

Chapter S9 Rainforest depletion in south-eastern Australia

THAT WHICH IS TRULY LOST: IS GONE FOREVER, BUT WHAT IS NEARLY GONE WE CAN SAVE



“.....There is apparently every reason to fear that in a few years time the natural beauties of Australia, that owe their attractiveness to its woods and forests, will have disappeared. The unique outgrowths of the Australian soil are being swept away from sight, year after year as the iron of cultivation is wielded.

So surely will the day come when large sums of money will have to be spent on replanting the trees which are now so eagerly destroyed...”

Snowy River Mail, September 13, 1890

Wallaga Lake, New South Wales. *Northern Deltaic* Littoral Rainforest was once abundant on the lower reaches of Narira Creek at its junction with Wallaga Lake, but at this site it is now only represented by a single depauperate stand on the right bank (behind the photographer) near Back Lagoon. The left bank pictured here has managed to retain a couple of majestic remnant emergent Southern Mahogany *Eucalyptus botryoides* and Forest Red Gum *E. tereticornis*. Nearby, River Oak *Casuarina cunninghamiana* also persists and almost miraculously still retains its cargo of Needle-leaf Mistletoes *Amyema cambagei*. This floristic community used to occur from Mogareeka Inlet at Tathra, north to Blackfellows Point on Tuross Lake. Littoral Rainforests and its habitat have been so decimated by land clearing, urban development, coastal recreation, deer and weeds that it has now been listed as Critically Endangered under the *Environmental Protection and Biodiversity Conservation Act (1999)*.

Depletion of rainforests in south-eastern Australia offers us an opportunity to redress the excesses of the past and to help restore that which was then “so eagerly destroyed”. Understanding the causes of depletion are as important as restoring the lost rainforests of our region. By simply replanting and replacing that which has been cleared, burned, weed invaded, overrun by pests or simply maltreated will not itself save these ecosystems. Instead, it will require an integrated response to both depletion and its causes as well as the current and future threats to this, our national environmental wealth. Such are the magnitude of the threats ranged against these precious rainforest pockets across our landscape that for us to truly restore our rainforest estate will take a concerted, coordinated and cooperative effort by everyone from governments through communities to individuals.

So that you may act with certainty to restore rainforests and convince others of the need to do so, we have compiled a depressingly long list of rainforest types and localities where rainforest has been, or is currently, being depleted by our actions: past, present and future. The need to act is not in doubt. But only time will tell whether our generation mustered the will and resources required to draw a line in the sand in order to make the necessary commitment that did ensure that the “attractiveness of our woods and forests” were not **truly lost to us all**.

Introduction

Depletion and an ongoing decline in rainforest health are both critical factors in rainforest restoration in south-eastern Australia. Although all rainforests types in south-eastern Australia are under threat and therefore are, or will be, diminished at the hand of humankind, not all are depleted. The difference being that depletion in this context refers to aerial depletion (see Opener), while loss of condition relates to loss of individual species and structural integrity. So while some rainforests are at severe risk with the loss of individual species through fire, Myrtle Wilt and deer, their aerial extent is often still recognisable as rainforest (however diminished in quality and health). Left unchecked, these threats inexorably lead to the aerial decline reported here. The following sections refer to the **loss in area of rainforest stands** that are known from the literature or to the author. More specific information is provided at the rainforest floristic community level in the relevant keys in Definitions.

As always, local knowledge trumps that which is provided here. If you or your group know of stands which have been lost or reduced in area, go with that knowledge and begin restoration works accordingly. Should the following treatment on rainforest depletion in south-eastern Australia prove inadequate, we have presented a section for 'rainforest detectives' so that you can work out a site's potential rainforest depletion from first principles (Chapter 3: Depletion of rainforests: principles for rainforest detectives) as well as: Example of rainforest detective work to determine depletion in the same chapter.

Depletion by rainforest type

Nearly all of the rainforest types of south-eastern Australia have been depleted since European occupation and all are threatened (Appendix S1: worksheet: Rainforest depletion; and worksheet: nomination status or potential). The causes are sometimes generic (loss of habitat), but are more often specific to a particular type and a locality: in other words, context and rainforest type are important. Depletion often occurs as a result of land use: agriculture, forestry, urbanisation, recreation and so on. The impacts are sometimes obvious (loss of particular stands, weed invasion and disease). Other impacts are much more subtle (edge effects, loss of genetic diversity, fragmentation, stand isolation, landscape-scale changes, fire frequency, extent and intensity): the full impacts of which may not be known for decades or even centuries. Climate change represents one of the most serious threats across all regions. Its multi-faceted effects are relatively easy to interpret when examined individually, but the interactions between these phenomena will be much more difficult to tease apart and to address (Step 3: What does the site need for rainforest to recover? Climate change: multiple threats, magnitudes and synergies).

Depletion by locality: where does (or did) the rainforest once occur?

Introduction

This section allows you to examine your restoration site's possible place in the depletion stakes by locality, district and landform to give you a reasonable chance of identifying what rainforest types may have once occurred there. It is an alternative route to starting out using the Rainforest Divination Tool. It also helps to verify your results if you have used the Tool first. Remember, though, that the Manual can only do so much at this regional and district scale (it cannot possibly account for every damaged, degraded or lost rainforest stand). The best information will always come from **local** observation, with one proviso: make sure your observations are precise, clear and well ordered **before** you draw any conclusions. Sloppy data collection (and being captured by your biases: i.e. wanting rainforest to have once been present) will lead you to a sloppy and unsupportable result – **do not go there!**

In the meantime, you should consult the pre-1750s mapping (along with the appendices for the species lists that you need to begin work): together these information sources will help you to decide the relevant restoration technique. When consulting pre-1750s maps, you must be careful to look up mosaics that contain rainforests as well seeking out areas that are specifically mapped as rainforest stands. It is also important to recognise the coarse scale of pre-1750s mapping and the varying reliability of these maps. So, if you have more compelling evidence of rainforest at the local scale (an historic account, expert opinion, or from using the Rainforest Divination Tool etc.), go with these more locally attuned methods; discount the mapping if the pre-1750s map for that specific location disagrees. **It cannot be over-emphasised that specific local knowledge always over-rides mapping done at a coarser scale.**

What you really need to know for cleared or degraded areas is: was rainforest on my property or the area that I manage and, if so: what sort was it? To speed up this process, this section is designed as a quick geographic reference guide, which can confirm what rainforest ecological vegetation classes and floristic communities were once in your district. Rainforest ecological vegetation classes are briefly listed and described in Chapter S1 and the species list relevant for each particular floristic community, geographic area and/or habitat is provided in Appendix S6.

More up-to-date and intimate knowledge of your local landscapes is always coming to light, such as evidence of Dry Rainforests on the eastern escarpment (e.g. at Murrays Flat) and in shallow gullies on the granite country along the eastern margin of the Bega River Valley; these are sure indicators that there is always more to learn. Certainly, these most recent additions to the rainforest typology of south-eastern Australia do not appear on pre-1750s mapping (as yet). Such 'recent discoveries' are included for completeness and in the hope that their composition and past extent will be more fully investigated in the near future by you the locals.

Use the rainforest descriptions in Chapter S1 and the species compositions in the Appendix S6 in combination with the following compilation of depletion by locality, and you should have the last pieces of information that are necessary for you to complete your rainforest remnant jigsaw puzzle. The following information should be augmented by the information Appendix S1: worksheet: Rainforest depletion, which provides more detailed information than the following summary. Depletion by locality is ordered by rainforest type.

Although the following list of depletion by locality is as complete as possible, remember this is not the last word on rainforest distribution. Use the Rainforest Divination Tool and local people who have knowledge [e.g. Kanooka *Tristaniopsis laurina* becoming extinct on the Bega River in the late 1950s to early 1960s (Toni Hall pers. comm.); source: local farmers)]. Other historical sources will prove invaluable, as will more modern contemporary innovations such as Google Earth®: look out for the small-crowned brighter green areas in fire-protected areas of the landscape. Be cautious, though, because the quality and colour balance of the aerial photographs varies across the landscape, and **you should always ground-truth what you think you are seeing.**

New South Wales (South Eastern Highlands Bioregion)

This area, like East Gippsland, has many rainforest communities that are largely intact from the land clearance perspective. All are threatened by global warming (loss of habitat, drying climate and increased fire frequency and intensity) and deer invasion, while those in the steeper foothill country may also be under threat from goats (Chapter S1). For many areas, there is little to do in the rainforest restoration context except to watch for the threats that are beginning to move into this bioregion and act as they become apparent. For some districts, depletion has been almost complete (the Bega Valley, Tanja, Nethercote, etc.), while in others stands are under immediate threat and require urgent actions to arrest the threatening processes that are undermining them.

