

**REVISION OF THE INTERIM BIOGEOGRAPHIC  
REGIONALISATION FOR AUSTRALIA (IBRA)  
AND DEVELOPMENT OF VERSION 5.1**

**SUMMARY REPORT**

**ENVIRONMENT AUSTRALIA  
NOVEMBER 2000**

## **Acknowledgments**

This report was compiled by Bruce Cummings and Ann Hardy of the National Reserves System Section (NRS), Environment Australia. We would like to acknowledge the major contribution of State personnel in the revision of bioregion boundaries and providing regional descriptions, and Gethin Morgan in providing advice on appropriate boundaries and the delineation of IBRA sub-regions in particular.

A technical workshop was held at Environment Australia in Canberra on Monday 24 July 2000 to review cross-border issues in relation to IBRA and sub-region boundaries, to resolve major anomalies in the digital data and to discuss mechanisms to more accurately capture on-ground variation in some regions.

## **Workshop participants:**

Australian Capital Territory	David Shorthouse (Environment ACT)
New South Wales	Rob Dick, Julianne Smart (National Parks and Wildlife Service)
Queensland	Gethin Morgan (Environmental Protection Agency)
South Australia	Tim Bond (Department of Environment and Heritage)
Tasmania	Dave Peters (Parks and Wildlife Service)
Victoria	David Parkes (Department of Natural Resources and Environment)
Western Australia	Norm McKenzie (Department of Conservation and Land Management)
Commonwealth	Richard Thackway (Bureau of Rural Sciences)
	Jim Tait (National Land and Water Resources Audit)
	Bruce Cummings, David Forsyth, Ann Hardy (NRS)

The implementation of a series of National Land and Water Resource Audit projects funded through the National Heritage Trust which utilise IBRA as a reporting framework provided the final catalyst for this IBRA update, in particular the Landscape Health Project. This project is a joint project between the NLWRA and the State of the Environment Reporting and National Reserve System Sections of Environment Australia. It was scoped and managed initially by Ian Cresswell (NLWRA), Allan Spessa (SoE) and David Forsyth (NRS), and then later by Jim Tait (NLWRA), Gary Whatman (SoE) and Bruce Cummings (NRS). Gethin Morgan was employed as a consultant to collate and analyse, in consultation with the States, a suite of environmental attributes within an IBRA and IBRA sub-region framework.

This Summary Report contains excerpts on the history of the development of the IBRA framework from Thackway and Cresswell 1995.

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Copies of this report are available from the National Reserves System Section Environment Australia, GPO Box 787 CANBERRA, 2601.

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## 1. Introduction

*Please note that this summary report outlines the process by which the 80 IBRA 4.2 bioregions were refined and updated into the 85 bioregions now found in IBRA Version 5.1. As part of this process a continental coverage of 354 IBRA sub-regions was also developed for data analysis in the National Land and Water Resource Landscape Health Assessment. At the request of some jurisdictions, this continental sub-region coverage at the time of publication is not publicly available, and thus not included in the IBRA 5.1 spatial data which is publicly available. This report thus only deals with the development of the new IBRA regions.*

The Interim Biogeographic Regionalisation for Australia (IBRA) was developed in 1993-94 under the coordination of Environment Australia by the States and Territories as a basis for developing priorities for the Commonwealth in funding additions to the reserve system under the National Reserve System Cooperative Program. This regionalisation built upon previous work by the Commonwealth, States and Territories to identify appropriate regionalisations to assess and plan for the protection of biological diversity.

The nationally agreed regionalisation was published in Thackway and Cresswell 1995, An Interim Biogeographic Regionalisation for Australia: a framework for setting priorities in the national reserves system cooperative program, Version 4.0, Australian Nature Conservation Agency. The National Reserve System Section (NRS), Environment Australia, are the custodians of the continental spatial data.

Since their inception, the IBRA regions have been used for a myriad of analyses by the States and the Territories looking at a broad range of physical and biological values from the status of vegetation to carbon. They now represent the premier tool for nature conservation planning in particular.

From the time of their publication, most State agencies have refined and adopted new boundaries. These are mostly only minor changes that relate to recent or more detailed linework derived from sub-region delineation. In the case of Tasmania substantially new boundaries have been defined through a NRSP funded project.

These changed boundaries have been adopted by the jurisdictions, but have never been formalised at the national level. Consequently, there were some important differences in the spatial data being used by the jurisdictions and the Commonwealth.

The enormity of the problem of each jurisdiction using a slightly different version of IBRA regional boundaries was not fully appreciated until environmental sub-region (or province) data was collated for the National Land and Water Resource Audit (NLWRA) Landscape Health Project. These data highlighted the fact that almost all jurisdictions had modified IBRA region boundaries to some extent. This created problems for several Commonwealth programs and projects, in particular NLWRA and Australian Greenhouse Office projects which were well advanced and soon to commence delivering areas statements for a range of environmental attributes for each IBRA region. NRS has facilitated the resolution of these inconsistencies and cross-border anomalies in the development of IBRA Version 5.1. This summary report outlines this process and describes the revisions.

## 2. The Lineage of IBRA 4.5

### 2.1. *The Rationale of IBRA Regions*

At the outset, the developers of the IBRA agreed on a conceptual process model as the basis for understanding and explaining ecological patterns and processes. Namely, it is the physical processes which drive ecological processes, which in turn are responsible for driving the observed patterns of biological productivity and the associated patterns of biodiversity (Thackway and Cresswell 1995).

IBRA regions represent a landscape based approach to classifying the land surface. Specialist ecological knowledge, combined with regional and continental scale data on climate, geomorphology, landform, lithology and characteristic flora and fauna were interpreted to describe these patterns (see Table 1 for baseline data used to delineate IBRA boundaries in each jurisdiction).

The resulting integrated regions were ascribed the term *biogeographic regions*. The developers of the IBRA acknowledged, given the paucity of biophysical data in some parts of the continent, that new information through time would modify our understanding of the regions, hence the term *interim* was used in the title of the IBRA.

Prior to the development of the IBRA the total number of existing biogeographic regions defined by nature conservation agencies across their respective jurisdictions was 130. Two methods were used to rationalise these existing regions and to derive the IBRA regions, region names and region descriptions:

1. map unit boundaries and descriptions were interpreted / integrated and transferred onto paper maps or drafting film, and then these boundaries were digitised; and
2. where finer scale GIS data were available, that is, map unit boundaries and descriptions, regions and their descriptions were interpreted and aggregated.

Eighty IBRA regions were derived across Australia by compiling the best available data and information about each State and Territory including specialist field knowledge, published resource and environmental reports, and biogeographic regionalisations for each State and Territory, as well as continental data sets.

Names and descriptions for the IBRA utilised existing common names and referenced published source documents. Where no descriptions were available specialist field knowledge was used to generate appropriate names and descriptions. Where region names were restricted to a particular State or Territory, eg Midlands (Vic), these names were revised to provide a more meaningful name in the IBRA context, eg Victorian Midlands.

The IBRA represented a 'milestone' product, meaningful to both field based ecologists and land managers. It was acknowledged at the time that validation of the regions were required and subsequent revisions would be necessary.

Table 1: Methodology used to modify existing State/Territory regionalisations to derive the State/Territory components of the IBRA

**Victoria**

The baseline data set for Victoria was the 1:500,000 scale land systems and geomorphic units produced by the Land Conservation Council. Given the nominal scale required for the IBRA, existing land systems and geomorphic map units were aggregated by grouping regions with similar landform, vegetation, and geology. Information from the "Flora of Victoria" was used to refine the regionalisation and to develop descriptions for each region.

**Tasmania**

The baseline data set for Tasmania was the 1:500,000 scale Nature Conservation Regions (Orchard 1988). Map regions were aggregated by grouping regions with similar climate, landform, geology/lithology, vegetation and floristics.

**New South Wales and Australian Capital Territory**

The natural regions or biogeographic regions for NSW and the ACT have been derived by expert assessment of available information on the distribution of geological, geomorphological and biological elements. The environmental regions developed by Morgan and Terrey (1992) were used as a regionalisation of the environment west of the Great Dividing Range.

**South Australia**

The baseline data set for South Australia was the 1:500,000 scale Environments of South Australia (Laut *et al* 1977). Map units were aggregated by grouping regions with similar landform, geology/lithology, vegetation, climate and floristics. The current regions represent an interpretation of all previous regionalisations tempered with field based knowledge.

**Western Australia**

The baseline data set for WA was Beard (1980) modified in consultation with N L McKenzie, G J Keighery, K F Kenneally and G Wardell Johnston (WA CALM) and R E Johnstone and L A Smith (WAM), after discussions with J S Beard. Cross-border adjustments were then made in consultation with M Fleming and D Howe (CCNT) and P Copley (SA DENR). Attributes considered were climate, geology, vegetation formations and floristics, and vertebrates. The current regions represent an interpretation of all previous regionalisations tempered by field based knowledge.

**Northern Territory**

The base data sets for the NT included land system mapping developed by CSIRO and the CCNT, vegetation mapping, environmental domains and biogeographic domains. Map regions were reclassified and aggregated to reflect affinities with those of adjacent States and Territories by grouping regions with similar geology, landform, soils and vegetation. The current regions represent an interpretation of all previous regionalisations tempered by field based knowledge.

**Queensland**

The base data set for Queensland consisted of the 1:500,000 scale land system mapping, 1:2,500,000 scale, Biogeographic Regions and a number of other resource and environmental reports. Map regions were aggregated by grouping regions with similar geology, landform, soils and vegetation.

Source: Thackway and Cresswell 1995.

## **2.2. Early IBRA Versions**

The first Technical Meeting for the development of IBRA was held in Adelaide (7-11 February 1994) with representatives from the States and Territories. As a result of this meeting a total of 80 regions were identified and documented in the report: ***Draft Interim Biogeographic Regionalisation for Australia (IBRA)***.

Successive versions of the IBRA were prepared and circulated both to the developers of the IBRA and to the wider community. Each new version comprised new information and corrections on the previous version. In the lead up to the Technical Meeting in Alice Springs Version 3.5 was prepared.

After the Alice Springs meeting ANCA circulated an ERIN alternative view of the number regions and the placement of boundaries based on the first IBRA map. The

developers of the IBRA agreed to review the ERIN classification of structural vegetation for Australia derived from a time series of continental satellite coverages of vegetation greenness, and to revise the IBRA where appropriate.

During the Adelaide Technical Meeting the IBRA regions were plotted at 1:3 million scale and verified with other data sets and expert knowledge. Subsequently, agencies responsible for development of the IBRA were sent copies of the IBRA map as GIS data files. A process of peer review in each agency was a key feature of the verification process. Where anomalies or omissions were detected, or new information had come to light, these changes were incorporated into successive revisions of the IBRA map and report. This process resulted in the publishing of version 4.0 in 1995 (Thackway and Cresswell 1995).

### **2.3. *The Validation and Update Process***

The developers of the IBRA recognised that it reflected the best information available at the time of its development. Since its inception the jurisdictions have undertaken a range of biological and environmental surveys that have provided both additional information to help define biological and physical patterns in the landscape and more detailed linework to refine boundaries. A brief overview of revisions is provided in Section 2.6.

