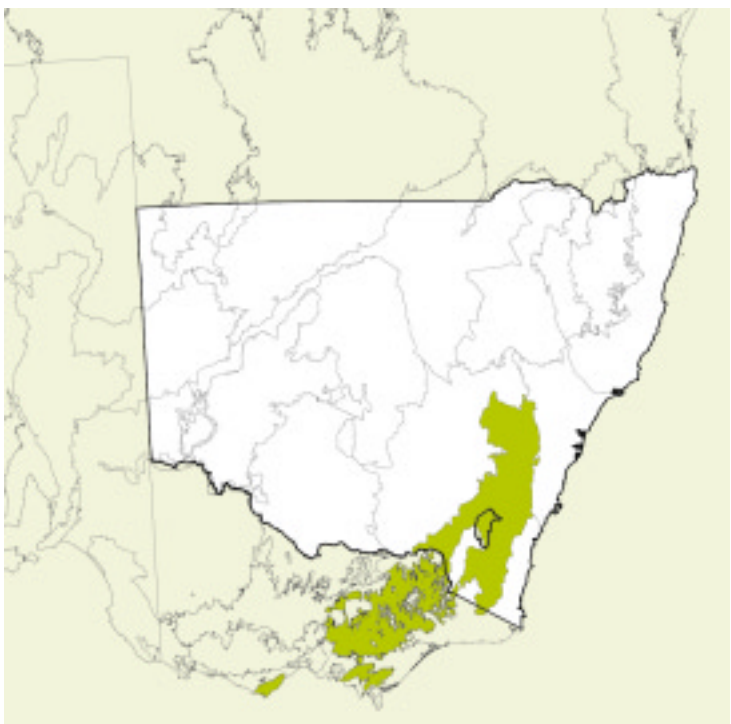

CHAPTER 16

The South Eastern Highlands Bioregion

1. Location

The South Eastern Highlands Bioregion lies just inland from the coastal bioregions of the South East Corner and the Sydney Basin, bounded by the Australian Alps and South Western Slopes bioregions to the south and west. The bioregion includes most of the ACT and extends south into Victoria.

With a total area of about 8,749,155 ha (IBRA 5.1), 55.9% or 4,888,633 ha of the South Eastern Highlands Bioregion lies in NSW. The bioregion occupies approximately 6.11% of the state.

The bioregion includes the towns of Orange, Bathurst and Lithgow in the north, Goulburn, Queanbeyan and Yass in the centre and Cooma, Jindabyne and Bombala in the south.

The Lachlan, Macquarie, Murray, Murrumbidgee, Shoalhaven and Snowy Rivers all flow across the bioregion.

2. Climate

This bioregion is dominated by a temperate climate characterised by warm summers and no dry season. Significant areas in the north and south of the bioregion are at higher elevations in a montane climate zone, where summers are much milder.

3. Topography

The South Eastern Highlands Bioregion covers the dissected ranges and plateau of the Great Dividing Range that are topographically lower than the Australian Alps, which lie to the southwest. It extends to the Great Escarpment in the east and to the western slopes of the inland drainage basins. The bioregion continues into Victoria. The substrate is formed of Palaeozoic granites, metamorphosed sedimentary rocks and Tertiary basalts.

Mean Annual Temperature	Minimum Average Monthly Temperature	Maximum Average Monthly Temperature	Mean Annual Rainfall	Minimum Average Monthly Rainfall	Maximum Average Monthly Rainfall
6 – 16°C	-3.8 – 4.7°C	18 – 31.3°C	460 – 1883mm	23 – 98mm	55 – 220mm

4. Geology and geomorphology

The highlands are part of the Lachlan fold belt that runs through the eastern states as a complex series of metamorphosed Ordovician to Devonian sandstones, shales and volcanic rocks intruded by numerous granite bodies and deformed by four episodes of folding, faulting and uplift. The general structural trend in this bioregion is north-south and the topography strongly reflects this. There are four centres of Tertiary basalt flows.