Mountains and montane plateaux

The dominant rainforests of this bioregion are Cool Temperate Rainforests that are classically dominated by one, or a combination of, Southern Sassafras *Atherosperma moschatum*, Sassafras *Doryphora sassafras*, Black Oliveberry *Elaeocarpus holopetalus* and/or Eastern Leatherwood *Eucryphia moorei*. At the highest elevations (in the northern sections of the study area (such as Clyde Mountain), such stands can be fringed by a type of cloud forest dominated by Hill Kanooka *Tristaniopsis collina* [in stands associated with *Clyde-Deua* Cool Temperate Rainforest (*sensu* Tindall *et al.* undated)]:

- **Cool Temperate Rainforests** are usually restricted to steep mountain gullies above 700-800m elevation and adjoining ridges and slopes, where rainfall is high, temperatures are cool and there is often abundant cloud cover. Because these rainforests occur over such a small altitudinal range that includes (in most cases) to the escarpment edge, there is a significant risk that their habitat (like that of alpine ecosystems) will vanish as the lowland's warmth overruns their narrow climatic envelope during global warming. The other threat is the damage wrought by Sambar and other feral deer species that are either present or likely to invade the area. A close watch needs to be kept on all of these threats and the appropriate, landscape-scale, regional and local action needs to be taken as, and when necessary if it is at all possible to ensure the survival of these ancient relicts.
 - **Floristic communities represented:**
 - New South Wales '*Southern Escarpments*' Cool Temperate Rainforest: refer to Beukers and Miles (in prep.); Keith and Bedward (1999); Keith and Saunders (1990) and Keith (2004)
 - *Clyde-Deua* Cool Temperate Rainforest (Tindall *et al.* undated) and Keith (2004).

New South Wales (South East Corner Bioregion)

Initial losses of rainforests have been as the result of land clearing for agriculture on arable land (particularly river valleys and fertile geologies), as well as on flatter land near the coast for port infrastructure. More recent clearing has occurred for urban development and coastal recreation. Ongoing damage and degradation of rainforests continue with weed invasion, *incremental development* and deer colonisation.

Foothills

As a general rule, there are many rainforest stands that occur in the foothills that are relatively remote and have remained safe from weed invasion and clearing. These sites are, however, at risk from deer and global warming. Some of the specific sites mentioned below fall into this category, though most of the areas discussed in detail have been cleared for agriculture.

All of the lowland rainforest ecological vegetation classes of this region are increasingly threatened by the impacts of deer. Other types occur, or used to occur, on fertile flatter land or land valued for other purposes such as agriculture, urban development or coastal recreation. To date, these are the areas that have suffered the greatest consequences of human activity and these are the ones that are in most urgent need of restoration. In the lower foothills, global warming threatens Warm Temperate Rainforest through forecast alterations to rainfall seasonality and amount, increased temperatures and more frequent and severe wildfires. On the coast, global warming (rising sea levels, altered prevailing winds and storm intensity and frequency) threaten Littoral Rainforests (SMEC 2008) on dunes, cheniers, estuarine deltaic deposits and estuarine islands.

Towamba River

Three types of rainforest occur on the lower reaches of this river system (at least downstream of the junction of the Snake Track and the Eden Towamba Road intersection). Gallery Rainforest dominated by Kanooka *Tristaniopsis laurina* may have occurred further upstream: however, the stream is so badly eroded that much of its habitat has disappeared. In addition, there will be an altitudinal limit to this EVC (that is dictated by a frost intolerance of the dominant canopy species). Local people will have to determine the community's upstream limit. Littoral Rainforest used to be more widespread in its estuarine reaches below the Princes Highway.

- **Warm Temperate Rainforest:** spills out of deeply dissected gullies and onto elevated (and consequently less flood-prone terraces): mostly on the river's left (that is to say north bank), where it is protected from fire by steeply eroded riverine escarpments. The depleted areas occur from at least as far upstream as the Snake Track intersection with the Eden-Towamba Road intersection.
- **Gallery Rainforest:** dominates the river margin (at least where there is still some of the original bank left intact). This is mostly in the narrower foothill sections where farming has not been as intense as in the upper valley. The depleted areas occur from at least as far upstream as the Snake Track intersection with the Eden-Towamba Road intersection. Depending on its frost limits, it may have occurred further upstream (perhaps as far as the township of Towamba itself).
- **Littoral Rainforest:** used to be once much more common in the estuarine reaches of the river on deltaic deposits such as levees and spits below the Princes Highway bridge.

Nethercote

This small scenic valley is a dryland farming locality based on basalt-derived soils. It once supported a grassy forest/woodland ecosystem on its fertile soils. It contains small degraded stands of rainforest.

- **Warm Temperate Rainforest:** is still retained in its steeper gullies, but much of its habitat is cleared.
 - **Floristic communities represented:** The floristic community present in the valley requires further investigation because it is growing on basalt, and therefore may not be represented by any of the entities presented in the existing typology for the region. As such, taking a site-specific species list is advised and this list should direct any restoration that is to occur in this valley; and
- **Dry Rainforest:** it is conceivable that the Nethercote district also supported small areas of this rainforest on north or west slopes and/or gully heads because it still has remnant Kurrajongs scattered throughout the valley and these, along with Lightwood and Sweet Pittosporum, are the dominant trees of Dry Rainforest. This is site marginally too far south for Port Jackson Figs *Ficus rubiginosa* (the usual dominant of Dry Rainforest further north in southern New South Wales), but we need to check on its past history at this site with the locals before dismissing it out of hand.
 - **Floristic communities represented:** the closest floristic community analogue would most likely be Dry Rainforest of the South Coast Forests (as nominated under the *EPBC Act*). Note, however, that because rainforest in this valley is growing on basalt, a close examination of the remnant stands is advised and that the species list derived from such a process should be the one that is used in any restoration. Refer also to Beukers and Miles (in prep.), Keith and Saunders (1990) and Keith and Bedward (1999).

Bega-Brogo valleys and west of the Coastal Range

The farming land in these valleys is based on two fertile igneous intrusions of granodiorite and consequently land clearance for agriculture has been the primary agent for the loss of rainforests in this district. Feral deer (mostly Sambar) are increasingly responsible for extensive damage and more recently loss of rainforest species in this district. Coastal settlements, as always, are supplying a seemingly endless numbers of garden escapees that are becoming transforming rainforest weeds (Cameron 2008), especially of Littoral Rainforests. The topography ranges from gently rolling hills around Bega to steeper topography and more deeply incised gullies west of the Brogo Gorge (Warrigal Range Road). Rainforest of different types occurred across a range of habitats in these valleys.

- **Warm Temperate Rainforest** grows in steep and deeply incised gully heads usually with moist aspects (south and east). These were geographically restricted as this landform is not common in the more gently rolling hills that dominate these valleys (for example on the eastern side of the Princes Highway) at its intersection with Israel Road north of the Brogo River crossing and along the eastern escarpment interface such as in the Murrays Flat area and Tarraganda;
- **Warm Temperate Rainforest** grows on the floors of flatter gully and creek lines that are topographically well protected from fire (steep gully-sides). These tend to be fern-dominated in the understorey as a result of abundant moisture from creeks or the steep narrow valley sides that reduce the amount of sunlight entering the rainforest habitat. Dominant trees are the typical suite of Warm Temperate Rainforest species including: Sassafras *Doryphora sassafras* and Lilly Pilly *Syzygium smithii*;
 - **Described floristic communities:** *Sand Rivers* Warm Temperate Rainforest associated with river and creek flats on the major sand rivers and creeks of the area (Brogo (including Brown's Creeks), Bega, Dry, Murrumbidgee, etc.). The floodway of the stream is usually colonised by Riparian Sheoak Forest (*sensu* Beukers and Miles in prep.) dominated by River Oak *Casuarina cunninghamiana* (Figures RD1 and RD2) whereas the better-drained alluvial terrace up from the river itself is the habitat for *Sand Rivers* Warm Temperate Rainforest (Figure S17) dominated by Sandpaper Fig *Ficus coronata*, Koda *Ehretia acuminata* and Muttonwood *Myrsine howittiana*. The overstorey is a variety of riverine eucalypts (Blue Box *Eucalyptus baueriana*, Southern Mahogany *E. botryoides*, River Peppermint *E. elata*) and River Oak. This rainforest community is notable for the absence of other common Warm Temperate Rainforest canopy species such as Sassafras *Doryphora sassafras*, Scentless Rosewood *Synoum glandulosum* and Lilly Pilly *Syzygium smithii* (Chapter S1).
- **Dry Rainforests** occupy dry north- or west-facing aspects of the Brogo-Warrigal Range area north of Bega, and the Bega Valley as a whole (though frost may set a lower limit for Rusty Figs): at least as far west as Candelo and probably as far north as Verona-Cobargo, where remnant figs are still relatively common in farmland (e.g. Buckajo Road 500m west of its intersection with Spring Creek Road) in an agricultural landscape that was formerly Bega Dry Grass Forest (an *Endangered Ecological Community EEC*) that provided fire protection. Apart from Rusty Figs, other emergent trees in this rainforest would also have included Forest Red Gum *E. tereticornis* and Rough-bark Apple *Angophora floribunda*. These Dry Rainforest stands are immersed in broader areas of Brogo Wet Vine Forest and

EEC as well. In the Bega-Candello district, they were found on any northern slope where there are exposed granite tors, and steepness does not seem to have been a necessary factor for their development and persistence (Figure S35). Fire is thought to have been mitigated in these situations by the grassy ecosystems surrounding them, and possible also by Koori burning to protect the enormous food reserves held on the figs as well as the other materials these rainforests provided. In the Brogo-Warragil Range these rainforest stands are generally associated with the steepest terrain on granitic outcrops that are initially colonised by Port Jackson Figs *Ficus rubiginosa* (Figures S35, S36, S37 and S38).