### **2.4. *Initial Data Analyses using the IBRA Framework***

The IBRA regionalisation was finalised in 1994 and provided a broad framework for identifying deficiencies in the existing system of protected areas, and for setting priorities for action in developing the national reserves system in Australia.

A series of analyses addressed:

- The representativeness of the existing reserve system;
- Biases in the existing reserve system;
- Major threatening processes within each IBRA region; and
- Identifying priority IBRA regions in urgent need of further reserve additions.

These analyses provided an invaluable framework for State reserve acquisition programs and a cornerstone for the implementation of the initial National Reserve System Cooperative Program and the later Natural Heritage Trust funded National Reserve System Program.

## **2.5. Subsequent Work by the States and Territories**

### **2.5.1. Queensland**

Queensland changed their bioregional boundaries as part of the development of the IBRA sub-regions (provinces) and the review of the status of regional ecosystem types across the State as part of the development of new land clearing regulations. These changes were published in Sattler and Williams (eds) 1999, *The Conservation Status of Queensland's Regional Ecosystems*, Queensland Environmental Protection Agency.

In general, all IBRA region boundaries had been changed due to finer scale data capture. Major differences occurred in the following IBRA regions:

- Cape York Peninsula – the southern boundary had been moved south to include a province which was formerly included in the Einasleigh Uplands;
- Desert Uplands boundary was moved northwards to include all of the Cape - Campaspe Plains.
- Brigalow Belt South – the northern boundary had been moved southwards in the north west and east to extend the Brigalow Belt North;
- South Eastern Queensland – the western boundary had moved eastwards to extend the Brigalow Belt South. The southern boundary had also been moved northwards to extend the NSW North Coast;
- Mulga Lands – the northern boundary had been moved south to extend the Mitchell Grass Downs; and
- The NSW North Coast had been moved east in the north west corner to extend the Brigalow Belt South.
- Channel Country - the western borders of this region had been moved further west due to refinements in the Western and Arid Lands land system mapping.

### **2.5.2. NSW**

Since the early development of provinces by Morgan and Terry (1992) in the Western Division of NSW and also in the New England Tableland (1999), there had been no further work on IBRA boundaries. The refinements to boundaries emanating from these studies were yet to be incorporated into the official IBRA boundaries for use by the State (and the Commonwealth). In brief, the New England Tableland region had been re-defined at a fine scale and the Darling Riverine Plain had been extended southwards into the Murray Darling Depression along the river plains to meet the Murray River. The Riverina bioregion had been extended westwards along the Murray River plains to the South Australian border.

### **2.5.3. Victoria**

Victoria changed their bioregional boundaries as part of the development of Victoria's biodiversity strategy. These are published in "Victoria's Biodiversity: Directions in Management", Department of Natural Resources and Environment 1997.

Many boundaries reflected a refinement of the IBRA Version 4 boundaries based on more detailed vegetation and other environmental mapping that had become available. Thus the Victorian Midlands, Victorian Volcanic Plain and the South east Coastal Plain had been substantially redefined.



Major differences between IBRA 4.1 and the Victorian bioregions were:

- Australian Alps – Victoria had greatly reduced the extent of this IBRA region by cutting back to the 1200 metre contour and using this as the new IBRA boundary. This created the difficulty of the Alps being defined by different methodologies in NSW and Victoria. This boundary is currently being reviewed (and changes have not been incorporated into IBRA version 5);
- South Eastern Highlands – revised boundaries for the Australian Alps had a substantial effect on the centre of this IBRA region. An additional area is also found in the northwest of the East Gippsland IBRA region and the boundary with the NSW South western Slopes was substantially different; and
- South East Corner – the western margin of this IBRA region would be moved into an enlarged South Eastern Highlands.

#### **2.5.4. Tasmania**

A review of the IBRA boundaries was funded under the NRSP. The project resulted in the suggested boundaries published in Peters and Thackway 1998, “A New Bioregionalisation for Tasmania”, Tasmanian Parks and Wildlife Service.

Major differences occurred in virtually all the Tasmanian IBRA regions, in particular:

- Ben Lomond – the north east coastal areas had been split off and joined with Flinders Island into a Flinders IBRA region;
- D’Entrecasteaux had been renamed Southern Ranges and extended northwards into the Central Highlands;
- Freycinet had been renamed South East and extended southwards to link with the Southern Ranges and westward;
- Tasmanian Midlands had been dramatically reduced to now just being the Northern Midlands; and
- West and South West remained largely unchanged except for the northern boundary which had moved a southwards and a new King Region established to comprise King Island and the North western tip of Tasmania (which had been part of Woolnorth).
- Woolnorth was now two regions, named King in the west and Northern Slopes in the east.

These new regions were been used extensively for conservation planning in Tasmania and have now been incorporated into IBRA Version 5.1.

#### **2.5.5. South Australia**

South Australia was still using IBRA Version 4 boundaries for official purposes. These boundaries had been originally derived from the mapping completed by P. Laut et al (1977), "Environments of South Australia". The biological Survey of South Australia provides vegetation association mapping and species distribution, which is used to refine IBRA boundaries. Recent surveys of the Stony Plains and Flinders and Olary Ranges highlighted anomalies in the boundaries. When presented with an opportunity to refine the IBRA boundaries with the compilation of an IBRA Version 5, South Australia addressed these anomalies and others from previous surveys. These changes are documented in section 3.3.

### **2.6.6 Western Australia**

Minor changes only had been made to the WA regions. The recent work in Western Australia by Norm McKenzie, Greg Keighery, Neil Gibson, Angas Hopkins, Ken Tinley, Ted Griffin and John Beard developing IBRA sub-regions revealed the need to refine IBRA boundaries in the Mallee-Coolgardie, Rudall and Irwin regions. All but one, Shark Bay, have been addressed in the development of IBRA Version 5.1.

### **2.6.7 Northern Territory**

The NT had continued to use IBRA version 3.2 wherein the Top End Coastal (TEC - IBRA Version 4.1) was separated into three bioregions, Arnhem Coast (ARC, in the east), Darwin Coastal (DAC, in the west) and Tiwi-Cobourge (TIW - the coastal islands). Similarly, the Pine Creek-Arnhem (PCA - IBRA Version 4.1) region had continued to be used as two bioregions- Pine Creek (PCK - in the west) and Arnhem Plateau (ARP - in the east). These regions had become enshrined in the Territory's conservation planning processes and formed an integral part of the Northern Territory Parks Masterplan. Given the extent of biological variation between the regions, and to help ensure the ongoing utilisation of the IBRA framework in the Northern Territory, these boundaries were incorporated into IBRA Version 5.1.

### **3. The Development of IBRA Version 5**

#### **3.1. *Collation of New Boundaries and Resolution of Anomalies***

Given that the States had implemented revised IBRA boundaries and established them within their State planning frameworks, NRS needed to update the continental IBRA coverage, seeking consensus between jurisdictions for the adoption of new linework where appropriate, and to establish a process for the resolution of cross-border mismatches in linework and anomalies in bioregion definition.

A priority outcome from this process was to ensure that a consistent set of linework would be used by the Commonwealth, States and other users in their policy development, conservation planning and other projects.

The revised IBRA boundaries developed by each jurisdiction was collated by Ann Hardy of NRS. Initial discussions in relation to the delineation of IBRA sub-regions also highlighted current difficulties and potential avenues for resolving these difficulties. A technical workshop was organised in Canberra on 24 July, 2000 with representatives from all jurisdictions except the Northern Territory present, to provide an overview of boundary changes and resolve any cross-border anomalies.

#### **3.2. *Outcomes of the Canberra Technical Workshop***

Representatives from Queensland, Victoria, Tasmania, South Australia and Western Australia detailed further work undertaken on sub-region delineation and other amendments to IBRA boundaries. Each presentation included some brief discussion in relation to clarifying the rationale and methodology adopted and any cross-border issues.

These issues were addressed either on the day in discussion with representatives from other States and Territories using GIS and other resources at hand, or were flagged for further action. There was broad agreement by participants for follow-up actions by each jurisdiction, Gethin Morgan, or EA – mainly National Reserve System Section staff. These are detailed in Appendix 1.

IBRA version 5.0 was sent to the States and Territories as a draft in late September 2000. Following some agreed upon changes, Version 5.1 was compiled by EA and released for official use in the NLWRA projects in November 2000. Formal ratification of IBRA Version 5.1 was to be gained from all the States and Territories in the following months.

#### **3.3. *Latest Boundary Changes***

The final IBRA Version 5.1 coverage contains the revisions that had been made by the States and Territories (as detailed in section 2.6) and some other important changes summarised below.

- Brigalow Belt South - the central western border area was extended into the Darling Riverine Plain, so that the Moonie Barwon Interfluvium and Collarenebri Interfluvium could properly come together in the BBS region. Also the boundary with Nandewar was better defined along the NSW/QLD state border.
- Carnarvon – the south eastern most corner of this region containing yellow sand plains has been incorporated into Geraldton Sandplain;

- Central Ranges – the Birksgate Ranges in the northern part of the Great Victoria Desert were added to the region. Sandplain between the Musgrave and Everard Ranges were added to the Great Victoria Desert. This created two outliers of the Central Ranges in South Australia.
- Channel Country – there has been a small area of dunes between the Cooper and Strzelecki Creeks in the south of this region, which has now been incorporated into the Simpson-Strzelecki Dunefields.
- Flinders and Olary Ranges - Lofty Block – were merged and a new region created for the Fleurieu Peninsula and Kangaroo Island forming the Kanmantoo Region.
- Gawler – has been extended into the Great Victoria Desert and Stony Plains to include low sandstone and quartzite plateaux and sandplains over the northern part of the Gawler Craton. Lake Torrens and its surrounds were included from the Flinders Olary Ranges.
- Gulf Plains - this region was extended further westwards into the Gulf Coastal region of the Northern Territory. This was as a result of mapping which better defined the Queensland part of the Gulf Plains.
- The CHC, SSD, Mulga Lands and Mitchell Grass Downs boundaries have been re-defined using the Queensland WARLUS (Western and Arid Lands Study Area) data and satellite imagery.
- The Darling Riverine Plain was extended into the Murray Darling Depression to include the flow channels, flood plains and overflow basins of the lower Darling alluvials.
- Kanmantoo – this new region in South Australia is a subdivision of the Lofty Block. The western slopes of the Mount Lofty Ranges, the Fleurieu Peninsula and Kangaroo Island which are underlain by the Kanmantoo Fold Belt are combined to form the new IBRA region. The remaining part of the Lofty Block was added to the Flinders and Olary Ranges to become the Flinders Lofty Block.
- Little Sandy Desert boundary has been moved north into to the Great Sandy Desert to include the northern parts of the Patterson Orogen.
- Lofty Block – the northern part was combined with the Flinders and Olary Ranges to form the Flinders Lofty Block. The Fleurieu Peninsula and Kangaroo Island in the south became Kanmantoo.
- Mallee – the northern edge of this region has been transferred from Coolgardie to include woodland and lake systems, Salmon Gum and Mallee woodland.
- Murray Darling Depression – the Lower Murray Lakes and Coorong were added from the Naracoorte Coastal Plain and the outwash plains of the Olary Ranges were added to the north western part of the region in South Australia.
- Naracoorte Coastal Plain – the western portion of this region has been incorporated into Murray Darling Depression to exclude the Lower Murray Lakes and Coorong from the Naracoorte Coastal Plain.
- NSW North Coast - the northern boundary was extended into the South East Queensland region to match the detailed mapping surveys which Queensland had undertaken.
- Riverina - this region was extended westwards into the Murray Darling Depression along the Murray River, both sides of the State NSW / Victorian border to include Riverine Grassy Woodlands and extended into South Australia to follow the wide scroll belt floodplain.
- Simpson Strzelecki Dunefields – the dunefields and sandplains of Anna Creek and Warriner Creek in the Stony Plains region were added from the western side of Lake Eyre.

