600 mm).

Avon Wheatbelt (AW)

Will be finalised when Salinity Action Plan survey data becomes available. Gradational north to south and east to west. May use palaeodrainages (J.S. Beard: *J. Roy. Soc. WA*).

1. Re-juvenated Drainage: Erosional surface of gently-undulating rises to low hills with abrupt breakaways. Continuous stream channels that flow in most years. Colluvial processes are active. soil formed in colluvium or in-situ weathered rock. Includes woodland of Wandoo, York Gum and Salmon Gum with Jam and Casuarina. Some areas of heath.
2. Ancient Drainage: The eastern part of the bioregion is an ancient peneplain with low relief. There is no connected drainage; salt lake chains occur as remnants of ancient drainage systems that now only function in very wet years. Lateritic uplands are dominated by yellow sandplain. Mosaic of scrub and woodland.

Jarrah Forest (JF)

1. Northern Jarrah Forest: The area east of the Darling Scarp, overlying Archaean granite and metamorphic rocks of an average elevation of 300 m, capped by an extensive latertic duricrust, dissected by later drainage and broken by occasional granite hills. In the east the laterite becomes deeply dissected until it compresses

isolated remnants. Rainfall is from 1100 mm on the scarp to ca. 700 mm in the east and north. Vegetation comprises Jarrah - Marri forest in the west with Bullich and Blackbutt in the valleys grading to Marri and Wandoo woodlands in the east with Powder bark on breakaways. There are extensive but localised sand sheets with *Banksia* low woodlands. Heath is found on granite rocks and as a common understorey of forests and woodlands in the north and east.

2. Southern Jarrah Forest: South of Collie the plateau broadens and slopes gently to the south coast, Drainage is still dissected in the west but broadening and leveling of the surface in the east causes poor drainage and large (Lake muir) and numerable small wetlands. The ironstone becomes less evident being buried beneath sands. Rainfall is from 1200 mm in the south west to ?700 mm in the east. Vegetation comprises Jarrah - Marri forest in the west grading to Marri and Wandoo woodlands in the east. The are extensive areas of swamp vegetation in the south - east dominated by Paperbarks and Swamp Yate. The understory component of the forest and woodland reflects the more mesic nature of this area.

Warren (WAR)

Some obvious lower level subdivisions (Leewin-Naturalist Ridge, Scott Coastal Plain, Karri Belt, eastern coastal plain), but heterogeneity is too low for subregion-level subdivisions equal to those of Pilbara and Dampier Land Bioregions.

Esperance Plains (ESP)

1. Fitzgerald: metamorphosed sandstones. Eocene marine sediment basement with small areas of Gneiss outcropping. Archaen greenstones – sand sheets with varying levels of lateritization. Vegetations include: scrub heath, mallee heath, coastal dune scrub, mallee, woodlands on greenstone, Yate and York Gum woodlands on alluvials, and Jarrah/Marri woodlands in the west. Temperate Mediterranean (600 – 800mm). Active drainage (rejuvenated) to south.
2. Recherche: Proterozoic gneiss and granite as well as Eocence and more recent coastal limestones. Quaternary coastal sandplains and dunes. Numerous granitic islands. Heath, coastal dune scrub, mallee, mallee-heath and granite heath. Temperate Mediterranean (500 – 700mm).

Mallee (MAL)

Re-define to include an area from the Coolgardie Bioregion – the area between Lake Hope, Forrestiana and Mount Holland, which comprises Salmon Gum and Morrell woodlands on greenstone, with smaller areas of mallee and *Acacia / Casuarina* thicket on sandplains.

1. Eastern Mallee: calcareous clays and loams as duplex soils that often contain sheet and modular kankar, outcrops of metamorphosed sandstone, and white and yellow sandplains and loamy plains with numerous salt pans (pan fields). Mallee on sandplains, samphire around small salt lakes, mallee and patches of woodland on clay, and scrub-heath on sandstone. Mallee with Boree (*Melaleuca pauperiflora*) on calcareous clay and loam. Mediterranean to semi-arid, winter rainfall 500 – 300mm.

2. Western Mallee: clays and silts underlain by Kankar, exposed granite, sandplains and laterite pavements. Salt lake systems on a granite basement. Occuded drainage system. Mallee communities occur on a variety of surfaces; *Eucalyptus* woodlands occur mainly on fine-textured soils, with scrub-heath on sands and laterite. Warm Mediterranean; 250-500mm rainfall..

Coolgardie (COO)

1. Mardabilla: Eocene marine limestone plain, on a granite basement in its western parts. Red-brown loams and aeolian sands over sheet and nodular kankar. *Eucalyptus* woodland over broomebush/greybush, bluebush and saltbush. Arid climate, with 250-300mm of winter rainfall.
2. Southern Cross: lies on the 'Southern Cross Terranes' of the Yilgarn Craton. Sandplains are of yellow sand.
3. Eastern Goldfield: lies on the Yilgarn Craton's 'Eastern Goldfields Terranes'. Its sandplains are comprised of red 'desert' sand.

The granite basement of the Southern Cross and Eastern Goldfield Sub-regions outcrops at mid-levels in the landscape. Upper levels are the eroded remnants of a lateritic duricrust yielding sandplaines, gravelly sandplains and laterite breakaways. Valleys have Quaternary duplex and graduational soils, and include chains of salt lakes. Parallel bands of greenstone intrude through the granite basement, and are are exposed as low ranges. Drainage is occuled. Diverse *Eucalyptus* woodlands occur around salt lakes, on ranges, and in valleys. *Acacia* thickets and scrub-heaths occur on sandplains. Salt lake support dwarf shrublands of samphire. Woodlands and *Dodanaea* scrub occur on granites of the Fraser Range. Semi arid to arid climate with 200-300 mm of rainfall, sometimes in summer but usually in winter.

Hampton (HAM)

No subdivision.