- **Floristic communities represented:**

- *South East Forests* Dry Rainforests (*TSC Act* and *EPBC Act* listed).
- Undescribed Grassy Dry Rainforest type [from the Bega Valley (and Tarraganda) and Brogo Valleys (Warragil Range)] that are, or were, protected from fire by the Bega Dry Grass Forest in the surrounding landscape. These grassy ecosystems protect the rainforest by maintaining low flame heights that the rainforest can suppress through its moist fuels beneath its canopy. Today, only two stands of this rainforest type are known to the author (both on private property). This Dry Rainforest type was probably found along the eastern margin of the Bega Valley where the steep habitat of Warm Temperate Rainforests stands in the escarpment spill out into broader shallower gullies of rolling granitic hills in the valley. Fire protection was provided primarily by the grassy ecosystems of the surrounding hills, including Brogo Damp Vine Forest and Bega Valley Dry Grass Forest, and major streams such as the Bega River (e.g. between it and the range) to the east along Murray's Road. It occurs wherever there are free-draining soils on gully or creek slopes. This Dry Rainforest type is dominated by Yellowwood *Acronychia oblongifolia*, Native Quince *Alectryon subcinereus* and Muttonwood *Myrsine howittiana* and has emergent eucalypts that include Blue Box *Eucalyptus baueriana* and Forest Red Gum *E. tereticornis*. These rainforests are likely to have been rarer in the core and lower areas of the Bega/Brogo Valleys because these zones would have been too frosty and/or dry. The higher hills around Quamma, though, are warmer and there is some evidence of rainforest remnants around Jews Hill and McLeods Road, with large Sassafras *Doryphora sassafras*, Port Jackson Fig *Ficus rubiginosa* and Blackwood *Acacia melanoxylon*, as well as a range of rainforest vines and ferns.
- Another form occurs on the west-facing escarpment of the eastern Bega Valley's margin near Murray's Flat Road with Maiden's Wattle *Acacia maidenii* and Koda *Ehretia acuminata*.

Bega and Murrah River valleys and east of the Coastal Range

Rainforests of this region have been lost mostly as the result of clearing for agriculture (especially on the Bega River along the estuary around and downstream of Kalaru; along the flats and in the gullies of the rolling country of the Tanja district) while coastal settlements and coastal recreation are having their usual (and serious)

incremental development impacts through coastal recreation and garden escapes that have become serious transforming weeds of rainforest. The rainforests of this district include:

- **Subtropical Rainforest (Subtropical Warm-Temperate Rainforest** (*sensu* Beukers and Miles in prep.)
 - **Floristic community:** 'South Coast Subtropical Rainforest: in the gullies with *feldspar*-rich rhyolites at Tanja. These rainforests had emergent Small-leaved Fig *Ficus obliqua*, Rusty Fig *R. rubiginosa*, and canopies with Maidens Wattle *Acacia maidenii*, Koda *Ehretia acuminata* and perhaps Giant Stinging Trees *Dendrochride excelsa* as their subtropical elements, and the usual suite of Warm Temperate Rainforest species. Reasonable examples still remain at Fig Valley and Hidden Valley between Goalen Head and Bunga Head nearer the coast.
- **Warm Temperate Rainforests** of steep gullies: usually with moist aspects (south and east). These stands are mostly restricted to Ordovician sedimentary geology, which produces these steep landforms.
- **Warm Temperate Rainforest** of alluvial flats: occur on sites that are topographically well protected from fire (steep gully sides or on broad rivers with *billabongs* and back swamps). See the entries for the western side of the Coastal Range.
- **Sand Rivers Warm Temperate Rainforest** associated with river and creek flats on the major sand rivers of the area (Brogo, Bega, Dry, Murrah, etc.). See entries for this type under the western side of the Mumbra Range. This vegetation is still best preserved in this area on the Murrah River and probably once occurred on similar landforms on the Bega River upstream of the estuary.
- **Dry Rainforests:** occupying dry north- or west-facing ridges are like the Dry Rainforests described on the western side of the range being dominated by Port Jackson Figs *Ficus rubiginosa* (Figures S35 to S38). Unlike the previously described Dry Rainforest stands on the west side of the Coastal Range, these dry rainforests are confined to rhyolitic ridges and rock screes inland of Bunga Head. This rainforest type also occurs on north- or west-facing gully sides on gabbro inland of Goalen Head.

- **Dry Gully Rainforest** occurs in steeply incised and 'drier' gullies than Warm Temperate Rainforest (which may occupy the gully floor) north of Cuttagee Inlet and inland to the granite belt.
- **Littoral Rainforests** of the estuarine deltaic deposits, coastal sands and headlands. These Littoral Rainforests are highly variable in their composition being dependent on geology, the age of the stand, time since disturbance, proximity of the stand to others and the size of the stand. The common elements are a canopy combination of Sweet Pittosporum *P. undulatum*, Wild Quince *Alectryon subcinereus*, Brittlewood *Claoxylon australe*, Rusty Fig *Ficus rubiginosa* on volcanic geologies and Lilly Pilly *Syzygium smithii* (in older stands). The understoreys are low in cover and dominated by grasses and forbs. The ground fern flora is also low in diversity and restricted to drought-tolerant species such as Bracken *Pteridium esculentum* and Necklace Fern *Asplenium flabellifolium*. Large epiphytes may be present in the oldest stands that have yet to have their plants poached.

Footslope of the Wadbilliga National Park: (Murrabrine Range)

This complex near-coastal range comprises the headwaters of the Dry River (Murrumbidgee River), the Tuross River (Tanto Creek) and Narira Creek (Wilgo Creek) and has a granitic geology of Cobargo Granites. Its valleys and lower slopes are cleared, with the upper slopes still bushland which include the Wadbilliga National Park and regenerating former farmlands. Some continuing rainforest clearing is still occurring (2008) in steep gully lines on 'productive' dairy farms for relatively minor gains in productivity and a significant risk of erosion.

- **Subtropical Rainforest (Subtropical-Warm-Temperate Rainforest)** (*sensu* Beukers and Miles in prep.): occurs in the deeper wetter and more fire-sheltered gullies with warm eastern, northern or western aspects, such as between Quinlans Road and County Boundary Road west of the Yowrie Road.
- **Dry Rainforests:** occupy dry north- or west-facing ridges, gully heads or tor fields presumed (though not thoroughly examined by the author) to be similar to those of the Warrigul Range.

Footslopes of the Kooraban National Park (north and north-east of Cobargo)

The rainforest in this area (on cleared farmland south of Sams Ridge Road and the Princes Highway north of Cobargo eastwards to the Gulaga National Park), is thought to once have been Warm Temperate Rainforest. This is based on aerial photographic interpretation and the south-trending aspects of the gully systems that flow off Sams Ridge.

Bermagui-Tilba Tilba-Narooma [including Gulaga (Mt Dromedary)]

Rainforests of this district have been lost primarily as the result of clearing for agriculture (especially around Gulaga and northwards to Narooma). Good examples of this landscape occur southwest of Narooma south to Corunna Lake (east and west of the old Princes Highway-Narooma Road and between Rainforest Parkway-Flying Fox Road (evocative names) and southwards to Tilba Tilba. Subdivisions, coastal settlements and coastal recreation are also having an impact (both from clearing) and through garden escapes that become serious environmental weeds (Cameron 2008): many of which are transforming species (e.g. *Lantana* **Lantana camara*) or have the potential to become so.