- South Eastern Highlands - the south eastern NSW part of the SEH region was extended southwards into the South East Corner region across the Victorian border.
- Stony Plains – the low sandstone and quartzite plateaux in the southern part has been added to the Gawler region, the sand plains and dunefields to the west of Lake Eyre have been added to the Simpson Strzelecki Dunefields. Gibber plains on the western side of the Northern Flinders Ranges were added to the region.
- Tanami - a new region has been delineated in the NT, the Davenport Murchison Ranges, which splits off these ranges in the east from the Tanami region.
- Victorian Volcanic Plain - an outlier of the VVP was delineated in South Australia around the ash cones of Mt Schank, Mt Gambier and Mount Burr.
- Yalgoo – extended the bioregion westwards to include the Toolong Plateau of the southwestern Carnarvon Basin.

### **3.4. IBRA Version 5.1 Regional Descriptions**

#### AA Australian Alps

A series of high elevation plateaux capping the South Eastern Highlands (Region SEH) and the southern tablelands in NSW. The geology consists largely of granitic and basaltic rocks. Vegetation is dominated by alpine herbfields, and other treeless communities, snow gum woodlands and montane forests dominated by alpine ash. The Victorian Alps component has been modified, contracting the Alps region essentially to the 1200 metre contour. This boundary requires further work.

#### ARC Arnhem Coast

Coastal strip extending from just east of Cobourg Peninsula to just north of the mouth of the Rose River in southeastern Arnhem Land, and including many offshore islands, most notably Groote Eylandt (and its satellites), the English Company and Wessel group, and the Crocodile Islands. Coastal vegetation includes well developed heathlands, mangroves and saline flats, with some floodplain and wetland areas, most notably the extensive paperbark forest and sedgelands of the Arafura Swamp. Coastal dune systems are unusually well developed on sections of Groote Eylandt and Cape Arnhem Peninsula. Rugged Cretaceous sandstone areas occur on Groote Eylandt and islands of the Wessel group. Tertiary laterites are extensive on the Gove Peninsula. Inland from the coast, the dominant vegetation type is eucalypt tall open forest, typically dominated by Darwin woollybutt (*Eucalyptus miniata*) and Darwin stringybark (*E. tetradonta*), with smaller areas of monsoon rainforest and eucalypt woodlands.

#### ARP Arnhem Plateau

The extensive and highly dissected Proterozoic sandstone massif of western Arnhem Land, which forms the headwaters of many of the major river systems of the Top End. It supports an unusually diverse biota, including very many relictual and endemic plant and animal species. The major vegetation types include sandstone heathlands, rainforests (characteristically dominated by the endemic tree *Allosyncarpia ternata*), hummock grasslands and eucalypt open woodlands (with a range of dominants including *Eucalyptus phoenicea*, *E. kombolgiensis*, *E. miniata* and *E. dichromophloia*). Most of the bioregion is Aboriginal land, including a major part of Kakadu National Park.

#### AW Avon Wheatbelt

Area of active drainage dissecting a Tertiary plateau in Yilgarn Craton. Gently undulating landscape of low relief. Proteaceous scrub-heaths, rich in endemics, on residual lateritic uplands and derived sandplains; mixed eucalypt, *Allocasuarina huegeliana* and Jam-York Gum woodlands on Quaternary alluvials and eluvials. Semi-arid (Dry) Warm Mediterranean. The south eastern boundary has been modified incorporating a small portion into the Mallee region. Extensively cleared for agriculture.

#### BEL Ben Lomond

Humid cool/cold mountain ranges situated in Tasmania's inland north-east. The mountains are capped by Jurassic dolerite with shallow gradational soils. Silurian-Devonian siltstones and mudstones covered with gradational soils constitute a substantial part of the lower hills. Lowland vegetation comprising mainly open sclerophyll woodlands and heath while the upper slopes consist of wet sclerophyll forests, some rainforest and alpine vegetation in the highest regions. Land use: forestry, mining and agriculture (grazing).

#### BHC Broken Hill Complex

Hills and colluvial fans on Proterozoic rocks; desert loams and red clays, lithosols and calcareous red earths; supporting chenopod shrublands *Maireana* spp. - *Atriplex* spp. shrublands, and mulga open shrublands *Acacia aneura*.

#### BBN Brigalow Belt North

Permian volcanics and Permian-Triassic sediments of the Bowen and Galilee Basins, Carboniferous and Devonian sediments and volcanics of the Drummond Basin and coastal blocks, Cambrian and Ordovician rocks of the Anakie inlier and associated Tertiary deposits. Subhumid to semiarid. Woodlands of ironbarks (*E. melanophloia*, *E. crebra*), poplar box and Brown's box (*E. populnea*, *E. brownii*) and brigalow (*Acacia harpophylla*), blackwood (*A. argyrodendron*) and gidgee (*A. cambagei*). Region reaches the coast in the dry coastal corridor of Proserpine - Townsville.

#### BBS Brigalow Belt South

Predominantly Jurassic and younger deposits of the Great Artesian Basin and Tertiary deposits with elevated basalt flows. Subhumid. Eucalyptus woodlands and open forests of ironbarks, poplar box, spotted gum (*E. maculata*), cypress pine (*Callitris glaucophylla*), Bloodwoods (eg. *E. trachyphloia*, *E. hendersonii* ms) brigalow-belah forests (*E. harpophylla*, *Casuarina cristata*) and semi-evergreen vine thicket.

#### BRT Burt Plain

Plains and low rocky ranges of Pre-Cambrian granites with mulga and other acacia woodlands on red earths.

#### CA Central Arnhem

Gently sloping terrain and low hills on Cretaceous sandstones and siltstones and lateritised Tertiary material; yellow earthy sands and shallow stony sands; Darwin Woollybutt and Darwin Stringybark open forest to woodland with grass understorey.

#### CAR Carnarvon

Quaternary alluvial, aeolian and marine sediments overlying Cretaceous strata. A mosaic of saline alluvial plains with samphire and saltbush low shrublands, Bowgada low woodland on sandy ridges and plains, Snakewood scrubs on clay flats, and tree to shrub steppe over hummock grasslands on and between red sand dune fields. Limestone strata with *Acacia startii* / *bivenosa* shrublands outcrop in the north, where extensive tidal flats in sheltered embayments support Mangal. Arid

#### CHC Channel Country

Low hills on Cretaceous sediments; forbfields and Mitchell grass downs, and intervening braided river systems of coolibah *E. coolibah* woodlands and lignum/saltbush *Muehlenbeckia* sp./*Chenopodium* sp. shrublands. (Includes small areas of sand plains.)

#### CK Central Kimberley

Hilly to mountainous country with parallel siliceous ranges of Proterozoic sedimentary rocks with skeletal sandy soils supporting *Plectrachne pungens* hummock grasses with scattered trees, and with earths on Proterozoic volcanics in valleys supporting Ribbon Grass with scattered trees. Open forests of River Gum and Pandanus occur along drainage lines. Dry hot tropical, sub-humid to semi-arid, summer rainfall.

#### CMC Central Mackay Coast

Humid tropical coastal ranges and plains. Rainforests (complex evergreen and semi-deciduous notophyll vine forest), *Eucalyptus* open forests and woodlands, *Melaleuca* spp. wetlands.

#### COO Coolgardie

Granite strata of Yilgarn Craton with Archaean Greenstone intrusions in parallel belts. Drainage is occluded. Mallees and scrubs on sandplains associated with lateritised uplands, playas and granite outcrops. Diverse woodlands rich in endemic eucalypts, on low greenstone hills, valley alluvials and broad plains of calcareous earths. In the west, the scrubs are rich in endemic Proteaceae, in the east they are rich in endemic acacias. Arid to Semi-arid Warm Mediterranean.

#### CP Cobar Penneplain

Undulating plains and low hills on Palaeozoic rocks; earths, lithosols; *E. populnea* and *E. intertexta* woodlands with mulga (*Acacia aneura*) in the more arid areas. Semi-arid climate.

#### CR Central Ranges

High proportion of Proterozoic ranges and derived soil plains, interspersed with red Quaternary sandplains. The sandplains support low open woodlands of either Desert Oak or Mulga over *Triodia basedowii* hummock grasslands. Low open woodlands of Ironwood (*Acacia estrophiolata*) and Corkwoods (*Hakea* spp.) over tussock and hummock grasses often fringe ranges. The ranges support mixed wattle scrub or *Callitris glaucophylla* woodlands over hummock and tussock grasslands. Arid, with summer and winter rain.

#### CYP Cape York Peninsula

Complex geology dominated by the Torres Strait Volcanics in the north, the metamorphic rocks and acid intrusive rocks of various ages of the Coen-Yambo Inlier which runs north-south along the eastern margin of the region and encompasses the high-altitude/high-rainfall areas of Iron Range and McIlwraith Range. The deeply dissected sandstone plateaus and ranges of the Battle Camp Sandstones lie in the south of the region adjacent to the undulating Laura Lowlands composed of residual weathered sands and flat plains of colluvial and alluvial clays, silts and sands. The west of the region is dominated in the south by the extensive Tertiary sand sheet dissected by intricate drainage systems of the Holroyd Plain, the Tertiary laterite of the undulating Weipa Plateau, the low rises of Mesozoic sandstones, with the northern extension of the Weipa Plateau and extensive coastal plains adjoining the Gulf of Carpentaria. Extensive aeolian dunefields lie in the east associated with Cape Bedford/Cape Flattery in the south and the Olive and Jardine Rivers.

The vegetation is predominantly *Eucalyptus tetradonta* and *Corymbia tessellaris*/*C. clarksoniana* woodlands, *Melaleuca viridiflora* woodlands, heathlands and sedgelands, notophyll vine forests, with semi-deciduous mesophyll vine forests on the eastern ranges and deciduous vine thickets on drier western slopes. Extensive mangrove forests are found in Kennedy Inlet in the north east of the region and estuaries on both the west and east coasts. Tropical humid/maritime climate, with rainfall varying from 1000 mm to 1600 mm.

#### DAB Daly Basin

Gently undulating plains and scattered low plateau remnants on Palaeozoic sandstones, siltstones and limestones; neutral loamy and sandy red earths; Darwin Stringybark and Darwin Woollybutt open forest with perennial and annual grass understorey.

DAC Darwin Coastal: Gently undulating plains on lateritised Cretaceous sandstones and siltstones; sandy and loamy red and yellow earths and siliceous sands from near the mouth of the Victoria River to just west of Cobourg Peninsula. The most notable vegetation feature is the extensive and diverse floodplain environment associated with the lower reaches of the many large river systems. There are also substantial areas of mangroves, and rainforest and other riparian vegetation fringing the rivers. Inland from the coast, the dominant vegetation type is eucalypt tall open forest, typically dominated by Darwin woollybutt (*Eucalyptus miniata*) and Darwin stringybark (*E. tetradonta*). Large waterbird colonies are a major conservation value of the bioregion.