The oldest rocks are a small sliver of the Early Ordovician serpentinite running from Gundagai past Tumut into the lower Snowy Mountains. These unusual rocks were formed in deep marine conditions and were plastered against the edge of Australia when an area of sea floor and an island arc closed up. A similar sequence is found at Lucknow, about 9km south-east of Orange.

The largest island arc environment is the late Ordovician Molong Volcanic Arc that extends from the northern end of the bioregion to Kiandra. This contains mixed sediment deposited from massive submarine landslides (turbidites) interbedded with quartz sandstone and basaltic tuffs. The sequence is intruded by gabbro, dolerites and later granites. Most granite bodies are oriented parallel to the general north-south structural trend, but the youngest bodies, like the Bathurst granite (about 325 million years old) cut across this trend.

In the Devonian, the region was open sea accumulating fine sediment now represented by shales, sandstone and volcanic sediments in a series of parallel troughs such as at Tumut, Hill End, and from Captains Flat to Goulburn. The whole rock sequence is highly mineralised and contains many large base metal and gold deposits of economic importance.

In the Tertiary, volcanic activity was widespread and there are large areas of associated river sands and gravels in the mid-Shoalhaven valley. Canobolas was a central volcano 50 km in diameter now eroded to reveal more than 50 remnant vents, plugs, dykes, and trachyte domes.

The largest lava fields are found on the Monaro where 65 eruption centres have been identified. These flows are very thin and are interbedded with river and lake sediments. They have been dated as 34-55 million years old. In the Snowy Mountains an inverted relief pattern of 18-20 million year old hill top flows burying river gravels was worked for gold at Kiandra. Similar flows preserving old valleys are found at Crookwell, Abercrombie, Nerriga and in the Macquarie Valley.

Topographically, the dominant features of the bioregion are plateau remnants, granite basins with prominent ridges formed on contact metamorphic rocks and the western ramp grading to the South Western Slopes. Streams cutting through the bioregion are deeply entrenched with only a few terrace features. Valleys are narrow and there is little Quaternary sediment except in the numerous lake basins of the Monaro province.

5. Geodiversity

There are numerous localities exposing structural features in the bedrock, such as the following:

- state circle faults in Canberra;
- complex folds in a railway cutting at Captains Flat;
- the mid-Devonian cauldron subsidence of the Bindook porphyry complex;
- mega debris flow blocks up to 1 km wide of Nubrigyn limestones at Molong; and
- the entire Canobolas volcanic field with numerous plugs and dykes.

The bioregion also holds important examples of rare rock types, such as:

- serpentinites in the Gundagai – Tumut belt and Lucknow; and
- a suite of metamorphic rocks associated with complex dioritic intrusions at Hartley.

Other significant features include the following:

- mine sites such as Adelong, Captains Flat, Burraga, Cadia, Sunny Corner and Hill End and their associated heritage;
- karst systems, deep limestone gorges and fossil sites in limestone are also significant, for example, Yass, Abercrombie, Bungonia, Wombeyan, Jenolan, Borenore, Molong and elsewhere;
- important Quaternary vertebrate fossil sites occur in swamps on the Monaro plateau; and
- numerous shallow or dry lake basins with lunettes and fossil high water strand lines occur in the bioregion; the best known examples are Lake George and Lake Bathurst, but similar features are found all over the Monaro and as far north as Bathurst; research at Lake George has revealed a story of climate and environmental change well into the Quaternary and all such lakes have potential for similar research.

6. Soils

Soils vary across the bioregion in relation to altitude, temperature and rainfall. On the Palaeozoic slates, sandstones and volcanics, mottled red and yellow texture contrast soils, with red earths are found. On the granites, shallow red earths occur on ridges, yellow texture contrast soils on all slopes and deep coarse sands in alluvium. On Tertiary basalts, shallow red-brown to black stony loams exist, with alluvial loams and black clays in swampy valley floors. Limited areas of shallow organic loams are present at high altitude on Canobolas. Some of the tertiary sands in the mid-Shoalhaven deep have been worked into low dunes under a past climate and now have deep siliceous sand or yellow earth profiles.