- **Subtropical Rainforest (Subtropical-Warm Temperate Rainforest)** *sensu* Beukers and Miles in prep.) growing in steep and deeply incised gully heads (in the absence of vegetation-derived fire protection) and slopes and broad ridges usually with moist and warm aspects (east, west and north) if other fire protection is available.
 - **Floristic community:** 'Tilba Tilba' Subtropical Rainforest: around the Tilba Tilba district. These stands occur on monzanite geology and would once have occurred even in open situations where they were/are afforded fire protection, not from steep landforms but from Bega Dry Grass Forest and Brogo Wet Vine Forest. North of Gulaga to Narooma, Subtropical Rainforest stands are mostly restricted to moist and warm north-east-facing gullies on Ordovician sedimentary geology, which produces these steep landforms. The extensive lake systems associated with Narooma (Wagonga River estuary) and Corunna Lake also provide landscape-scale protection, as does the high rainfall associated with the Gulaga massif. These features allow Subtropical Rainforest in this locality to extend out of gullies and across saddles. The dominant tree species include Brush Bloodwood *Baloghia inophylla*, Giant Stinging Tree *Dendrochne excelsa* Small-leaved Fig *Ficus obliqua*, Port Jackson Fig, Cabbage-tree Palms *Livistona australis* and Buff Hazelwood *Symplocos thwaitesii*. Disturbed areas are colonised by Mabel's Wattle *Acacia mabellae*, Maiden's Wattle *A. maidenii*, Red Ash *Alphitonia excelsa*, Southern Kurrajong (Blackfellows Hemp) *Commersonia rossii* and Pencil Cedar *Polyscias murrayi*.
- **Warm Temperate Rainforest** growing at elevations from near sea level 700m in steep south- or east-facing gullies that are topographically well protected from fire. These occur on poorer geologies and in cooler south-facing gullies compared with Subtropical Rainforest and at higher elevations when juxtaposed with this rainforest type (such as in the mid-sections of gullies associated with Gulaga). See the entries for the western side of the Coastal Range.

- **Cool Temperate Rainforests** occupy the upper gullies and ridges of Gulaga.
- **Dry Rainforests** occupying the monzanite tors associated with Gulaga (Mt Dromedary) and Nachinuka (Little Dromedary) and are like those described for the Bega Valley west of the Mumbra Range.
- **Dry Gully Rainforests** occupy steep and/or deeply incised north- or west-facing gullies. They are dominated by Myrtle *Backhousia myrtifolia* and Sweet Pittosporum *P. undulatum*. The gullies have dry aspects and are primarily composed of Ordovician sedimentary geology.
- **Littoral Rainforests** of the estuarine deltaic deposits, coastal sands and headlands. These Littoral Rainforests are highly variable in their composition, being dependent on geology, the age of the stand, time since disturbance and the size of the stand (Peel in prep.). See the Littoral Rainforest entry for the eastern side of the Coastal Range. As an example, using the divination tool for a cursory survey of the urban area on the sand flat at Narooma between Wagonga Estuary entrance and Quota Park on Forsters Bay accrued a score of 135 (i.e. 'could have once been rainforest').

Dalmeny-Batemans Bay

Rainforests of this district have been lost as the result of clearing for agriculture and coastal settlements and coastal recreation. More recent losses are occurring as garden escapes become serious environmental weeds, many are transforming species.

- **Warm Temperate Rainforest** growing in steep and deeply incised gully heads usually with moist aspects (south and east).
- **Dry Rainforests** associated with Rusty Figs scattered in the grassy woodlands on basalts and gabbros on the Tuross peninsula (south side of Coila Lake) and on the north side of Coila Lake to Bingie Bingie Point and perhaps as far north as Mullimburra in the Eurobodalla National Park. It is possible this vegetation type once extended west and northward to Moruya on the rolling granite hills of this country. Local knowledge will better address this prospect.
- **Dry Gully Rainforests** occupy steep and/or deeply incised north or west facing gullies, primarily on Ordovician sedimentary geology. See the entries for this rainforest type under the *Bermagui-Tilba Tilba-Narooma* section.
- **Littoral Rainforests** of the estuarine deltaic deposits, coastal sands and headlands. These Littoral Rainforests are highly variable in their composition; this is dependent on geology, the age of the stand, time since disturbance and the size of the stand (Peel in prep.). The Littoral Rainforests of this coast have more canopy species derived from the sub-tropical climate zone, including Red Olive Plum *Elaeodendron australe*, Rusty Fig *Ficus rubiginosa* and Cheese Tree *Glochidion ferdinandi*. There are several localities from which the original extent is now much reduced: on the coastal hills of gabbro and basalt based around Rusty Figs associated with Tuross and the shores of Coila Lake and Bingie Point. Between Bingie Point and Coila Lake at the southern end of Kelly's Road to its east: the Grey Myrtle *Backhousia myrtifolia* dominated stands on the coastal sands behind the secondary dunes are very unusual. This species is only known from one other Littoral Rainforest locality in the region: on the north-western edge of Broulee Island.

Tuross-Moruya-Deua-Clyde River valleys

These are the first of the substantial river valleys at the southern limit of the subtropical climate zone and include the lowland reaches of the Tuross, Moruya and Clyde Rivers.

Rainforest, or evidence of rainforest, could not be located in the Tuross or Moruya Rivers (with the exception of the Knoll on the right bank downstream of the Princes Highway between Moruya and South Heads), but then neither can it be located in many lowland rivers of the region unless you are a local and know where to look for small remnants or single remnant trees. So, use the Rainforest Divination Tool and rely on the advice of local people with more intimate knowledge of these valleys before dismissing its past presence out of hand.

Limited areas of Dry Gully Rainforest line the Deua River, where steep rocky hillsides abut the river with Gallery Rainforest just above the Riparian Sheoak Forest (River Oak *Casuarina cunninghamiana*) zone. In general, neither of these rainforest types occurs on arable land, so there is no need for rainforest restoration in these river valleys, except where clearing and grazing goes right to the river's edge or transforming weeds such as Wandering Jew *Tradescantia fluminensis* are establishing. However, wherever there is a combination of an elevated river flat, backed by a steep slope (often with Dry Gully Rainforest) and a Warm Temperate Rainforest gully, then the elevated river flat was probably Warm Temperate Rainforest. In general, these **hypothesised** past rainforest sites seem to be marked by dense regrowth of Downy Ground-fern *Hypolepis glandulifera*, Kangaroo Apple *Solanum aviculare* and Tree Tobacco *Solanum mauritianum*. Such sites first appear in the foothill sections of the Deua River downstream of its confluence with Araleun Creek from about 3km upstream of Merricumbene Creek.

In the lowland sand river valleys, there is some potential for *Sand Rivers* Warm Temperate Rainforest to have once occurred in the vicinity of billabongs and southern (right banks) of these major river systems, but these are now so completely cleared that no evidence was uncovered in a relatively brief search of these valleys. But, as Einstein was once quoted: "Absence of evidence is not evidence of absence". So, it is up to all keen local restorers to come up with the answer remembering that sometimes the past presence of rainforest can only be inferred by association. Your 'site for association' occurs on the Murrah River upstream of Benny Gowings Bridge, so go for it!

Buckenbowra River

These river flats are well watered with (generally) reliable summer rainfall and the soils are fertile. As a consequence, they have had their fertile alluvial flats extensively cleared of their native vegetation. Some of that vegetation would almost certainly have been rainforest (perhaps Gallery and Subtropical Rainforest). However, definitive evidence has yet to be uncovered, so rely on the Rainforest Divination Tool and the advice of local people with more intimate knowledge of the valley.

Araluen Valley

On the eastern side of Dirty Butter Creek, there appears to be Dry Rainforest associated with rock outcrops in the bushland and consequently these are not depleted. However, on the western side of the Araluen valley, there appear to be many depleted and/or damaged rainforest stands in the cleared or partially cleared Grassy Woodlands on granitic geology associated with the Benmanang Range.

- **Dry Rainforest** on hills and slopes with east, north-east and north aspects: in the catchments of the Shellharbour and Benmanang Creeks, and the Deua River tributaries of the Bettowynnd Telowar and Neringia Creeks, there are many remnant Rusty Figs *Ficus rubiginosa*. These occurrences of Rusty Figs and the Grassy Woodlands in which they occur appear analogous to the landscape and ecosystem disposition of the past distribution of Dry Rainforests in the Bega, Brogo Valley and the Warragil Range.
- **Other rainforest types:** possibly Warm Temperate Rainforests associated with gullies and streams running out of the ranges to the: north-west, west, east and south-west of the valley itself (in the catchments of those creeks already mentioned for Dry Rainforest as well as Majors Creek).

Murramarang National Park: coastline

Littoral Rainforest appears to have occurred in all of the gullies supporting rainforest that run off the eastern face of Durras Mountain. The rainforest in the gullies upstream of the coast (on the Permian sediments), most closely matches *Sandstone Scarp* Warm Temperate Rainforest (*sensu* Tindall *et. al.* undated), but when they emerge onto the small coves on the shoreline there are Littoral Rainforest communities present.

- **Warm Temperate Rainforest** in the gully systems of the Park and from the back of the Littoral Rainforest stands at the foot of Durras Mountain upslope to the basalt capping on the summit ridge.
- **Littoral Rainforests** on well drained sediments and cobble berms at the mouths of creeks and gullies, where depleted by the early settlement and associated logging industry (Pebbly Beach), and subsequently, as a result of recreational access, Little Pebbly Beach (the cove to the north) (Yvonne McFarlane pers. comm.) also has depleted Littoral Rainforest.
- **Littoral Rainforests** on the Permian sediment cliffs and gully sides that open out onto these coves: these have been damaged by the loss of the storm shutter of Littoral Rainforests on the gully mouth (for the reasons outlined above). This has been arrested at Pebbly Beach by some very good early restoration works by National Parks and Wildlife Service at Pebbly Beach (Yvonne McFarlane pers. comm.) (Chapter S1: Table S2).