#### DEU Desert Uplands

Ranges and plains on dissected Tertiary surface and Triassic sandstones; woodlands of *E. whitei*, *E. similis* and *E. trachyphloia*.

#### DL Dampierland

- (1) Quaternary sandplain overlying Jurassic and Mesozoic sandstones with Pindan. Hummock grasslands on hills.
  - (2) Quaternary marine deposits on coastal plains, with Mangal, samphire - *Sporobolus* grasslands, *Melaleuca acacioides* low forests, and *Spinifex* - *Crotalaria* strand communities.
  - (3) Quaternary alluvial plains associated with the Permian and Mesozoic sediments of Fitzroy Trough support tree savannas of *Crysopogon* - *Dichanthium* grasses with scattered *Eucalyptus microtheca* - *Lysiphyllum cunninghamii*. Riparian forests of River Gum and Cadjeput fringe drainages.
  - (4) Devonian reef limestones in the north and east support sparse tree steppe over *Triodia intermedia* and *T. wiseana* hummock grasses and vine thicket elements.
- Dry hot tropical, semi-arid summer rainfall.

#### DMR Davenport Murchison Ranges

Low but rugged rocky hills, formed from folded volcanics and sandstone, siltstone and conglomerates, which contrast starkly with the generally flat sandplain surrounds of the Tanami bioregion. Vegetation includes hummock grasslands and low open woodlands dominated by eucalypt and *Acacia* species.

#### DRP Darling Riverine Plain

Alluvial fans and plains; summer/winter rainfall in catchments, including occasional cyclonic influence; grey clays; woodlands and open woodlands dominated by *Eucalyptus spp.*

#### EIU Einasleigh Uplands

High plateau of Palaeozoic sediments, granites, and basalts; dominated by ironbark (*Eucalyptus spp*) woodlands.

#### ESP Esperance Plains

Proteaceous Scrub and mallee heaths on sandplain overlying Eocene sediments; rich in endemics. Herbfields and heaths (rich in endemics) on abrupt granite and quartzite ranges that rise from the plain. Eucalypt woodlands occur in gullies and alluvial foot-slopes. Warm Mediterranean.

#### EYB Eyre and Yorke Block

Archaean basement rocks and Proterozoic sandstones overlain by undulating to occasionally hilly calcarenite and calcrete plains and areas of aeolian quartz sands, with mallee woodlands, shrublands and heaths on calcareous earths, duplex soils and calcareous to shallow sands, now largely cleared for agriculture.

#### FIN Finke

Arid sandplains, dissected uplands and valleys formed from Pre-Cambrian volcanics with spinifex hummock grasslands and acacia shrublands on red earths and shallow sands

#### FLB Flinders Lofty Block

Temperate to arid Proterozoic ranges, alluvial fans and plains, and some outcropping volcanics, with the semi arid to arid north supporting native cypress, black oak (belah) and mallee open woodlands, Eremophila and Acacia shrublands, and bluebush/saltbush chenopod shrublands on shallow, well-drained loams and moderately-deep, well-drained red duplex soils. The increase in rainfall to the south corresponds with an increase in low open woodlands of *Eucalyptus obliqua* and *E. baxteri* on deep lateritic soils, and *E. fasciculosa* and *E. cosmophylla* on shallower or sandy soils.

#### FLI Flinders

Moist and dry subhumid warm coastal plains and granitic island chain comprised of the Furneaux islands and coastal north-eastern Tasmania. Devonian granites dominate the elevated areas of the subregion forming low rugged ranges. These are overlain by shallow stony/gravelly gradational or duplex soils carrying *Eucalyptus amygdalina* open forest and woodland with *Eucalyptus nitida* open heath on higher peaks. Quaternary/Tertiary materials overlain by deep sandy soils typify extensive lowland plains, coastal deposits and dunes. Coastal plains have been heavily modified by agriculture (grazing).



#### GAS Gascoyne

Rugged low Proterozoic sedimentary and granite ranges divided by broad flat valleys. Open mulga woodlands occur on shallow earthy loams over hardpan on the plains, with mulga scrub and Eremophila shrublands on the shallow stony loams of the ranges. The Carnegie Salient, in the east, is characterised by extensive salt lake features supporting succulent steppes. Arid.

#### GAW Gawler

Semi arid to arid, flat topped to broadly rounded hills of the Gawler Range Volcanics and Proterozoic sediments, low plateaux on sandstone and quartzite with an undulating surface of aeolian sand or gibbers and rocky quartzite hills with colluvial footslopes, erosional and depositional plains and salt encrusted lake beds, with black oak (belah) and myall low open woodlands, open mallee scrub, bluebush/saltbush open chenopod shrublands and tall mulga shrublands on shallow loams, calcareous earths and hard red duplex soils.

#### GD Gibson Desert

Lateritised upland on flat-lying Jurassic and Cretaceous sandstones of Canning Basin. Mulga parkland over *Triodia basedowii* on lateritic "buckshot" plains. Mixed shrub steppe of Acacia, Hakea and Grevillea over *Triodia pungens* on red sand plains and dune fields. Lateritic uplands support shrub steppe in the north and mulga scrub in the south. Quaternary alluvia associated with palaeo-drainage features support Coolabah woodlands over bunch grasses. Arid, mainly summer rainfall.

#### GFU Gulf Fall and Uplands

Undulating terrain with scattered low, steep hills on Proterozoic and Palaeozoic sedimentary rocks, often overlain by lateritised Tertiary material; skeletal soils and shallow sands; Darwin Boxwood and Variable-barked Bloodwood woodland to low open woodland with spinifex understorey.

#### GS Geraldton Sandplains

Mainly proteaceous scrub-heaths, rich in endemics, on the sandy earths of an extensive, undulating, lateritic sandplain mantling Permian to Cretaceous strata. Extensive York Gum and Jam woodlands occur on outwash plains associated drainage. Semi-arid (Dry) warm Mediterranean.

#### GSD Great Sandy Desert

Mainly tree steppe grading to shrub steppe in south; comprising open hummock grassland of *Triodia pungens* and *Plectrachne schinzii* with scattered trees of *Owenia reticulata* and Bloodwoods, and shrubs of *Acacia* spp, *Grevillea wickhamii* and *G. refracta*, on Quaternary red longitudinal sand dune fields overlying Jurassic and Cretaceous sandstones of the Canning, Centralian, Arunta and Armadeus Basins. *Casuarina decaisneana* (Desert Oak) occurs in the far east of the region. Gently undulating lateritised uplands support shrub steppe such as *Acacia pachycarpa* shrublands over *Triodia pungens* hummock grass. Calcrete and evaporite surfaces are associated with occluded palaeo-drainage systems that traverse the desert; these include extensive salt lake chains with samphire low shrublands, and *Melaleuca glomerata* - *M. lasiandra* shrublands. Monsoonal influences are apparent in the north-western sector of this region. Arid tropical with summer rain.

#### GUC Gulf Coastal

Gently undulating plains with scattered rugged areas on Proterozoic sandstones and Tertiary sediments; sandy red earths and shallow gravelly, sandy soils; Darwin Stringybark woodland with spinifex understorey.

#### GUP Gulf Plains

Marine and terrestrial deposits of the Carpentaria and Karumba basins; plains, plateaus and outwash plains; woodlands and grasslands.

#### GVD Great Victoria Desert

Arid active sand-ridge desert of deep Quaternary aeolian sands overlying Permian and Mesozoic strata of the Officer Basin. Tree steppe of *Eucalyptus gongylocarpa*, Mulga and *E. youngiana* over hummock grassland dominated by *Triodia basedowii*. Arid, with summer and winter rain.

#### HAM Hampton

Quaternary marine dune systems on a coastal plain of the Eucla Basin, backed by stranded limestone scarp. Areas of marine sand are also perched along the top edge of the scarp. Various mallee communities dominate the limestone scree slopes and pavements, as well as the sandy surfaces. Alluvial and calcareous plains below the scarp support eucalypt woodlands and Myall open low woodlands.

#### JF Jarrah Forest

Duricrusted plateau of Yilgarn Craton characterised by Jarrah-Marri forest on laterite gravels and, in the eastern part, by Marri-Wandoo woodlands on clayey soils. Eluvial and alluvial deposits support *Agonis* shrublands. In areas of Mesozoic sediments, Jarrah forests occur in a mosaic with a variety of species-rich shrublands. Warm Mediterranean climate.

#### KAN Kanmantoo

Temperate, well defined uplands of Cambrian and Late Proterozoic marine sediments, and a lateritized surface becoming increasingly dissected northwards, with eucalypt open forests and woodlands and heaths on mottled yellow and ironstone gravelly duplex soils in the wetter areas, and *Eucalyptus odorata* and drooping sheoak on shallow rocky soils in drier areas. Extensively cleared for agriculture.

#### KIN King

Perhumid warm coastal plains and low hills comprising King Island and the north-western tip of Tasmania. It is a region of subdued topography and low relief. Precambrian metamorphic rocks are overlain by diverse soils, including recent marine deposits covered by deep sandy profiles that support extensive *Eucalyptus obliqua* open forest and *Nothofagus cunninghamii* closed forest. *Acacia melanoxylon* closed forest and *Melaleuca ericifolia* closed forest occur on poorly drained low-lying sites. The vegetation of King Island has been substantially degraded by clearing and burning following European settlement.

#### LSD Little Sandy Desert

Red Quaternary dune fields with abrupt Proterozoic sandstone ranges of Bangemall Basin. Shrub steppe of acacias, *Thryptomene* and grevilleas over *Plectrachne schinzii* on sandy surfaces. Sparse shrub-steppe over *Triodia basedowii* on stony hills, with River Gum communities and bunch grasslands on alluvial deposits in and associated with ranges. Arid with summer rainfall.

#### MAC MacDonnell Ranges

High relief ranges and foothills covered with spinifex hummock grassland, sparse acacia shrublands and woodlands along watercourses.

#### MAL Mallee

Re-defined 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.

The south-eastern part of Yilgarn Craton is gently undulating, with partially occluded drainage. Mainly mallee over myrtaceous-proteaceous heaths on duplex (sand over clay) soils. *Melaleuca* shrublands characterise alluvia, and *Halosarcia* low shrublands occur on saline alluvium. A mosaic of mixed eucalypt woodlands and mallee occur on calcareous earth plains and sandplains overlying Eocene limestone strata in the east. Semi-arid (Dry) Warm Mediterranean. Extensively cleared for agriculture.

#### MDD Murray - Darling Depression

An extensive gently undulating sand and clay plain of Tertiary and Quaternary age frequently overlain by aeolian dunes. Vegetation consists of semi-arid woodlands of Black Oak / Belah, Bullock Bush/ Rosewood and *Acacia spp.*, mallee shrublands and heathlands and savanna woodlands.

The region is known in Victoria as the Victorian Mallee region and characteristically has few surface water bodies because its soils are highly permeable and its climate promotes high evaporative losses. Approximately 70 per cent of Victoria's mallee vegetation has been cleared and as a direct consequence of farming practices, the 1930s saw a part of the Victorian Mallee become one of the worst wind eroded areas in Australia. Substantial areas of mallee remain today in the western aeolian dunes, mainly in South Australia and but also western NSW. Clearing has also been widespread in the

north eastern portion of the bioregion in NSW particularly on the undulating plains and relict river channels and lakes associated with the Murray and Darling Rivers.