7. Biodiversity

7.1 Plant communities

Both soils and vegetation vary across the bioregion in relation to altitude, temperature and rainfall. Temperature affects the vertical distribution of species and can be observed in inverted sequences in frost hollows.

Diverse vegetation communities occur across the bioregion, including those consisting of yellow box (*Eucalyptus melliodora*), red box (*Eucalyptus polyanthemos*) and Blakely's red gum (*Eucalyptus blakelyi*), with areas of white box (*Eucalyptus albens*) occupying lower areas. Red stringybark (*Eucalyptus macrorhyncha*), broad-leaved peppermint (*Eucalyptus dives*) and white gum (*Eucalyptus rossii*) associations dominate hills in the west of the bioregion. Brown barrel (*Eucalyptus fastigata*) communities are more common in the east. River oak (*Casuarina cunninghamiana*) is seen along main streams. Grey gum (*Eucalyptus punctata*) and Blaxland's stringybark (*Eucalyptus blaxlandii*) are found on lower areas, and brown barrel, mountain gum (*Eucalyptus dalrympleana*), narrow-leaved peppermint (*Eucalyptus radiata*) and ribbon gum (*Eucalyptus viminalis*) occur on higher areas. Small areas of Argyle apple (*Eucalyptus cinerea*) can be found near Goulburn. Patches of snow gum (*Eucalyptus pauciflora*) occur in the highest places in cold air pockets. High diversity swamps occur on the Boyd Plateau with Carex appressa and tea tree (*Leptospermum myrtifolium*) and sphagnum bogs in the streams. Dwarf casuarina (*Casuarina nana*), tea tree (*Leptospermum lanigerum*) and Calytrix tetragona heath are present on the dry aspects of ranges at the head of the Shoalhaven River.

Granite-derived soils support apple box (*Eucalyptus bridgesiana*), yellow box, some white box and red stringybark associations, with ribbon gums on the lower slopes and brown barrel occurring in the eastern parts of the bioregion. Rocky outcrops support patches of black cypress pine (*Callitris endlicheri*), whereas cold plateaus support open woodlands of snow gum and black sallee (*Eucalyptus stellulata*), with grasslands on the Monaro. River oak is widespread along streams.

Soils derived from Tertiary basalts support vegetation communities dominated by yellow box and Blakely's red gum, with red stringybark, white gum and broad-leaved peppermint across most of the Canobolas plateau. Ribbon gum and candle-bark gum (*Eucalyptus rubida*) associations dominate the lower slopes, while snow gum and mountain gum occupy cold patches and the high altitudes of Canobolas. Extensive grasslands are common on the driest plains of the Monaro, the characteristic species being snow grass (*Poa sieberiana*), spear grasses (*Stipa scabra* and *Stipa variabilis*), kangaroo grass (*Themeda australis*) and wallaby grass (*Danthonia* sp.). Clumps of snow gum can also be found among rocky outcrops.

Areas of sandy soils in the mid-Shoalhaven support woodlands of broad-leaved peppermint, snappy gum (*Eucalyptus racemosa*), forest oak (*Allocasuarina torulosa*), *Banksia marginata* and *Banksia integrifolia*.

7.2 Significant flora

There are 88 species listed in the schedules of the TSC Act in the South Eastern Highlands Bioregion (NSW NPWS 2001). Of these, 36 are listed as endangered, 50 are listed as vulnerable, and 2 species, *Stemmacantha australis* and *Galium australe*, are considered extinct.

Eucalyptus recurva is one threatened species that is also endemic to the bioregion. It has been described as the rarest of all eucalypts and is known from only 3 stands in the South Eastern Highlands (NSW NPWS 1999a). The plumed midge orchid (*Genoplesium plumosum*) is also endemic to the bioregion, known from only 6 colonies east of Marulan (NSW NPWS 1999b). *Grevillea wilkinsonii*, located east of Tumut, is also endemic to the bioregion.