Murramarang National Park: Durras Mountain

The summit of Durras Mountain has a basalt capping. This fertile geology was cleared in the 1800s for dairy farming. It was subsequently abandoned, purchased and added to the Murramarang National Park in 1973. Since that time, a paddock rainforest starter (a furry-leaved form of White Sallow Wattle *Acacia floribunda*) has enabled much of the rainforest to regenerate naturally.

- **Subtropical Rainforest:**
 - **Floristic community:** 'Durras Mountain' Subtropical Rainforest: the old coast road used to traverse the fertile ridge of Durras Mountain and this facilitated the development of farming on the deep red volcanic *krasnozems* that cap this coastal range's ridge line. Detailed floristic lists from Durras Mountain suggest that at least the stands on the eastern side of the summit and the summit ridge itself (both basalt) were Subtropical Rainforest (especially when compared with the pioneer and secondary species regenerating, which are in common with the Subtropical Rainforest at Tilba Tilba). A Subtropical Rainforest floristic community was described by Tindall *et. al.* (undated) as having its southern outlier at Milton (on basalt), but this community only has a 45% species similarity. For this reason, it has been described as the new FC *Durras Mountain* Subtropical Rainforest in this study (see Appendix S1: worksheet: Rainforest depletion; Appendix S6: worksheet: All species). Previous suggestions by Miles and Kendell (2006), that the eastern stands on the mountain are Littoral Rainforest appear to be only partially accurate based on field checking by the author (see Murramarang National Park coastline above) and their tentative treatment of this mapping as unvalidated Littoral Rainforest is to be commended. Downslope of the ridge the regenerating Subtropical Rainforest abuts *Sandstone Scarp* Warm Temperate Rainforest, which is typical of the less fertile Permian sediments of the region, though it is at a lower elevation than reported by Tindall *et. al.* (undated). The Warm Temperate Rainforest was not cleared and is not depleted at this locality because of its infertility and steepness – also noted for this type throughout its range (Tindall *et. al.* undated). The Littoral Rainforests spoken of by Miles and Kendall only occur within several hundred metres of the coastline. Since the old farming area was brought in 1973 and added to the Murramarang National Park, the area has been naturally regenerating through the auspices of a broad range of paddock rainforest starters (see Chapter 1: Opener).

East Gippsland (South Eastern Highlands Bioregion)

This area, like New South Wales, has many rainforest communities that are largely intact from the land clearance perspective. All are threatened by global warming (loss of habitat, drying climate and increased fire frequency and intensity) and Sambar. Sambar is a clear and immediate threat, with substantial damage documented by Peel *et. al.* (2005). To date, there is little to do in the rainforest restoration context except to come up with an effective landscape-scale control measure for Sambar, and to prepare for the mega-fires that now threaten the region. Otherwise, maintain a watch and monitor for the threats that are beginning to move into this bioregion and act on them as soon as they become apparent.

Mountains and montane plateaux

Although the observed impacts of Sambar on rainforests are currently the most severe in the South East Corner Bioregion (at lower elevations, for which they were listed in 2007 as a Potentially Threatening Process under Victoria's *FFG Act*) Sambar are known from the mountains of Tulloch Ard (Craig Ingram pers. comm.), which is the divide between the Murrindal and Snowy River catchments. Thankfully, a search for them in the Cool Temperate

Rainforests at Betts Creek in September 2006 failed to find any clear evidence of deer impacts at the present time. A further search for deer damage in the Cool Temperate Rainforests of Murrungowar Range showed that deer are working their way up Murrungowar Road and there is obvious damage to rainforest only 7km away from the nearest Cool Temperate Rainforest stands on that road. For this reason, and the likely impacts of global warming (Chapter S1), the East Gippsland Cool Temperate Rainforest floristic communities are also included in the Manual for restoration, in recognition of the imminent arrival of deer and the likely impacts they will have on these rainforests (as is already occurring in New South Wales section of the South Eastern Highlands Bioregion). By finding an effective landscape-level population control for Sambar, these rainforests could be spared the horrors of what is taking place in the rainforests of lower elevations in the region. Climate change (particularly megafires) is a clear and imminent threat to all rainforest types of the Bioregion.

In this bioregion, rainforests are largely restricted to steep montane gullies with south or east aspects. On rare occasions, and on the wettest plateaus such as the Errinundra Plateau, rainforests may extend over saddles between gullies and onto the plateau itself.

- **Cool Temperate Rainforests** are usually restricted to steep mountain gullies above 900m elevation and adjoining ridges and slopes, where rainfall is high, temperatures are cool and there is often abundant cloud cover. Overlap Cool Temperate Rainforest communities occur between 533 and 870m (Peel 1999). The threats to this rainforest EVC are the same as those listed for the New South Wales entry for Mountains and montane plateaux under the South Eastern Highlands Bioregion.
 - **Floristic communities represented** (*sensu* Peel 1999):
 - *East Gippsland Cool Temperate Rainforest*
 - *East Gippsland Montane Riparian Cool Temperate Rainforest*
 - *East Gippsland Montane Scrub Cool Temperate Rainforest*
 - *East Gippsland Overlap Cool Temperate Rainforest*.

East Gippsland (South East Corner Bioregion)

Initial losses of rainforests were largely restricted to land clearing for agriculture on arable land (particularly river valleys) as well as on flatter land near the coast for port infrastructure. More recent clearing has occurred for urban development, subdivision, grazing and coastal recreation. Major ongoing damage and degradation of rainforests are still continuing with weed invasion and deer colonisation.

Foothills

The foothills of this region are replete with rainforest stands that are relatively remote. This isolation has ensured that many stands have remained largely safe from weed invasion and clearing (although wildfire and logging have affected some stands). The Gippsland Forest Management Plan (DSE 2004c) and the Management Procedures for Timber Harvesting (DSE 2007a) set in place buffer zones around rainforest stands in areas to be logged and this has substantially improved the lot of rainforests where forestry operations occur. However, buffers remain inadequate, and the best protection is reserved for those stands with the highest conservation significance (*sensu* Peel 1999) and this is not going to protect other less fortunate stands of lower conservation significance from ecotone disruption and the development of dense and highly flammable regrowth eucalypt forests. During wildfires, these regrowth forests represent a greater fire threat than the preceding old-growth forests: a risk immeasurably increased by the impacts of climate change across the region and the mega-fires that are occurring there.

Today, the risks to rainforest brought about by logging are joined by those from deer, global warming and weed invasion. Deer damage has been extensive along the Mitchell and Snowy Rivers, where Warm Temperate, Dry and Gallery Rainforests are the most severely affected. It is likely that these effects are also present on the intervening Nicholson, Tambo, Buchan and Murrindal River catchments, though these sites have not been specifically searched for these impacts.

Weed invasion in the foothills has begun to take hold (particularly along the river valleys), with Blackberry invasion prominent as a result of logging and logging roads. Some of the specific sites mentioned below fall into this category, though most of the areas discussed in detail have been cleared for agriculture.

As time goes on, and the geographic extent of impacts of deer is more fully documented, it is clear that there will be a major restoration task to repair the damage that they are currently causing in the foothills and lowlands of East Gippsland. Restoration of deer damage is already required around the Gippsland Lakes, Lake Tyers and on the Snowy River and in the Eden district. Although it is currently thought that the major culprit is Sambar, it may well include Fallow and Red Deer, both of which have feral populations in East Gippsland.

Other rainforest ecological vegetation classes and floristic communities occurring on fertile flatter land (cleared for agriculture) also occur on land valued for other purposes such as urban development or coastal recreation. It is these areas that have suffered the greatest consequences of human activity to date, and it is these that are (at present) most in need of restoration.

Rainforests in this part of the landscape were largely restricted to the steep south- and east-facing gullies or on the river flats of intermontane basins such as the Buchan and Combienbar Rivers and the lower floodplains of the Mitchell, Nicholson, Tambo, Gippsland Lakes, Snowy, Brodribb and Bemm Rivers.