#### MGD Mitchell Grass Downs

Undulating downs on shales and limestones; *Astrebla* spp. grasslands and *Acacia* low woodlands. Grey and brown cracking clays.

#### MII Mount Isa Inlier

Rugged hills and outwash, primarily associated with Proterozoic rocks; skeletal soils; low open eucalypt woodlands dominated by *Eucalyptus leucophloia* and *E. pruinosa*, with a *Triodia pungens* understorey. Semi-Arid.

#### ML Mulga Lands

Undulating plains and low hills on Cainozoic sediments; red earths and lithosols; *Acacia aneura* shrublands and low woodlands.

#### MUR Murchison

Mulga low woodlands, often rich in ephemerals, on outcrop hardpan washplains and fine-textured Quaternary alluvial and eluvial surfaces mantling granitic and greenstone strata of the northern part of the Yilgarn Craton. Surfaces associated with the occluded drainage occur throughout with hummock grasslands on Quaternary sandplains, saltbush shrublands on calcareous soils and Halosarcia low shrublands on saline alluvia. Areas of red sandplains with mallee-mulga parkland over hummock grasslands occur in the east.

#### NAN Nandewar

Hills on Palaeozoic sediments; lithosols and earths; *Eucalyptus albens* woodlands; summer rainfall.

#### NCP Naracoorte Coastal Plain

A broad coastal plain of Tertiary and Quaternary sediments with a regular series of calcareous sand ridges separated by inter-dune swales closed limestone depressions and young volcanoes at Mount Gambier. Vegetation is dominated by heathy woodlands and mallee shrublands with wet heaths in the inter-dune swales. Extensively cleared for agriculture

#### NET New England Tableland

Elevated plateau of hills and plains on Palaeozoic sediments, granites and basalts; dominated by stringy bark/peppermint/box species, including *E. caliginosa*, *E. nova-anglica*, *E. melliodora* and *E. blakleyi*.

#### NK Northern Kimberley

Dissected plateau of Kimberley Basin. Savanna woodland of Woollybutt and Darwin Stringy bark over high Sorghum grasses and *Plectrachne schinzii* hummock grasses on shallow sandy soils on outcropping Proterozoic siliceous sandstone strata. Savanna woodlands on *Eucalyptus tectifica* - *E. grandiflora* alliance over high Sorghum grasses on red and yellow earths mantling basic Proterozoic volcanics. Riparian closed forests of paperbark trees and *Pandanus* occur along drainage lines. Extensive Mangal occurs in estuaries and sheltered embayments. Numerous small patches of monsoon rainforest are scattered through the district. Dry hot tropical, sub-humid, summer rainfall.

#### NNC NSW North Coast

Humid; hills, coastal plains and sand dunes; *Eucalyptus* - *Lophostemon confertus* tall open forests, *Eucalyptus* open forests and woodlands, sub-tropical rainforest often with *Araucaria cunninghamii* (complex notophyll and microphyll vine forest), *Melaleuca quinquenervia*. wetlands, and heaths.

#### NSS NSW South Western Slopes

An extensive area of foothills and isolated ranges comprising the lower inland slopes of the Great Dividing Range extending through southern New South Wales to western Victoria. Vegetation consists of wet/damp sclerophyll forests, peppermint forests and box/ironbark woodlands. Extensively cleared for agriculture.

#### NUL Nullarbor

Tertiary limestone plain; subdued arid karst features. Bluebush - Saltbush steppe in central areas; low open woodlands of Myall over bluebush in peripheral areas, including *Myoporum platycarpum* and *E. oleosa* in the east and west. Arid Non-seasonal.

#### OVP Ord Victoria Plains

Level to gently undulating plains with scattered hills on Cambrian volcanics and Proterozoic sedimentary rocks; vertosols on plains and predominantly skeletal soils on hills; grassland with scattered Bloodwood and Snappy Gum with spinifex and annual grasses. Dry hot tropical, semi-arid summer rainfall. The lithological mosaic has three main components:

- (1) Abrupt Proterozoic and Phanerozoic ranges and scattered hills mantled by shallow sand and loam soils supporting *Triodia* hummock grasslands with sparse low trees.
- (2) Cambrian volcanics and limestones form extensive plains with short grass (*Enneapogon* spp.) on dry calcareous soils and medium-height grassland communities (*Astrebla* and *Dichanthium*) on cracking clays. Riparian forests of River Gums fringe drainage lines.
- (3) In the south-west, Phanerozoic strata expressed as often lateritised upland sandplains with sparse trees. This component recurs as the Sturt Plateau Region in central Northern Territory.

#### PCK Pine Creek

Foothill environments below and to the west of the western Arnhem Land sandstone massif. Its main defining feature is the highly mineraliferous Pine Creek Geosyncline, comprising Archaean granite and gneiss overlain by Palaeoproterozoic sediments. The major vegetation types are eucalypt tall open forests, typically dominated by Darwin woollybutt (*Eucalyptus miniata*) and Darwin stringybark (*E. tetradonta*), and woodlands (dominated by a range of species including *E. grandifolia*, *E. latifolia*, *E. tintinnans*, *E. confertiflora* and *E. tectifera*), with smaller areas of monsoon rainforest patches, *Melaleuca* woodlands, riparian vegetation and tussock grasslands. Characteristic species include the granivorous birds Gouldian finch *Erythrura gouldii*, hooded parrot *Psephotus dissimilis* and partridge pigeon *Geophaps smithii*.

#### PIL Pilbara

There are four major components to the Pilbara Craton.

- (1) Hamersley. Mountainous area of Proterozoic sedimentary ranges and plateaux with Mulga low woodland over bunch grasses on fine textured soils and Snappy Gum over *Triodia brizoides* on skeletal sandy soils of the ranges.
- (2) The Fortescue Plains. Alluvial plains and river frontages. Salt marsh, mulga-bunch grass, and short grass communities on alluvial plains. River Gum woodlands fringe the drainage lines. This is the northern limit of Mulga (*Acacia aneura*).
- (3) Chichester. Archaean granite and basalt plains supporting shrub steppe characterised by *Acacia pyrifolia* over *Triodia pungens* hummock grasses. Snappy Gum tree steppes occur on ranges.
- (4) Roebourne. Quaternary alluvial 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. Arid tropical with summer rain.

#### RIV Riverina

An ancient riverine plain and alluvial fans composed of unconsolidated sediments with evidence of former stream channels. The Murray and Murrumbidgee Rivers and their major tributaries, the Lachlan and Goulburn Rivers flow westwards across this plain. Vegetation consists of river red gum and black box forests, box woodlands, saltbush shrublands, extensive grasslands and swamp communities.

#### SB Sydney Basin

Mesozoic sandstones and shales; dissected plateaus; forests, woodlands and heaths; skeletal soils, sands and podzolics.

#### SCP South East Coastal Plain

Undulating Tertiary and Quaternary coastal plains and hinterlands occur in several distinct segments (Warrnambool Plain, Otway Plain and Gippsland Plain) rise up to 200 metres in altitude and extend from Tyrendarra in the west to Lakes Entrance in the east and including Geelong, eastern Melbourne and the Mornington Peninsula. The area has a temperate climate with rainfall varying from about 500 to 1100 mm, typically with higher rainfall in winter. Adjacent areas of higher altitude (e.g. the Otway and Strzelecki Ranges) produce rainshadow effects in some parts of the area.

The Warrnambool Plain is dominated by nutrient deficient soils over low calcareous dune formations and the distinctive cliffed coastline. Much of the limestone has been overlain by more recent sediments, and between the limestone dunes, areas of swamplands are characterised by highly fertile peats and seasonal inundation. The area east of Warrnambool is characterised by deeper soils of volcanic origins overlying limestone, which are dissected by streams. The Otway Plain includes coastal plains, river valleys and foothills from the Bellarine Peninsula west to Princetown. A small isolated component at Werribee, on the western shore of Port Phillip Bay, is included. The Gippsland Plain includes lowland coastal and alluvial plains characterised by generally flat to gently undulating terrain. The coastline is varied and includes sandy beaches backed by dunes and cliffs, and shallow inlets with extensive mud and sand flats.

The vegetation includes lowland forests, open forests with shrubby or heathy understoreys, grasslands and grassy woodlands, heathlands, shrublands, freshwater and coastal wetlands, mangrove scrubs, saltmarshes, dune scrubs and coastal tussock grasslands. Extensively cleared for agriculture.

#### SEC South East Corner

A series of deeply dissected near coastal ranges composed of Devonian granites and Palaeozoic sediments, inland of a series of gently undulating terraces (piedmont downs) composed of Tertiary sediments and flanked by Quaternary coastal plains, dunefields and inlets. The regional climate is strongly influenced by the Tasman Sea and the close proximity of the coast to the Great Dividing Range. Vegetation consists of high elevation woodlands, wet and damp sclerophyll forests interspersed with rain-shadow woodlands in the Snowy River Valley. Lowland and coastal sclerophyll forests, woodlands, warm temperate rainforest and coastal communities occur in the lower areas.

#### SEQ South Eastern Queensland

Metamorphic and acid to basic volcanic hills and ranges (Beenleigh, D'Aguilar, Gympie, Yarraman Blocks) sediments of the Moreton, Nambour and Maryborough Basins, extensive alluvial valleys and Quaternary coastal deposits including high dunes on the sand islands such as Fraser Island. Humid. Eucalyptus-Lophostemon-Syncarpia tall open forests, Eucalyptus open forests and woodlands, sub-tropical rainforests often with *Araucaria cunninghamii* emergents and small areas of cool temperate rainforest dominated by *Nothofagus moorei* and semi-evergreen vine thickets, *Melaleuca quinquenervia* wetlands and Banksia low woodlands, heaths and mangrove/saltmarsh communities.

#### SEH South Eastern Highlands

Steep dissected and rugged ranges extending across southern and eastern Victoria and southern NSW. Geology predominantly Palaeozoic rocks and Mesozoic rocks. Vegetation predominantly wet and dry sclerophyll forests, woodland, minor cool temperate rainforest and minor grassland and herbaceous communities. Large areas, particularly in the Box-Ironbark Forests, were felled for fuel and timber for the mines during the gold rushes in Victoria. Large areas have also been cleared in NSW for grazing or plantations.

#### SSD Simpson Strzelecki Dunefields

Arid dunefields and sandplains with sparse shrubland and spinifex hummock grassland, and cane grass on deep sands along dune crests. Large salt lakes, notably Lake Eyre and many clay pans are dispersed amongst the dunes. Several significant arid rivers terminate at Lake Eyre, Cooper Creek and Warburton River. They are fringed with coolibah and redgum woodlands.

#### STP Stony Plains

Arid stony silcrete tablelands and gibber and gypsum plains with sparse low chenopod shrublands on duplex soils and calcareous earths, dissected by large arid drainage systems with coolibah and redgum on cracking clays along riverbanks of numerous creeks and rivers.

#### STU Sturt Plateau

Gently undulating plains on lateritised Cretaceous sandstones; neutral sandy red and yellow earths; variable-barked Bloodwood woodland with spinifex understorey.