7.3 Significant fauna

Eighty-eight fauna species from the South Eastern Highlands Bioregion are listed in the schedules of the TSC Act (NSW NPWS 2001). Of these, 25 are listed as endangered and 63 are listed as vulnerable.

A noticeable decline in the numbers of the endangered regent honeyeater (*Xanthomyza phrygia*) in the bioregion is illustrative of a general decline in woodland bird species such as robins, treecreepers and many small honeyeaters (Australian Terrestrial Biodiversity Assessment 2002). These declines have been attributed to fragmentation of the landscape, which in this bioregion tends to occur at the edges of largely intact remnants.

This contrasts with substantial increases in noisy miner (*Manorina melanocephala*), Australian magpie (*Gymnorhina tibicen*) and grey butcherbird (*Cracticus torquatus*). These trends are consistent with those that might be expected in a fragmented landscape with a gradual decay in diversity in remnant patches, a decay that may only become evident over decades. Over 7% of all observations were of introduced taxa, with the

Photo: NPWS

bioregion being particularly important for the Eurasian tree sparrow (*Passer montanus*), common blackbird (*Terdus merula*), song thrush (*Terdus philomelos*) and common myna (*Acridotheres tristis*). The last species was recorded much more frequently in the second Atlas period than in the first. Although there was no decline in reporting rate apparent among those taxa that specialise in rainforest, temperate forest or temperate woodland, generalists did decrease, perhaps suggesting there has been little change in the high quality areas, but that gradual environmental degradation is occurring across the broader landscape.

7.4 Significant wetlands

There were no bioregionally significant wetlands recorded in the NSW part of the South Eastern Highlands Bioregion (Australian Terrestrial Biodiversity Assessment 2002). A number of wetlands in the bioregion are regarded as nationally important and listed in the Directory of Important Wetlands in Australia (ANCA 1996).

These wetlands are exposed to a variety of threats including exotic weed invasion, feral animals, grazing pressure, sedimentation and changed water regimes. Four-wheel driving and camping can also threaten the biodiversity of wetlands in the bioregion.

8. Regional history

8.1 Aboriginal occupation

The major Aboriginal groups that traditionally occupied the South Eastern Highlands Bioregion were the Walbanga in the centre, Ngarigo in the centre and southern parts of the bioregion, and Ngunawal and Gandangara in the north of the bioregion (HO and DUAP 1996). Other groups were the Walgal towards the west of the bioregion near the northern part of Kosciuszko National Park, and the Bidawal, a coastal group whose homeland extended inland to the south of Bombala. These inland groups were more nomadic than the coastal groups, perhaps because of the less plentiful food supply away from the coast. The people of the South Eastern Highlands Bioregion relied on the continuous supply of vegetables available in the tablelands. Spring, summer and autumn yielded the tubers of the yam daisy, wattle-seeds were plentiful in July and August, and orchid tubers were consumed in August and September (HO and DUAP 1996). Fish and crayfish were taken from the rivers from September to May, while possums and larger grazing animals were hunted throughout the year.

The Aboriginal groups around the centre of the bioregion made an annual pilgrimage in December and January to the Bogong Mountains and Snowy Mountains where the men of various groups participated in feasts of roasted bogong moths (*Agrotis infusa*) high on the rocky granite outcrops of the mountains.

The nomadic lifestyle of the Aboriginal people, so dependent on the land of the South Eastern Highlands Bioregion, was disrupted by the arrival and early settlement of Europeans in the 1820s. From this time on, there were reports of diminishing water, fish and native animals so important to the Aboriginal diet (HO and DUAP 1996). Some Aborigines adapted to the change by taking on work for the new settlers such as washing sheep, cutting bark and picking potatoes, while others chose to remain on the land and continue hunting.