- **Warm Temperate Rainforests** of the foothills are dominated by Blue Oliveberry *Elaeocarpus reticulatus*, Muttonwood *Myrsine howittiana* and Sweet Pittosporum *P. undulatum* and Lilly Pilly *Syzygium smithii*. Vines are prominent as are ground ferns and tree-ferns.
 - **Floristic communities present** (*sensu* Peel 1999):
 - *East Gippsland Overlap* Warm Temperate Rainforest is restricted to the foothills surrounding the Errinundra Plateau and Mount Ellery in steep gullies at elevations between 500 and 700m.
 - *Coastal Ranges Overlap* Warm Temperate Rainforest largely occurs in New South Wales, where it has been named by Floyd (1990) as a Cool Temperate type Sub-alliance No. 55: *Eucryphia-Syzygium*, also known as Community (a) *Eucryphia moorei* (Austin and Sheaffe 1976). Keith and Bedward (July 1999) named this community Coastal Warm Temperate Rainforest: *Syzygium smithii* / *Eupomatia laurina* / *Cissus hypoglauca*. In Victoria, it is restricted to the creek and gully systems that run south-westwards from the Howe Range into Mallacoota Inlet. This includes Harrisons Creek and Dowell Creeks. It is more widespread in New South Wales where it occurs at Maxwells Creek, Watergums Creek and Wandella, with scattered pockets in the higher foothills as far north as Moruya (Peel 1999).
 - *Alluvial Terraces* Warm Temperate Rainforest occurs at elevations of less than 470m on the alluvial flats of creeks and rivers from the Mitchell River National Park to the Genoa River flats north-west of Mallacoota (Peel 1999). Based on research in the last 8 years by the author, this floristic community is considered to be endemic to East Gippsland, contrary to the earlier advice of Peel (1999), who suggested it may occur into New South Wales as far north as the Wadbilliga River west of Narooma. It was once widespread both in the foothills and on the coastal lowland floodplains of the major rivers of East Gippsland, where it has been preferentially cleared for its fertile and well-watered soils. It has largely been lost from the foothill reaches of the Buchan and Murrindal Rivers, but some good examples remain on the Brodribb, Combienbar, Bemm and Thurra Rivers (though most of these remain threatened by mega-fires, weed invasion and Sambar).
 - *East Gippsland Foothills* Warm Temperate Rainforest occurs in the steep gullies of the hills of East Gippsland north of the Princes Highway from Buchan to the Wingan River at elevations of between 20 and 750m, with most sites at elevations of greater than 100m. Although this floristic community has largely escaped clearing, it is increasingly being degraded by Sambar and is at great risk from mega-fires.
 - *Hinterland* Warm Temperate Rainforest occurs in the foothills between Cann River and Mallacoota, and faces similar threats to those listed for *East Gippsland Foothills* Warm Temperate Rainforest.
- **Gallery Rainforests** occur along the margins of streams of the lower foothills and broader lowland river valleys of the Mitchell, Buchan, Murrindal, Brodribb, Bemm, Combienbar, Errinundra and Cann Rivers. They occur at elevations up to 600m. Gallery rainforest is characterised by the dominance of Kanooka *Tristaniopsis laurina* and a general paucity of large woody vines and tree-ferns, though ground ferns are the dominant life-form of the ground stratum. These rainforests are particularly at risk of riparian transforming weeds such as Cape Ivy **Delairea odorata*, Wandering Jew **Tradescantia fluminensis*, Blue Periwinkle **Vinca major* and, with the advent of climate change, Madeira Vine **Anredera cordifolia*. Other threats include deer and climate change.
 - **Floristic communities present** (*sensu* Peel 1999):
 - *Perennial Streams* Gallery Rainforest (on permanent streams).
 - *Ephemeral Streams* Gallery Rainforest (on intermittent streams).
- **Dry Rainforests** were always very rare in this region. These are (or were) found along the rocky gorges and riverine cliffs of the Mitchell (on Devonian mudstones and redbeds as well as feldspar-rich rhyolites). The dominant canopy species are Muttonwood *Myrsine howittiana* and Sweet Pittosporum *P. undulatum*. There are usually emergent Kurrajongs *Brachychiton populneus* present at most sites. They are at risk from loss of habitat, deer (particularly Sambar), feral goats and weed invasions.
 - **Floristic communities present** (*sensu* Peel 1999):
 - *Gorges* Dry Rainforest at elevations between 50 and 180m on all geologies other than limestone along the Mitchell River and Genoa River in Victoria only (Peel 1999).

- *East Gippsland Karst Dry Rainforest*: these rainforests are restricted to the Buchan and Murrindal Valleys, as well as a small area around Jacksons Crossing on the Snowy River (in Victoria only), where they exclusively occur on Devonian limestones (Peel 1999) at elevations of 50-300m and have been almost entirely cleared and grazed. Stands occurring on Tertiary limestones around the Gippsland Lakes classified as Dry Rainforest by Peel (1999) have now been described as several floristic communities of Littoral Rainforest (Peel in prep.).

Lowland river valleys

Warm Temperate and Littoral Rainforests are severely damaged by Sambar and Hog Deer around Lake Tyers and Ewings Marsh, with the infestation moving eastward from the Snowy River. Global warming (rising sea levels, changes in frequency and intensity of storms) also threaten Littoral Rainforests on dunes, cheniers, estuarine deltaic deposits and estuarine islands. Increases in the severity of weather events will likely put existing shorelines (and Littoral Rainforest habitat) at risk of catastrophic erosion and accelerate the rate of re-activation of marginal bluffs that also support Littoral Rainforest.

The fertile river flats of East Gippsland have been a major agricultural asset for more than one hundred years and clearing for this purpose has been the primary agent for the loss of Littoral Rainforests along the estuarine reaches of rivers and Gallery Rainforest and Warm Temperate Rainforest along the freshwater reaches. These flats were cleared because of their fertile well-watered soils and amenable (warm lowland) climate. Large areas of the vegetation that used to occur on these river flats were rainforests (Map 3). Key localities include the Mitchell, Nicholson, Tambo, Buchan, lower Snowy, Brodribb, Cann, Genoa and Wallagaraugh rivers, as well as the major creeks: Maringa, Bunga, Cabbage Tree and Tonghi, Carlo, Dowell and Harrisons. Three ecological vegetation classes of rainforest used to occur on these river flats, depending on the landform, flood-energy and river reach involved (Peel 1999 and this publication). The following rainforest types were found along the freshwater reaches of these lowland streams.

- **Warm Temperate Rainforest** occupied the higher levees of major rivers and the alluviums of smaller streams where the flood force is less than that for Gallery Rainforest habitat. This rainforest type occurred from the Mitchell River in the west to the Genoa River in the east and fits hand-in-glove with the habitat and distribution of Gallery Rainforest. This rainforest in East Gippsland is dominated by a dense canopy of Muttonwood *Myrsine howittiana*, Sweet Pittosporum *P. undulatum* and Lilly Pilly *Syzygium smithii*, (Peel 1999). Threats are the same as for EVCs in the *Foothills*.
 - **Floristic communities present** (*sensu* Peel 1999):
 - *East Gippsland Coastal* Warm Temperate Rainforest was once widespread along the narrow (often Tertiary limestone-derived) gully systems around the lower reaches of the Mitchell, Nicholson and Tambo Rivers, the Metung to Lake Bunga area of the eastern Gippsland Lakes, and the lower Snowy River valley: localities from which they are now largely cleared. Some (until recently) largely intact examples used to occur around Lake Tyers (Toorloo Arm and Nowa Nowa Arm), but these are in an advanced state of degradation (due to Sambar). Weeds, grazing and subdivision and urbanisation are major threats to this community.
 - *Alluvial Terraces* Warm Temperate Rainforest occurs at elevations of less than 470m on the alluvial flats of creeks and rivers from the Mitchell River National Park to the Genoa River flats north-west of Mallacoota (Peel 1999). Based on research in the last 8 years by the author, this floristic community is considered to be endemic to East Gippsland, contrary to the advice of Peel (1999), who suggested it may occur into New South Wales as far north as the Wadbilliga River west of Narooma. It was once widespread both in the foothills as well as on the coastal floodplains of the major rivers of East Gippsland where it has been preferentially cleared for its fertile and well-watered soils. This vegetation is almost completely cleared from the lowland river valleys and their associated smaller streams that include: the Mitchell, Nicholson and Tambo Rivers, Maringa and Bunga Creeks, Snowy and Brodribb Rivers, Cabbage Tree Creek, Bemm River, Tonghi Creek, Cann River, Carlo Creek Wingan River, Genoa River and Wallagaraugh Rivers. This floristic community used also to occur in the associated large gullies with alluvial flats that joined these streams. Major threats include weed invasion by riparian transforming weeds (see *Foothills* entry for this FC), deer and the effects of climate change.
- **Gallery Rainforest** used to occupy the high flood energy toe of the bank and the bank proper of streams from the Mitchell River in the west to the Genoa River in the east. Fortunately, many fine examples of this still remain (Bemm River, Thurra River, etc.). Gallery Rainforest is characterised by a canopy of Kanooka *Tristaniopsis laurina* and few vines with a ferny understorey that lacks tree-ferns. The latter two life-form categories are absent because of the frequent flooding (Peel 1999). Threats are the same as for EVCs in the *Foothills*.