#### SWA Swan Coastal Plain

Low lying coastal plain, mainly covered with woodlands. It is dominated by Banksia or Tuart on sandy soils, *Allocasuarina obesa* on outwash plains, and paperbark in swampy areas. In the east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah woodland. Warm Mediterranean. Three phases of marine sand dune development provide relief. The outwash plains, once dominated by *A. obesa*-marri woodlands and *Melaleuca* shrublands, are extensive only in the south.

#### TAN Tanami

Mainly red Quaternary sandplains overlying Permian and Proterozoic strata which are exposed locally as hills and ranges. The sandplains support mixed shrub steppes of *Hakea suberea*, desert bloodwoods, acacias and grevilleas over *Triodia pungens* hummock grasslands. Wattle scrub over *T. pungens* hummock grass communities occur on the ranges. Alluvial and lacustrine calcareous deposits occur throughout. In the north they are associated with Sturt Creek drainage, and support *Crysopogon* and *Iseilema* short-grasslands often as savannas with River Gum. Arid tropical with summer rain.

#### TCH Tasmanian Central Highlands

Perhumid cool to cold high plateau surface and rugged mountain ranges to the west formed by Jurassic dolerite and Tertiary basalts, with skeletal soils to alluvium in valleys, and humid cool to cold lower plateau surface underlain by Jurassic dolerite, Permo-Triassic sediments and Tertiary basalts, with sandy to clay loam soils. Vegetation ranging from dry sclerophyll woodlands and wet sclerophyll forest on the lower plateau to alpine complexes and coniferous forest patches in fertile, fire protected situations on the higher plateau. Land use is a combination of conservation, forestry, agriculture (grazing) and water catchment.

#### TNM Tasmanian Northern Midlands

Dry subhumid cool inland lowland plain underlain by Tertiary basalts, Jurassic dolerite, Permo-Triassic sandstones, and recent alluvium lying in the Tamar. Vegetation comprises grasslands and grassy woodlands on deep loams and alluvium and dry sclerophyll forest and woodland on, Tertiary. Grasslands and woodlands have been reduced to remnants. Land use is primarily agriculture (grazing) with some forestry. Extensively cleared for agriculture.

#### TNS Tasmanian Northern Slopes

Humid warm coastal plains and deeply dissected lowland hills rising from Tasmania's central north coast to the foot of the Central Highlands in a rolling hilly plateau. This is a geologically diverse region comprising complexes of Cambrian and Pre Cambrian metasediments, basic-intermediate volcanics, and post-Carboniferous sediments with soils ranging from deep basaltic loams to acid sandy coastal soils. Vegetation is wet and dry sclerophyll forest with coastal heaths and some rainforest which progressively replaces the sclerophyll forest in the west. Native vegetation has been replaced by improved pasture and cropland throughout the lowlands. Land use is primarily forestry and agriculture (cropping).

#### TSE Tasmanian South East

Subhumid cool to subhumid warm coastal plains on a highly indented coastline, bordered inland by low mountain ranges formed from Jurassic dolerite and Permo-Triassic sediments. Soils predominantly clay to sandy loams. Vegetation is predominantly dry sclerophyll forest, with patches of wet sclerophyll forest, relict rainforest, coastal heath and dry coniferous forest. Extensive areas have been converted to improved pasture and cropland. Land use is primarily agriculture (grazing) and forestry.

#### TSR Tasmanian Southern Ranges

Humid cool mountainous tract of central southern Tasmania. Permo-Triassic sediments and Jurassic dolerite, mantled with sandy to clay loams. Heavily forested, grading from mixed forest, wet sclerophyll forest and patches of rainforest in the uplands to dry sclerophyll forest on the coastal lowlands. Land use primarily forestry and agriculture (grazing and cropping).

#### TWE Tasmanian West

Perhumid cold lowlands, low hills and low ranges, comprising most of coastal and inland western Tasmania. Folding and subsequent erosion has resulted in rugged dissected inland ranges dominated by Precambrian and Cambrian rocks supporting oligotrophic acid peat soils or shallow organic horizons over deep mineral profiles. From 300 metres elevation a discontinuous coastal plain slopes westward to the ocean. Vegetation is a complex mosaic of rainforest (*Nothofagus*), buttongrass (*Gymnoschoenus sphaerocephalus*) moorlands and *Eucalyptus nitida* scrub. Principal land uses are conservation, mining and forestry.

#### TIW Tiwi Cobourg

This coastal region includes Australia's second and fifth largest islands (Melville and Bathurst Island in the Tiwi island group), Croker Island and the adjacent Cobourg Peninsula. Coastal vegetation includes some mangroves and saline flats, although this bioregion lacks the large rivers which influence vegetation patterning in other coastal regions. Most of this bioregion is covered by tall eucalypt open forests, typically dominated by Darwin woollybutt (*Eucalyptus miniata*), Darwin stringybark (*E. tetrodonta*) and Melville Island bloodwood (*E. nesophila*), but often with northern cypress-pine *Callitris intratropica* and the tall palm *Gronophyllum ramsayi* co-dominant. The Tiwi Islands support a relatively high density and total area of monsoon rainforest patches, with distinctive species composition. There are also substantial areas there of a distinctive "treeless plain" vegetation. This bioregion is of low relief, with laterite and Cretaceous sandstone the dominant substrates. The Tiwi Islands support about 20 endemic plant and vertebrate animal taxa. The bioregion contains some important marine turtle breeding sites, and a Ramsar wetland on the Cobourg Peninsula. The bioregion is entirely Aboriginal land.

#### VB Victoria Bonaparte

Phanerozoic strata of the Bonaparte Basin in the north-western part are mantled by Quaternary marine sediments supporting Samphire - *Sporobolus* grasslands and mangal, and by red earth plains and black soil plains with an open savanna of high grasses. Outcrops of Devonian limestone karst in the west support tree steppe and vine thicket. Plateaux and abrupt ranges of Proterozoic sandstone, known as the Victoria Plateau, occur in the south and east, and are partially mantled by skeletal sandy soils with low tree savannas and hummock grasslands. In the south east are limited areas of gently undulating terrain on a variety of sedimentary rocks supporting low Snappy Gum over hummock grasslands and also of gently sloping floodplains supporting *Melaleuca minutifolia* low woodland over annual sorghums. Dry hot tropical, semi-arid summer rainfall.

#### VM Victorian Midlands

An extensive area of foothills and isolated ranges comprising the lower inland slopes of the Great Dividing Range extending from North-eastern Victoria to Casterton in Western Victoria. Large areas of the region were cleared during the gold rushes of the late nineteenth and early twentieth centuries so today it is characterised by patches of woodland and forest interspersed with a rural landscape with modified pastures and some cropping. Vegetation includes most of the Box Ironbark Woodland in Victoria, as well as substantial areas of Eucalyptus forests and woodlands with a grassy ground layer.

The flatter and more fertile areas of the Victorian Midlands have been substantially cleared for agriculture, principally sheep and beef cattle grazing. Timber harvesting remains an important land use in the Victorian Midlands. Much of the forests were extensively cut for timber to meet the demands of the gold mining industry of last century. In the less fertile parts of the Victorian Midlands, substantial areas of native vegetation remain today in good condition, for example, the Grampians National Park.

#### VVP Victorian Volcanic Plain

An extensive undulating basaltic plain in south-western Victoria, stretching from Melbourne west to Portland, south to Colac and north to Beaufort. It is characterised by vast open areas of grasslands, small patches of open woodland, stony rises denoting old lava flows, the low peaks of long extinct volcanoes dotting the landscape and numerous scattered large shallow lakes with extensive wetlands.

The grassland communities are floristically rich, usually dominated by Kangaroo Grass with a wide variety of perennial herbs. The open and fertile grassy plains were one of the first areas settled for agriculture in Victoria and native grasslands are now reduced to a few thousand hectares in extent. The major land use is agriculture, especially sheep and cattle grazing and cropping.

#### WAR Warren

Dissected undulating country of the Leeuwin Complex and Albany Orogen with loamy soils supporting Karri forest, laterites supporting Jarrah-Marri forest, leached sandy soils in depressions and plains supporting paperbark/sedge swamps, and Holocene marine dunes with *Agonis flexuosa* woodlands. Moderate Mediterranean.

#### WT Wet Tropics

The bioregion is dominated by rugged rainforested mountains, including the highest in Queensland Mt Bartle Frere (1622m). It also includes extensive plateau areas along its western margin, as well as low lying coastal plains. The most extensive lowlands are in the south, associated with the floodplains of the Tully and Herbert Rivers. Most of the bioregion drains to the coral sea from small coastal catchments, but higher western areas drain in the south into the Burdekin River, and in the north into tributaries of the Mitchell River. The region contains extensive areas of tropical rainforest, plus beach scrub, tall open forest, open forest, mangrove and *Melaleuca* woodland communities.

#### YAL Yalgoo

This region is an interzone between South-western Bioregions and Murchison. It is characterised by low woodlands to open woodlands of *Eucalyptus*, *Acacia* and *Callitris* on red sandy plains of the Western Yilgarn Craton and southern Carnarvon Basin. The latter has a basement of Phanerozoic sediments. This Bioregion has been extended westwards to the boundary of the South-west Botanical Province, so that it now includes the Toolong Plateau of the southern Carnarvon Basin. Semi-arid to arid, warm, Mediterranean climate. Mulga, *Callitris-E. salubris*, and Bowgada open woodlands and scrubs on earth to sandy-earth plains in the western Yilgarn Craton. Rich in ephemerals. Arid to semi-arid warm Mediterranean.

### **3.5. Assumptions and Limitations Underlying the IBRA**

Continental regionalisations, like the IBRA, have a number of limitations including the coarseness of some parts of the data capture process and slight differences in the methods to define boundaries between some jurisdictions. In an era of increasing demand for improved spatial accuracy in the identification of physical and biological values, both from site data and from sophisticated modelling tools, these limitations should not be forgotten and analyses tempered accordingly. It is recognised, that considerable knowledge and investment of effort has gone into the development of the biogeographic classification systems used by the State and Territory nature conservation agencies which form the underlying basis for IBRA.

Methodological variations are perhaps most apparent along the Victorian, South Australian and New South Wales borders. Victoria utilises detailed vegetation mapping (which includes a physical component in their delineation) to define certain features, whereas New South Wales and South Australia utilise coarser land system mapping and the mapping of geological or geomorphological features to define boundaries. Similarly, Western Australia relies heavily on the vegetation studies of Beard, which again contain a physical component. The methodological differences between the jurisdictions are more marked in the definition of IBRA sub-regions rather than IBRA itself.



### **3.6. *Scope for Further Development***

The development of IBRA version 5.1 has removed some important anomalies in the previous versions. This rationalisation process, coupled with improved data capture, means that it represents a far more detailed approximation of Australia's environmental variation. It provides an even more cogent framework for conservation planning.

At the time of writing there are some known areas for further development, including:

- The improved definition of the Australian Alps both in NSW and Victoria. This is a priority for resolution;
- Improved definition of the western boundary of the Yalgoo region in Western Australia taking in the northern end of the current Geraldton Sandplains adjacent to the southern part of Shark Bay; and
- Further work in the arid zone of the Northern Territory
- Further work on the Finke/Stony Plains boundaries on the NT/SA border

It is also likely that additional work in some of the data poor regions, further work on refining IBRA sub-regions and improved data capture for certain physical features where the current boundary only represents an approximation, will provide for the future refinement in some IBRA region boundaries.