The new settlers not only changed the lifestyle of Aboriginal people, but also their health which was affected by exotic diseases which devastated many populations, particularly the influenza epidemic in 1846-7 and syphilis (HO and DUAP 1996). Eight centuries of tradition in the bioregion's Aboriginal communities were destroyed within 50 years. The bogong moth ceremonies ceased and intertribal meetings and corroborees also came to an end. Traditional Aboriginal life in the bioregion is considered to have ended by 1850 (HO and DUAP 1996). The *Sydney Morning Herald* reported in 1856 that the Aboriginal people in the south of the bioregion were extinct but the census indicated 166 Aborigines (likely to have been Ngarigo) around Cooma and 319 near Bombala (most probably Bidawal). The well-known Bony Jack and his son Biggenhook were surviving members of the Ngarigo people, with Biggenhook living into the twentieth century, a firm supporter of the Cooma Cricket Club. Ngarigo numbers were dwindling by this time and when Biggenhook died in 1914 at the age of 62, the Ngarigo people became extinct.

8.2 European occupation

The South Eastern Highlands Bioregion was first explored between 1817-20 by Hamilton Hume, Charles Throsby, James Meehan and John Oxley who indicated that the area showed clear potential for grazing and agriculture (HO and DUAP 1996). Soon after this exploration, land was settled in the area throughout the 1820s. John Macarthur settled Taralga in 1822, various Scots arrived in the Braidwood area in the 1830s, and almost 10,000 cattle and sheep were farmed in the open country around Goulburn in 1821. The 1830s saw the whole southern area of the bioregion occupied by squatting runs (HO and DUAP 1996).

Goulburn was earmarked as a town by 1828, founded between 1829 and 1833, and had a population of 650 by 1841, which almost doubled by 1845 (HO and DUAP 1996). Bathurst, in the north of the bioregion, was established in 1833 and the site of Orange chosen by 1846 (HO and DUAP 1996). Bombala was a successful town with 300 residents by the 1850s. Cooma was gazetted as a town in 1849 and grew quickly. By 1889, it was linked to the rail line from Goulburn (HO and DUAP 1996). Other towns such as Bungonia and Marulan developed gradually or did not flourish while towns such as Bungendore and Braidwood were dependent on the crafts industry. Although slow to prosper in the depression of the 1840s, Braidwood blossomed with the advent of the gold rush in 1851 and many shops, banks and hotels experienced a boom, as did the agricultural industry (HO and DUAP 1996). At the turn of the century,

Photo: Peter Hitchcock

when this progressive period ended, Braidwood's eminence soon faded, although its heritage remains as the basis for tourism in the area. Gunning and Gundaroo have similar histories.

Yass developed as an agricultural centre after gazettal in 1837 and has remained established into the twenty-first century along with Crookwell, which developed later after the initial drive from the gold rush of the 1850s, becoming the local centre for wheat growing from the 1860s onwards (HO and DUAP 1996). Sofala, another town based on the gold rush of 1851-2, had a cosmopolitan population although the town itself was reasonably short-lived when the population growth shifted to Hill End in the 1870s as this area began to dominate in gold-mining (HO and DUAP 1996).

The copper rush from the 1840s to the late 1890s also had an impact on the bioregion. The area particularly in the north of the bioregion has the longest history of copper mining in NSW (HO and DUAP 1996). Copper was first discovered in the bioregion at Copper Hill south of Molong in 1845 and was also found at several locations throughout the region, including Carcoar, Sunny Corner and Blayney. Gold, silver, antimony and zinc were also mined at Sunny Corner, the landscape now barren and almost sterile from the lead and arsenic produced from the smelting of silver ores.

Crops and orchards have been common in the South Eastern Highlands ever since miners in the area planted apple, plum and cherry trees near Batlow in the 1850s and 60s, although the first commercial orchard of the area was not planted until 1895 (HO and DUAP 1996). By 1907, there were 5,000 fruit trees in the area and more orchards continued to be planted. Batlow benefited from this attention and was declared a town in 1910. The advent of the railway to the area in 1923 further enhanced it as a prominent fruit-growing district (HO and DUAP 1996).