- **Littoral Rainforest** grows along the estuarine (saline) lower river reaches (on deltaic deposits such as levees, spits and islands) from the Mitchell River in the west to the Genoa River in the east. It is characterised by few ferns and a range of rainforest-adapted coastal species including: Coast Wattle *Acacia sophorae*, Coast Banksia *B. integrifolia*, Common Boobialla *Myoporum insulare*, Seaberry Saltbush *Rhagodia candolleana* and New Zealand Spinach *Tetragonia tetragonoides* that in the driest niches occur in conjunction with Muttonwood *Myrsine howittiana*, Sweet Pittosporum *P. undulatum* and Lilly Pilly *Syzygium smithii* in the wetter climate zones on the Snowy and Brodribb to Wingan River estuaries (Peel in prep.). Threats to this rainforest EVC include deer, and the effects of climate change (Appendix S1: worksheet: Rainforest depletion).

Cliff systems of the lowland and foothill river valleys

Geology and aspect play a role in the distribution of rainforest ecological vegetation classes on these landforms (Figure S235). The primary threats have been land clearing and grazing by domestic stock. Increasingly, garden and farm plants are now becoming transforming weeds in rainforest in this district as are various species of deer.

- **Gorges Dry Rainforest** used to grow on the sandstone cliffs associated with the Mitchell River upstream of the Calulu Bridge to the Mitchell River National Park. Many are severely degraded by clearing, grazing and weed invasion. There are usually emergent Kurrajong *Brachychiton populneus* with a dense canopy layer of Sweet Pittosporum and Muttonwood.
- An undescribed type of **Dry Rainforest** of the lower Mitchell River valley that occurred on riverine cliffs downstream of the Glenaladale on Tertiary outwash loams. It probably had emergent Yellow Box, Coast Grey Box *Eucalyptus bosistoana* and Forest Red Gum *E. tereticornis* ssp. *medianus*. The canopy (based on limited numbers of remnants) included: Coast Banksia *B. integrifolia*, Large-leaf Bursaria *B. spinosa* var. *macrophylla*, Cherry Ballart *Exocarpos cupressiformis*, Gippsland Hemp Bush *Gynatrix macrophylla*, Sweet Pittosporum *P. undulatum* and, curiously, Kanooka *Tristaniopsis laurina*. The rainforest gaps would have been grassy and there are a number of saltbushes present including Nodding Saltbush *Einadia nutans*, Saloop Saltbush *E. hastata*, Seaberry Saltbush *Rhagodia candolleana* and Berry Saltbush *Atriplex semibaccata*.
- **Littoral Rainforest** used to grow on the limestone cliffs with north or west aspects along the Mitchell, Nicholson, Tambo and Snowy Rivers. It grows in the freshwater reaches of these river valleys because of the connate salts retained in this relatively young marine limestone geology. Dominant plants include a range of emergents that include eucalypts (especially if cliffs are subject to landslides) as well as Coast Banksia *B. integrifolia* and Limestone Blue Wattle *A. caerulescens* and a canopy dominated by Muttonwood *Myrsine howittiana* and Sweet Pittosporum *P. undulatum* on the driest aspects. On southern and eastern aspects, another Littoral Rainforest floristic community once grew and here the dominant canopy species also included Yellowwood *Acrorychia oblongifolia* and Lilly Pilly *Syzygium smithii*.

Gullies of the Bairnsdale Foothills

These gullies occur on the near-coastal plain from Iguana Creek at Glenaladale to the lower reaches of the Snowy River downstream of Bete Belong. Land clearing for agriculture, weeds and feral deer are the primary threats to rainforest in this district. They are characterised by three major geology types.

- **Gorges Dry Rainforest** occurs on Ordovician sandstones and Devonian mudstones and has a grassy understorey that is protected from fire in a similar fashion to that found in the Bega-Brogo river valleys by surrounding Grassy Woodlands. These rainforests occurred on valley sides of sandstones capped by Tertiary outwash along the northern valley side of the Mitchell River between Glenaladale and the Wuk Wuk Bridge. They were dominated by Yellowwood *Acrorychia oblongifolia*, Kurrajong *Brachychiton populneus*, Gippsland Hemp Bush *Gynatrix macrophylla*, Muttonwood *Myrsine howittiana* and Sweet Pittosporum *P. undulatum*, with an emergent overstorey of Yellow Box *E. melliodora* and Forest Red Gum *E. tereticornis*. Relatively intact versions still remain in the Mitchell River National Park above the pumping station water off-take.
- **East Gippsland Coastal Warm Temperate Rainforest**, with its ferny understorey, occurred along steep gullies composed of Tertiary limestones and marls on the Mitchell River from the Wuk Wuk Bridge downstream to Bairnsdale, along the Nicholson and Tambo rivers downstream of the Great Alpine Road. It was also once extensive in the gullies that drain onto the northern shore of the Gippsland Lakes as well as Lake Bunga (east of the Tambo River downstream of the Princes Highway) and Lake Tyers to Petman's Beach (downstream of the Buchan-Nowa Nowa Road and the Princes Highway in the east). This floristic community grows on the valley or gully sides on moist fire-protected, south or eastern aspects. The gully floor hosts *Alluvial Terraces* Warm Temperate Rainforest: another fern-rich rainforest community of East Gippsland (Peel 1999).

The Gippsland Lakes

There are five primary agents of rainforest loss in this district, and a fifth that is imminent. The first two are subdivision of past and current habitat (foreclosing options for the recovery of the component EVCs; EGRCMN 2007), and clearing for agriculture and coastal townships. The third is more recent: garden escapee plants that have become, or have the prospect of becoming, transforming weeds of rainforest in this area. The fourth is now a serious and increasing loss of rainforest as the result of browsing by feral deer (primarily Sambar and Hog Deer), which are currently causing the loss of rainforest plant species and areas of rainforest. The fifth is global warming (declining rainfall, change in seasonality of rainfall, increasing temperatures, rising sea levels and changes to the frequency and severity of storm events), which threatens all Littoral Rainforests.

This area is characterised by a range of landforms associated with the estuarine system that host Littoral Rainforest along the northern shore of the Lakes as well as around Lake Bunga – the seacoast between this lake and Lake Tyers – as well as around Lake Tyers itself.

- **Littoral Rainforest** (see entry under Lowland River Valleys). Much of the former habitat of Littoral Rainforest, particularly the flatter sandy sites around the Lakes have been cleared: Tambo Bay, Metung, Fraser Island, Rigby Island, Bell Point and Lakes Entrance. Other habitats to suffer significant losses include the low-lying levees (0.3-1.5m above average water levels) beside the estuarine reaches of the Mitchell, Nicholson and Tambo Rivers (including their attendant silt jetties), and the steeper limestone marginal bluffs along the northern lakeshore of the Gippsland Lakes east of Metung. The limestone bluffs have had less land cleared (except in the North Arm, Lake Bunga and lower Lake Tyers), but most of what remains is either severely weed-invaded or at risk of weed invasion due to their proximity to cleared farmland or the urban centres of Metung, Nungurner, Lakes Entrance, Lake Bunga and Lake Tyers.

Marlo Estuary (including Lake Wat Wat and Coringle Slips)

There are four primary agents of rainforest loss in this district, the first two being clearing for agriculture and coastal recreation. The third is more recent: garden escapee plants are becoming serious transforming weeds of rainforest in this area. There is also now a serious and increasing loss of rainforest as the result of browsing by feral deer (primarily Sambar and Hog Deer).

- **Littoral Rainforest** (see entry under Lowland River Valleys). Sites around the estuary that carry, or once used to carry, Littoral Rainforest include the lower estuarine reaches of the Snowy River, including not only the whole levee (downstream of Lochend Jungle) but also includes the lower bank as far upstream as Orbost because of the Snowy Mountains Scheme has robbed the river of 80% of its headwater freshwater flows. The Littoral Rainforest habitat of the Brodribb River extends on to the low lying levees as far upstream as the Brodribb Flora Reserve. The balance of the Littoral Rainforest habitats surround the Marlo Estuary and include the lower Coringle Creek downstream of Coringle Road, Coringle Slips, the hind dunes and cheniers between east Coringle Beach access and the west Coringle Beach access and the shores and marginal bluff systems associated with Lake Wat Wat and Lochend Jungle.

Rain shadow river valleys on limestone (Buchan-Murrindal valleys)

The foothills in general are more intact than most of the flatter areas of East Gippsland. However, some foothill basins such as the Buchan and Murrindal river valleys have suffered disproportionate clearing of rainforests because of their moderate rainfall combined with fertile river flats and limestone valley geology.