One of the driving forces for the IBRA update has been the development of IBRA sub-regions. Victoria (DNRE 1997) and Queensland (Sattler and Williams 1999) developed sub-regions some years ago and have incorporated these into their conservation planning frameworks. The lack of a state-wide coverage of sub-regions in NSW limited the wider use of the early work of Morgan and Terrey (1992) in the NSW Western Division. An example of sub-regions, sub-regional descriptions and how they may be used is provided in Box 1.

### **3.7. *Availability of Spatial Data***

The National Reserve System Section of Environment Australia is the custodian of the IBRA spatial data. These data are available for viewing or download through the National Reserve System website <http://www.ea.gov.au/parks/nrs/ibraimcr/index.html> or upon request from the National Reserve System Section 02 6274 1111. Downloads are available as ArcInfo export files or ArcView shapefiles in both UNIX compressed and Winzip formats.

## Victorian Midlands

## BOX 1

The Victorian Midlands area comprises four bioregions. Dundas Tablelands is an undulating area to the west of the Grampians, much of which has been cleared for agriculture. The Greater Grampians bioregion is dominated by the striking parallel ranges and valleys which comprise the Grampians National Park, and retains substantial areas of native vegetation. The topography of the Goldfields bioregion is dominated by rolling plains and low hills between Stawell and Wangaratta, north of the Great Dividing Range. It supports fragmented native forests and woodlands, mostly on the relatively poor soils.

At the time of European settlement the Victorian Midlands were dominated by forests and woodlands. The Aboriginal inhabitants are believed to have actively managed the landscape with fire to promote the growth of food plants and enhance populations of grazing animals. Twelve BVTs occurred in the Midlands, including most of the Box Ironbark Woodland Complexes in Victoria, as well as substantial areas of Valley Grassy Forest Complexes, Inland Slopes Woodland Complexes, Herb-rich Woodland Complexes and Plains Grassy Woodland Complexes.

Today, the Victorian Midlands continue to support a wide variety of forest and woodland species; 980 species of flora have been recorded, of which 96 are rare or threatened; 502 species of fauna have been recorded, of which 105 are rare or threatened. Species endemic to the Victorian Midlands and found in more than one bioregion include Mount William Beard-heath, Creeping Grevillea, Twining Scale-rush and Scented Bush-pea. Threatened fauna species in the region include the Powerful Owl, Brush-tailed Phascogale and Common Dunnart.

Each of the four bioregions within the Victorian Midlands is distinct. At the time of European settlement, the Dundas Tablelands were dominated by Plains Grassy Woodland Complexes, Grassland Complexes and Inland Slopes Woodland Complexes. Endemic flora species in the Dundas Tablelands bioregion include Mossy Woodruff, Reader's Daisy, Hairy Raspwort and Hoary Bush-pea. The Greater Grampians bioregion remains dominated by Dry Foothill Forest Complexes, Inland Slopes Woodland Complexes, Herb-rich Woodland Complexes and Plains Grassy Woodland Complexes with small patches of Heathy Woodland Complexes and Valley Grassy Forest Complexes. The Greater Grampians is well recognised as an exceptionally rich area for plants, supporting a large number of endemic species, with a diverse range of fauna.

The Goldfields bioregion was dominated by Box-Ironbark Forest but also had large areas of Dry Foothill Forest Complexes, Inland Slopes Woodland Complexes, Plains Grassy Woodland Complexes and Herb-rich Woodland Complexes. Endemic flora species of the Goldfields bioregion include several orchids, Narrow Goodenia, Whorled Zieria and Goldfields Grevillea.

Dry Foothill Forest Complexes dominated the Central Victorian Uplands, but large areas of Moist Foothill Forest Complexes and Valley Grassy Woodland Complexes also occurred. This bioregion also supports a range of endemic plants.

Ninety per cent of the Dundas Tablelands bioregion has been cleared for agriculture. Remnants of Plains Grassy Woodland Complexes constitute 30 per cent of the remaining area of this BVT in Victoria. In the Greater Grampians bioregion, Plains Grassy Woodland Complexes is the only BVT that has been substantially cleared and remains poorly reserved.

Fragmented but considerable remnants of Box–Ironbark Forest BVT occur within the Goldfields bioregion, while most other BVTs are almost all cleared for agriculture. Moderate proportions of the Mallee and Dry Foothill Forest BVTs remain, mostly on public land outside conservation reserves. The Goldfields bioregion has a very high number of threatened flora species and many of these are not present or adequately represented in conservation reserves.

Fragmented but moderately extensive remnants of Foothill Forest BVT remain within the Central Victorian Uplands. Substantial areas of the Moist Foothill Forest and the Dry Foothill Forest BVTs remain within this bioregion, plus significant remnants of Valley Grassy Forest BVT, which has been depleted across its range in Victoria. The Central Victorian Uplands include a large number of rare or threatened fauna species (e.g. one of four Victorian populations of the Smoky Mouse). The Grampians State Forest supports a significant remnant of Plains Grassy Woodland BVT.

Source: DNRE 1997.

#### **4. References**

Anon. 1997 Northern Territory Parks Masterplan “Towards a future secured”. Parks and Wildlife Commission Northern Territory, Darwin.

Morgan, G and Terrey, J 1992 Nature Conservation in Western New South Wales. Land Water Management. National Parks Association of NSW.

Peters and Thackway 1998, “A New Bioregionalisation for Tasmania”, Tasmanian Parks and Wildlife Service.

Sattler, P and Williams, R 1999 The Conservation Status of Queensland’s Bioregional Ecosystem. Queensland Environmental Protection Agency, Brisbane

Thackway, R and Cresswell, I 1995 An Interim Biogeographic Regionalisation for Australia: a framework for setting priorities in the National Reserves System Cooperative Program Version 4, Australian Nature Conservation Agency, Canberra.

Victorian Department of Natural Resources and the Environment 1997 Victoria’s Biodiversity: Directions in Management. DNRE Melbourne.

## **APPENDIX 1**

### **Outcomes of IBRA Update Technical Workshop Canberra 24/7/2000**

#### **Attendees**

Tim Bond – South Australian Department of Environment, Rob Dick – New South Wales National Parks and Wildlife Service, David Parkes – Victorian Department of Natural Resources and Environment, Norm McKenzie - Western Australian Department of Conservation and Land Management, Gethin Morgan – National Land and Water Resources Audit /Queensland Environmental Protection Agency, Richard Thackway – Bureau Rural Sciences, Dave Peters - Tasmanian Parks and Wildlife Service, David Shorthouse – Environment ACT, Julianne Smart - New South Wales National Parks and Wildlife Service, Jim Tait – National Land and Water Resources Audit, Bruce Cummings – NRS, David Forsyth – NRS, Ann Hardy – NRS.

**Agenda:** attached

#### **Summary of Discussions**

The day was designed to build on previous discussions that have been ongoing over some years on IBRA region delineation and anomalies with certain regional boundaries. These discussions have been brought to a head in recent times with the growing use of the IBRA framework and the implementation and reporting on the NLWRA projects.

Each presentation included some brief discussion in relation to clarifying the rationale and methodology adopted and any cross-border issues. These were addressed either on the day through the examination of geological, land system or vegetation maps, or through the viewing of spatial data on the GIS, including LANDSAT MSS data.

There was broad agreement for certain follow-up actions by each jurisdiction, Gethin Morgan, or EA – mainly National Reserve System Section staff. These actions are articulated in the outcomes of the day listed below.

#### **Outcomes**

1. Agreed to adopt new Tasmanian IBRA regions (Version 5) developed by Peters and Thackway 1998 into new continental IBRA V5.1. Additional tasks:
  - 1.1 EA revised naming convention for new Tasmanian IBRA regions in continental coverage. Naming resolved in consultation with Dave Peters and Peter Bosworth.
2. Agreed to adopt Victorian IBRA and province boundaries delineated in the development of the Victorian Biodiversity Strategy, with minor revision on State borders and consultation with NSW re Australian Alps. Additional tasks:
  - 2.1 Gethin Morgan to define and NRS to add Monaro Tableland as an additional province in East Gippsland. Completed
  - 2.2 Gethin Morgan to refine and NRS to add Riverina boundary along the Murray on the Victorian side of the border to be consistent with NSW. Completed
  - 2.3 Gethin Morgan to review cross-border boundaries with SA and NRS to add new province boundaries. Completed
  - 2.4 David Parkes to talk to NSW NPWS re redrawing Vic Alps boundary to be more spatially accurate and in accord with NSW definition.

3. Agreed to adopt revised IBRA regions in South Australia developed from the delineation of new environmental provinces in consultation with EA and Gethin Morgan as part of the NLWRA Landscape Health Project. Additional tasks:
  - 3.1 SA to send latest spatial data to EA . Completed
  - 3.2 Gethin Morgan to review cross-border boundaries with NT, WA, Vic, NSW and Qld. Completed
  - 3.3 NRS to build refined SA IBRA and province coverage. Completed
4. Agreed to adopt revised IBRA regions in Western Australia developed from the delineation of new environmental sub-regions by Norm McKenzie, Greg Keighery, Neil Gibson, Ken Tinley, Ted Griffin and John Beard, as part of the NLWRA Landscape Health Project. Additional actions:
  - 4.1 Gethin Morgan to review cross-border boundaries with NT and SA. Completed
  - 4.2 NRS to build refined WA IBRA and province coverage in ARC Info format. Completed
  - 4.3 Norm McKenzie to pursue the review and adoption of province boundaries within CALM.
5. Agreed to adopt revised IBRA regions in the Northern Territory developed from the delineation of new environmental sub-regions in consultation with EA and Gethin Morgan as part of the NLWRA Landscape Health Project. Additional actions:
  - 5.1 Gethin Morgan to review cross-border boundaries with NT, Qld and SA. Completed.
  - 5.2 NRS to build refined NT IBRA and province coverage. Completed
  - 5.3 Gethin Morgan to discuss further environmental sub-region delineation with the NT.
6. Agreed to adopt revised IBRA regions in the Queensland developed from the delineation of environmental provinces published in Sattler and Williams 1999. Additional tasks;
  - 6.1 Paul Sattler had provided approval for Gethin Morgan approval to standardise province delineation in the Qld Channel Country region. These provinces were re-drawn from the WARLUS land system spatial data and LANDSAT imagery.
  - 6.2 Gethin Morgan to review cross-border boundaries with NT, SA and NSW. Completed.
  - 6.3 NRS to build refined Qld IBRA and province coverage. Completed
7. Agreed to revise and adopt IBRA regions and environmental province boundaries in NSW including the following:
  - 7.1 Darling Riverine Plain additions in the south previously adopted by NSW
  - 7.2 Gethin Morgan to review provinces in the New England Tableland
  - 7.3 Gethin Morgan to review cross-border boundaries with Qld, Vic and SA. Completed.
  - 7.4 NRS to build refined NSW IBRA and province coverage. Completed
  - 7.5 Gethin Morgan to discuss further environmental sub-region delineation within the South West Highlands and coastal IBRA regions with NSW NPWS.