When the railway reached Lithgow in the 1870s it managed to transform the sleepy rural town into one of the major industrial towns in the state. The local coal mine, Western Coalfield, began to realise its true economic potential as coal could now be transported by rail. Lithgow also benefited in 1900 from the opening of the first steelworks in Australia followed by the first modern iron ore blast furnace built there in 1906-7 (HO and DUAP 1996). These days, since the coalmines have closed and the wool industry has shifted, Lithgow owes much of its current existence to nearby electric generating stations at Wallerawang and Mt Piper and their open-cut coalmines (HO and DUAP 1996).

The Snowy Mountains Hydro-Electric Scheme considerably altered the bioregion (as well as the adjacent Australian Alps Bioregion) from 1949, both physically and demographically. Construction of the scheme began at Adaminaby on 17 October 1949 and was completed 25 years later in 1974 (Department of Immigration website – http://www.immi.gov.au/).

The purpose of the Scheme was to use the rivers of the Snowy Mountains to produce electricity as well as to divert water from the coastal rivers for use in irrigation around the Murray and Murrumbidgee catchments (Australian Science and Technology Heritage Centre website – www.austehc.unimelb.edu.au). More than 100,000 men and women from over 30 countries worked on the scheme during its planning and construction, the workforce reaching a peak in 1959 with 7,300 people (Snowyhydro renewable energy website – www.snowyhydro.com.au/).

Australians (including indigenous Australians) comprised a third of the workforce while the remaining two-thirds were migrants, encouraged to Australia by an intensive recruitment campaign targeting migrants from Europe and by the Government's immigration scheme following World War II. The extensive workforce employed for the scheme required townships and camps for their accommodation. Several regional townships were either created (in the case of Khancoban, Cabramurra and Talbingo) or relocated (Adaminaby and Jindabyne) and other nearby towns (Cooma, Tumut and Corryong) benefited from the activities and population of the area (Snowyhydro renewable energy website – www.snowyhydro.com.au).

In both the South Eastern Highlands and Australian Alps bioregions, the Snowy Mountains Scheme has had, and continues to have, considerable impact on the environment. These impacts are now more recognised and efforts are being made to reduce them. At Island Bend Dam, for instance, the timing and flow regime of water releases for maintenance purposes have been altered to protect the breeding habitat of the spotted tree frog (*Litoria spenceri*). As well as ensuring that water is released gradually, the timing of this work takes into consideration the frogs' breeding season (Snowyhydro renewable energy website – www.snowyhydro.com.au). In late 2000, the Victorian and NSW governments outlined a plan to restore Snowy River flows to a targeted 28% of their original levels and the plan is now beginning to be implemented (Planet Ark website – www.planetark.org).

9. Bioregional-scale conservation

The South Eastern Highlands Bioregion is managed in conservation tenures that together occupy about 726,530.55 ha or 14.86% of the bioregion. National parks and nature reserves make up the majority of this area, occupying an area of 596,638.58 ha or 12.22% of the bioregion. Twelve wilderness areas in the bioregion provide further management under the Wilderness Act 1987, with a total of 177,381.15 ha or 3.63% of the national parks or nature reserves in the bioregion. They are Bimberi, Bogong Peaks, Brogo, Budawang, Byadbo, Ettrema, Goobarragandra, Jagungal, Kanangra-Boyd, Pilot, Woila Deua and Yowrie wilderness areas. Other lands managed under the provisions of the NPW Act 1974 include karst conservation reserves, with 3,740.80 ha (or 0.08%) managed under this special tenure. Hartley and Hill End historic sites occupy 119.04 ha or 0.002% of the bioregion and land managed as state recreation areas totals 11,999.08 ha or 0.245% of the bioregion.

There are no Aboriginal areas and no regional parks in the bioregion.

In recent years, landholders have entered into 12 voluntary conservation agreements, which together occupy about 2,889.07 ha or 0.06% of the bioregion. Landholders on 96 properties also hold wildlife refuges occupying 68,776.84 ha or 1.41% of the bioregion. Updated mapping, being undertaken at the time of writing, is likely to increase the area occupied under wildlife refuges.

In addition, landholders on 141 properties have entered into property agreements under the NVC Act 1997. The conservation zones of the agreements occupy about 6,354.29 ha or 0.13% of the bioregion.

Thirteen flora reserves managed under the provisions of the Forestry Act 1916 occupy 4,654.83 ha or 0.10% of the bioregion and contribute towards biodiversity conservation. In addition, State forests managed primarily for forestry activities under the Forestry Act 1916 occupy 357,262.24 ha or 7.31% of the bioregion.

A significant proportion of the bioregion receives supplementary management under the provisions of SEPP 58 (Protecting Sydney's Water Supply). This area is 1,015,258.25 ha or 20.77% of the bioregion.

10. Subregions of the South Eastern Highlands Bioregion

(Morgan 2001)

Subregion	Geology	Characteristic landforms	Typical soils	Vegetation
Hill End	Silurian and Devonian slates, sandstones and volcanics with numerous quartz veins. Steeply dipping, tightly folded sequence. Tertiary basalt caps with river gravels parallel to the main streams.	Plateau with hilly to mountainous edges into deep entrenched channels of Turon and Macquarie River cutting across the structural trends.	Mottled red and yellow texture contrast soils, with red earths.	Yellow box, red box and Blakely's red gum on lower areas, red stringybark, broad-leaved peppermint and white gum on hills. Brown barrel in the east. Areas of white box. River oak along main streams.
Orange	Ordovician acid volcanics and slates and phyllites and Silurian volcanics. Extensive Tertiary basalts from Canobolas and small stocks of granite. Limited limestone and serpentinite.	Low hilly to hilly plateau with Canobolas peaks rising above. Numerous volcanic features: plugs, dykes and domes in the Canobolas complex. Karst landscapes at Borenore and Molong.	Deep structures red and brown loams on basalt and fine metasediments. Mellow texture contrast soils on any slopes with a sand component in the bedrock. Alluvial loams and black clays in swampy valley floors. Limited areas of shallow organic loams at high altitude on Canobolas.	Yellow box and Blakely's red gum with red stringybark, white gum, broad-leaved peppermint across most of the plateau. Ribbon gum on lower slopes, snow gum in cold patches and high levels of Canobolas. River oak along main streams.
Bathurst	Carboniferous granite with limited areas of Tertiary basalt caps and Quaternary sands along the Macquarie River.	Rounded hills in a granite basin surrounded by steep slopes on the contact margin. Outcrops with tors near margins. Chain of ponds streams in wide flat valley floors. Terrace alluvium along the Macquarie River.	Shallow red earths on ridges, yellow texture contrast soils on all slopes and deep coarse sands in alluvium.	Apple box, yellow box, some white box and red stringybark. Ribbon gums on lower slopes and brown barrel in the east. Patches of black cypress pine in rocky outcrop areas. River oak along streams.
Kanangra	Devonian sandstones with small areas of granite and fine-grained Silurian and Ordovician sediments at the edge of the Sydney Basin.	Ridges and small plateaus to 1200 m, deep valleys, swampy upper tributary floors, outcrops and tors on granite hills.	Red and yellow earths and structured loams. Well drained slopes, moderate fertility.	Grey gum, Blaxland's stringybark on lower areas, and brown barrel, mountain gum, narrow-leaved peppermint and ribbon gum on higher areas. Patches of snow gum. High diversity swamps on Boyd Plateau with carex and tea tree, sphagnum bogs in streams.
Oberon	Fine grained Silurian and Devonian slates, shales and sandstones with Ordovician acid volcanics. Basalt caps and flows on highest crests.	Rounded and stepped hills of plateau, dendritic drainage pattern parallels basalts on crests and ridges.	Red and yellow texture contrast soils on slopes, well-structured deep red loams on basalt. Moderately fertile soils but cold environment.	Narrow-leaved peppermint, mountain gum and some snow gum on high areas. Apple box, yellow box, ribbon gum and Blakely's red gum in the west.