**IBRA Update Meeting 24/7/2000**  
**Waratah Room (1.125) - John Gordon Building King Edward Tce Parkes.**

**AGENDA**

- 9.00 Welcome and Brief Introduction
- 9.15 Cross-border IBRA and province boundary issues for SA-Vic, SA-WA, SA-Qld and SA-NT
- 10.15 Morning Tea
- 10.30 Dave Peters – Short Summary of IBRA Update project in Tasmania, methodological issues and IBRA boundary changes
- 10.45 Tim Bond - Short Summary of recent environmental province delineation, methodological issues and proposed changes to IBRA boundaries in South Australia
- 11.00 David Parkes – Short Summary of bioregion definition in Victoria, methodological issues and consequent IBRA boundary changes
- 11.15 Rob Dick/Julianne Smart - Short Summary of the status of IBRA and environment province delineation in NSW
- 11.30 Norm McKenzie - Short Summary of environmental province delineation in the Western Australia, methodological issues and proposed changes to IBRA boundaries
- 11.45 Gethin Morgan - Short Summary of environmental province delineation in Queensland, methodological issues and IBRA boundary changes
- 12.00 Gethin Morgan (+ NT contacts by telephone if need be) Short Summary of environmental province delineation in the Northern Territory, methodological issues and proposed changes to IBRA boundaries
- 12.15 General Discussion
- 12.30 Lunch - including 15 minute update on Landscape Health Project by Jim Tait/Gethin
- 1.15
  - 1. Cross-border IBRA and province boundary issues for SA-NSW
  - 2. Cross-border IBRA and province boundary issues for Vic-NSW
  - 3. Cross-border IBRA and province boundary issues for NSW – Qld
- 3.15 Afternoon Tea
- 3.30
  - 1. Priority actions to finalise IBRA version 5
  - 2. Timetable for implementation of IBRA Version 5 into National Land and Water Resources Audit projects, the State of the Environment Reporting process, Tropical Rangeland CRC projects and State conservation planning projects
  - 3. IBRA region aggregations and appropriate names
- 4.00 Finish.

David Shorthouse from ACT Parks and Wildlife, Richard Thackway from BRS and Chris Derrick from ERIN will also attend.

## **APPENDIX 2**

### **METADATA FOR IBRA Version 5.1 BOUNDARIES**

#### **Dataset**

##### **Title**

Australia, Interim Biogeographic Regionalisation for Australia (IBRA), Version 5.1

##### **ANZLIC Identifier**

ANZCW0501007500

##### **Custodian**

Environment Australia, Reserve Systems Section  
<http://www.ea.gov.au/parks/nrs/ibraimcr/index.html>

##### **Publication date**

18 Oct 2000

##### **Acknowledgments**

Australian Surveying and Land Information Group (AUSLIG) - Internal State boundaries of Australia.

State/Territory government departments: - delineation of IBRA boundaries

NSW: National Parks & Wildlife Service (NSW NPWS)

VIC: Dept of Natural Resources and Environment (DNRE)

TAS: Dept Primary Industries, Water and Environment (DPIWE)

WA: Dept of Conservation & Land Management (CALM) & Department of Agriculture

SA: Dept of Environment and Heritage (DEH)

NT: Parks & Wildlife Commission of the Northern Territory (PWCNT)

QLD: Department of Environment (DoE)

QLD: Department of Natural Resources (DNR)

Environment Australia (EA), Reserve System Section - edge matching of IBRA boundaries and compilation of national coverage

##### **References**

"Revision of the Interim Biogeographic Regionalisation for Australia (IBRA) and Development of Version 5.0 - Summary Report", Environment Australia, September 2000.

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## **Description**

##### **Abstract**

IBRA regions represent a landscape based approach to classifying the land surface of Australia from a range of continental data on environmental attributes. 85 biogeographic regions have been delineated, each reflecting a unifying set of major environmental influences which shape the occurrence of flora and fauna and their interaction with the physical environment.

IBRA Version 5.1 is the result of refinement of the IBRA Version 4 boundaries. These refined boundaries were jointly defined by the Commonwealth, State and Territory nature and conservation agencies. Following an EA facilitated workshop on the revision of boundaries on 24 July 2000, spatial data refinements were

undertaken by EA in conjunction with relevant State / Territory agencies. Formal agreement from all contributing parties, to make the final IBRA5\_1 dataset publicly available, was gained in November 2000.

Nominal attributes for the IBRA are; climate, lithology/geology, landform, vegetation, flora and fauna, and landuse. The use of these attributes varies across the States and details can be found in "Revision of the Interim Biogeographic Regionalisation of Australia (IBRA) and Development of Version 5.1 - Summary Report", EA, Sept 2000.

This dataset is available in ArcInfo export file format, Projection Geographicals, Datum and Spheroid WGS84. It is also available as ArcView shapefiles.

#### **Dataset contains spatial data**

#### **States, Territories, Seas and Oceans**

Australia

#### **Defined Region**

Australia

	9.0 S	
112.0 E		154.0 E
	44.0 S	

#### **Search Word(s)**

BOUNDARIES Biophysical Maps  
ECOLOGY Landscape Classification

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### **Data Currency**

#### **Beginning date**

01 Dec 1995

#### **Ending date**

18 Oct 2000

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### **Dataset Status**

#### **Progress**

Complete

#### **Maintenance and Update Frequency**

As Required

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### **Access**

#### **Stored Data Format(s)**

DIGITAL - Arc/Info polygon coverage  
DIGITAL - Spatial Database Engine

#### **Available Format Type(s)**

DIGITAL - Arc/Info export file  
DIGITAL - ArcView shapefiles



### **Access Constraint**

Access to the IBRA data is freely available to the public, with the following caveats:

- 1) The client shall not pass a copy of the IBRA data to a third party.
- 2) The client shall not use the IBRA data or its derivatives for commercial gain without the prior agreement of EA.
- 3) The client is not restricted in publishing any findings which use the IBRA data, providing that the client ensures appropriate acknowledgment of the contributors to the IBRA data in that publication.

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## **Data Quality**

### **Lineage**

The original IBRA data (1995) were compiled from various scales of mapping by the State/Territory nature & conservation agencies onto a 1:3 million scale base map. Since 1995, all States & the Northern Territory have reviewed and enhanced these data to improve the spatial positioning of the boundaries and homogeneity of the regions. In 2000, Environment Australia collated the proposed changes to the IBRA regions (referenced under heading 'additional metadata' below), appended the State/Territory data into a national coverage and held a workshop in July 2000 to discuss anomalies across State/Territory borders.

EA was given the authority at the July workshop by the State/Territory agencies to undertake spatial refinements of the boundaries (using landsystems, geology, vegetation and image data), in conjunction with Gethin Morgan, consultant to the National Land and Water Resources Audit (NLWRA) Landscape Health project, to ensure that the edgematching of region boundaries reflected environmental variation.

Given that Queensland, Western Australia and South Australia had undertaken extensive mapping the IBRA boundaries on the NT side of the common State borders based on available imagery; specifically the SSD/CHC, MGD/GFU, GUP/GUC, VB/OVP and TAN/GSD boundaries. Through consultation SA and VIC agreed to changes to the MDD/NCP and RIV boundaries.

The AUSLIG 1:100,000 coverage was used to maintain a standard for the internal borders of the State/Territories of Australia. The coastline boundary is as received from each of the States and the Northern Territory, with the exception of NSW where the AUSLIG coastline has been used. (The coastlines are defined at a much smaller scale than was the case in IBRA 4 - thus contributing to the larger size of IBRA 5 dataset).

IBRA version 5 was completed by 1 September 2000. However, based upon WA advice that the LSD region was incorrectly defined, EA compiled another continental coverage and IBRA Version 5.1 with 85 Bioregions was ratified by all the States/Territories in October 2000.

### **Numeric spatial scale denominator**

250000

### **Positional accuracy**

Less than two kilometres in most areas of Australia. Generally the data is at least accurate to 1:250,000

#### **Attribute accuracy**

The IBRA data has five attributes:

- \* Reg\_code - The two or three letter abbreviation for the IBRA region

- \* Reg\_name - The full name of the IBRA region

All region abbreviations and names have been double checked by State/Territory authorities and are correct.

- \* Prior-97 - The priority allocated to the IBRA region in 1997 for the enhancement of the National Reserve System. These priorities are based on IBRA v4 and will be reviewed in 2001, to reflect the boundary changes in IBRA v5. The priorities are allocated to assist in the development of a CAR reserve system (representative, comprehensive and adequate).

- \* State - Standard AUSLIG state boundaries have been incorporated in IBRA v5.

- \* Reg\_no - the number allocated to each IBRA region; consistency with IBRA4 has been maintained where possible.

#### **Logical consistency**

All polygons are correctly labelled.

#### **Completeness**

The data are complete and up to date.

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## **Contact Information**

### **Metadata contact**

Position:	Project officer
Organisation:	Environment Australia, National Reserve System Section
Address:	GPO Box 787
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## **Additional Metadata**

### **Additional Metadata**

This data set was compiled from data supplied by each State/Territory Nature and Conservation Department/Agency and then combined to make a national coverage by EA, Reserve System Section. See acknowledgments for data set contributors.

#### **Queensland:**

"Bioregions and Provinces of Queensland (bioprov3) - Version 3", Department of Environment. It consists of regions defined in IBRA 4.1 and the 13 bioregions defined in the report "The Conservation Status of Queensland's Bioregional Ecosystems" Sattler and Williams 1997. The prov-name attribute was edited in consultation with Gethin Morgan in April 2000 when visiting EA for talks in regard to the National Land and Water Audit (NLWRA) sponsored Landscape Health Project.

WARLUS Landsystem mapping data - Geographic Extent - Western and Arid Lands Study area - 6 datasets. Qld Department of Natural Resources.1999

**New South Wales:**

GMPROV\_V2.e00 and accompanying metadata: "Statewide Bioregional Project - Release data". NSW National Parks and Wildlife Service. 2000

**Victoria:**

VICBIOREGION250.e00, Department of Natural Resources and Environment (DNRE) 1997 and vicbioreg.xls (which provides attribute information). HVEG250\_BVT coverage, DNRE, used to define the Riverina Bioregion by selecting out the Broad Vegetation Type (BVT) Number 23, Riverine Grassy Woodlands and BVT 18 Plains Grassy Woodlands.

**Tasmania:**

IBRA5.e00 which accompanied the report "A New Biogeographic Regionalisation for Tasmania", David Peters and Richard Thackway 1998. Tasmanian Parks and Wildlife Service GIS Section.

**Northern Territory:**

NT\_PROVINCES.e00, Parks and Wildlife Service of the Northern Territory (PWCNT).

**South Australia:**

SA\_PROV\_NEW\_REGION.SHP which accompanied the report "CARRS Minutes of the IBRA boundary issues workshop", 17 May 2000. Department of Environment and Heritage (DEH). (Report also details IBRA sub-regionalisation boundaries.)

**Western Australia:**

IBRA\_SUBR\_JUNE2000.SHP, which accompanied report "ibra\_sub.doc", Department of Conservation and Land Management (CALM), 2000. Finer scale mapping of IBRA4 boundaries, with changes to YAL/GS and MAL/COO boundaries. (Most of report deals with IBRA sub-regionalisation boundaries).

**Metadata Access**

Public

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Environmental Data Directory 20 Nov 2001

URL: <http://www.environment.gov.au/net/edd.html>

## APPENDIX 3

## MAP of IBRA Version 5.1