10. Subregions of the South Eastern Highlands Bioregion *CONTINUED*

Subregion	Geology	Characteristic landforms	Typical soils	Vegetation
Crookwell	Fine grained Ordovician and Silurian sedimentary rocks, with some granites. Tertiary basalts with buried river gravels along ridges well above present streams.	Hilly, with some rugged areas and deep valleys. Hill tops may be small plateaus or capped by basalt and showing inverted relief.	Red and yellow texture contrast soils, thin and stony on steep slopes. Stony brown structured loams on basalts.	Apple box, mountain gum with Blakely's red gum and yellow box. Red stringybark, white box, broad-leaved peppermint and mottled gum on stony ridges in the north. Small areas of Argyle apple.
Bungonia	Primarily fine-grained Palaeozoic sedimentary and meta-sedimentary rocks, with minor areas of acid volcanics and limestone. Areas of Tertiary river terrestrial sediments and low sandsheets in the south with very limited basalt.	Distinct plateau with very steep, deep margins on the Great Escarpment dropping into the Shoalhaven River. Strong linear ridges on resistant sandstones and volcanics, wide valleys with some cold air drainage and inverted tree lines.	Mostly yellow texture contrast soils some with harsh clay subsoils. Shallow structured organic loams on limestone and basalt, deep siliceous sands and clayey sands on Tertiary sediments.	Mottled gum, broad-leaved peppermint, white gum, red stringybark and black ash forests and woodlands. Snow gum with and snow grass in cold pockets. Black she-oak common as understorey and in regeneration areas. Limited distribution of argyle apple.
Murrumbateman	Fine-grained Palaeozoic sedimentary and meta-sedimentary rocks, with minor areas of coarse acid volcanics. Tertiary alluvial terraces along main streams.	Undulating plateau with rounded hills and peaks, entrenched meandering streams with chain of ponds tributaries.	Mottled yellow and brown texture contrast soils with strongly bleached topsoils. Dark organic loams and clay loams on valley floors. Saline patches present.	Blakely's red gum, yellow box, on lower slopes, red stringybark, bundy and white gum on ridges. Areas of apple box, and mottled gum. Limited swampy flats and valley floor grasslands.
Western Fall	Silurian and Devonian acid intrusives, fine-grained Palaeozoic sedimentary and meta-sedimentary rocks and areas of granite.	Rugged hills, with small plateau areas. Steep stony slopes and string structural control on ridge lines.	Red earths and red texture contrast soils. Typically thin and stony on slopes, thickening on footslopes, and becoming yellow and harsh on valley floors.	Narrow-leaved peppermint, red stringybark, ribbon gum, and mountain gum open forests.
Monaro	Block faulted ranges and closed lake basins in Silurian and Devonian acid fine grained sedimentary and metamorphic rocks with some granites. Extensive areas of thin Tertiary basalt flows over lake and river sediments.	Sloping plateau rising from 600 to 1300 m north to south. Structural ridges of more resistant rock. Stepped plains on basalt with intervening low areas of granite or sedimentary rocks. Numerous shallow lakes and swamps, a few permanent many are closed basins and periodically dry. Area is in rainshadow with rainfall 450-700mm.	Harsh yellow texture contrast soils in general. Shallow red brown to black stony loams on basalt.	Snow gum, ribbon gum, candle-bark gum, broad-leaved peppermint and mountain gum open woodlands with Kangaroo grass understorey. White gum, mottled gum on hills. Brown barrel and black ash forests in east with west facing patches of dwarf casuarina heathland. Extensive grasslands of snow grass, spear grass and wallaby grass on the driest plains with clumps of snow gum amongst rocky outcrops.

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http://www.austehc.unimelb.edu.au/tia/814.html

http://www.snowyhydro.com.au/corporate/storyofpeople.cfm

http://www.snowyhydro.com.au/recreation/powerofwater/green.cfm