- **Warm Temperate Rainforest** is also likely to have once occurred on the river flats of the Murrindal River (a warm river valley) and within 1km upstream of the East Buchan Bridge on the Buchan River where it is warmed by the inflow of the Murrindal Rive and the Snowy River downstream.
- Small areas of **Gallery Rainforest** occur at the foot of Dry Rainforest stands at the Anticline and the Pyramids on the Murrindal River and at Spring Creek in the Buchan Caves Reserve. Gallery Rainforest is likely to have once occurred along most sections of the Murrindal and Buchan Rivers and their associated larger streams that are topographically and grassy ecosystem (Limestone Grassy Woodland) protected.
- **Dry Rainforest** is still present as one last (but magnificent) stand on the limestone cliffs at the Anticline and a more minor occurrence at Murrindal and on cliffs and dolines at the Pyramids on the Murrindal River (Figure 3.11). Similar landforms (particularly steep north- and east-facing cliffs and slopes along rivers surrounded by Limestone Grassy Woodland) exist on the Buchan River that would have almost certainly hosted Dry Rainforest stands in the past (Figures 3.12 and 3.13).

Central Highlands (South Eastern Highlands Bioregion)

In this bioregion, rainforests are largely restricted to steep montane gullies or the gullies of gentler topography in high rainfall regions where there is a south or east aspect. Less commonly, rainforests may extend over saddles between gullies and onto the plateaux themselves on the wettest massifs such as the Lake Mountain, Mt. Donna Buang, Lake Mountain, Toorongo Plateau and the Baw Baws.

- **Cool Temperate Rainforests** are usually restricted to steep mountain gullies above 228m elevation and adjoining ridges and slopes, where rainfall is high, temperatures are cool and there is often abundant cloud cover. For global warming threats and actions, see the New South Wales entry for the South Eastern Highlands Bioregion. Because these rainforests are dominated by Myrtle Beech *Nothofagus cunninghamii*, they are under severe threat from Myrtle Wilt: a fatal disease of the dominant canopy tree and one that is exacerbated by any forestry or road building that damages these trees (Packham *et. al.* 1992; Cameron and Turner 1996).
 - **Floristic communities represented** (*sensu* Peel 1999):
 - *Central Highlands Cool Temperate Rainforest*
 - *Central Highlands Montane Riparian Cool Temperate Rainforest*
 - *Central Highlands Montane Scrub Cool Temperate Rainforest*.

There have been extensive losses of Cool Temperate Rainforests across this region as the result of recurrent wildfire and Myrtle Wilt and, to a lesser degree in one district, through land clearing.

Landscape level loss (fire, Myrtle Wilt and weeds)

Recurrent high intensity wildfire is able to kill the dominant canopy species of this rainforest, with significant areas burnt by the 1926 and 1939 wildfires (Peel 1999). The prospects for this rainforest type with the advent of mega-fires appear particularly dire.

Any disturbance that damages Myrtle Beech *Nothofagus cunninghamii*, or exposes stands containing this species to damage, can exacerbate the spread of Myrtle Wilt, which is fatal to the dominant canopy tree of Cool Temperate Rainforest (Cameron and Turner 1996), the dominant species in this region. Forestry operations and road infrastructure have damaged significant areas of Cool Temperate Rainforest dominated by Myrtle Beech in this region (Peel 1999). Subsequent loss of structural integrity and the resulting diminution of sub-canopy humidity and moisture lead to a loss of moisture-dependent species, drier fine fuels and a consequent greater vulnerability to fire.

Weed invasion that has developed in association with road building and timber harvesting are a significant threat to Cool Temperate Rainforest in the region, with Glandular Willow-herb **Epilobium ciliatum* and Blackberry **Rubus fruticosus* spp. agg. being the worst (Peel 1999).

Montane plateaux

The woodland form of this community is being lost to timber harvesting, while those along streams are being damaged as the result of snow recreation infrastructure and the maintenance of ski runs on Mt. Baw Baw and Lake Mountain (Peel 1999).

Altered stream flow regimes

The diminution of stream flow as the result of the conversion of old-growth forests to regrowth forests following logging and/or wildfire has a significant impact on streams that are the habitat of *Central Highlands Montane Riparian* Cool Temperate Rainforest (Peel 1999).

Central Highlands (Australian Alps Bioregion)

Cool Temperate Rainforests in this bioregion are associated with the Baw Baw Plateau and other smaller massifs (Lake Mountain and Mt Donna Buang).

- **Cool Temperate Rainforests** occurs at the interface between the montane and sub-alpine environment as low scrubs. The woodland forms of these rainforests have suffered depletion through logging (Davies cited in Peel 1999), while the scrub forms have been depleted by road building and the development of ski trails. With global warming, these rainforests will increasingly lose their habitat as climatic zones migrate up the topographic profile and the increasing temperatures expose the dominant tree (Myrtle Beech *Nothofagus cunninghamii*) to the fatal disease of Myrtle Wilt (which is endemic at lower altitudes).

Otway Ranges (South Eastern Highlands Bioregion)

In this bioregion, rainforests are largely restricted to steep gullies of the low hills of this coastal range with south or east aspects. Less commonly on the wettest areas (in the western portion of the range and at its highest points), they also occurred in north and west-facing gullies and even spilt out of these gullies and occupied saddles and whole hillsides. These areas have been cleared for agriculture, though there are extensive *oldfield scrubs* of Blackwood *Acacia melanoxylon* and Satinwood *Nematolepis squamea* that are recovering this former Cool Temperate Rainforest, which offer excellent prospects for rainforest restoration in the Lavers Hill to Weeaprouna district, should the locals take up the cause. But be quick because these forests are beginning to collapse and now

is the time to act by introducing Myrtle Beech. Extensive stands of Cool Temperate Rainforest occur on the lowland river flats of the western end of the Range.

- **Cool Temperate Rainforests** are usually restricted to the highest rainfall zones of the range (whereby climate provided fire protection in the past) on almost any landform, but retreating into deeper and steeper gullies in sections of the range as the rainfall declined. For global warming threats and actions: see the New South Wales entry for the South Eastern Highlands Bioregion.
 - **Floristic communities represented** (*sensu* Peel 1999):
 - *Otways* Cool Temperate Rainforest; and
 - *Otways Redwater* Cool Temperate Rainforest.

The advice provided under Central Highlands (South Eastern Highlands Bioregion) regarding the impacts of Myrtle Wilt and weed invasion on the Cool Temperate Rainforests also applies to this region where the impacts of Myrtle Wilt have been even more severe than in the Central Highlands.

Land clearing has occurred both on the lowland river flats and slopes as well as on the gently undulating country associated with the western and highest parts of the Range. Land was cleared both for agriculture and timber plantations (Peel 1999) and there have undoubtedly been significant losses of Cool Temperate Rainforest in these areas of the Otway Ranges during this process.

Strzelecki Ranges (South Eastern Highlands Bioregion)

Foothill gullies and narrow river valleys

As far as is known, there is only one lowland Warm Temperate Rainforest community found in this high rainfall and geologically fertile area of West Gippsland. It was described from relatively little field data and the floristic community is (not surprisingly) called *Strzeleckis* Warm Temperate Rainforest (Peel 1999).

It was historically found in fire-protected south- and east-facing gullies between 80 and 240m all around the Strzelecki Ranges (Peel 1999), though more recent field work suggests it may have occurred close to sea level where the Range meets Corner Inlet. Today, few remnants remain and these can be found as widely dispersed patches around the foothills of the ranges from Macks Creek near Yarram in the east to the catchment of the Korumburra water supply (No. 2 Reservoir on Ness Creek) in the west to the Agnes Falls and the lower reaches of the Deep Creek in the south and along its northern margin in the Morwell National Park (Peel 1999).

It is possible that a more fern-rich alluvial terraces version used to once occur on larger creeks and river flats with good fire protection and/or high rainfall (>1200mm). Local people may well be aware of such examples. In any event, rainforest restorers in this region should seek out such examples as reference sites, if they exist, before undertaking restoration in such habitats.

Higher elevation gullies and slopes

These once hosted Cool Temperate Rainforest but have been significantly modified as the result of past land clearing and, in some cases, ongoing, timber operations. See the advice under the Central Highlands (South Eastern Highlands Bioregion) treatment for the implications of these ongoing disturbances to Cool Temperate Rainforest in the Strzelecki Ranges.

Wilsons Promontory (Flinders Bioregion)

Lowlands and montane peaks

Threats include climate change, fire and deer. Areas of regrowth dominated by secondary species (e.g. Sealers Creek) should be monitored for primary rainforest recovery. If this is failing, then the ecological brake should be identified and the necessary rainforest restoration processes begun.

- **Overlap Warm Temperate Rainforest** is found in gullies, broad river valleys and at lower elevations, where fire and past logging have caused considerable disruption (Peel 1999).
- **Cool Temperate Rainforest** occurs on the highest mountain peaks where there has been significant depletion through wildfire (Peel 1999).

SUMMARY	
COMPREHENSION: STOP	<p>Consider whether rainforest has been lost from your site.</p> <p>From where has it been lost?</p> <p>Is the rainforest in your care, depleted, in poor health or both?</p>
KNOWLEDGE: THINK	<p>What do these discoveries mean for the site and you?</p> <p>Do you want to make amends and actively manage the site for the return or repair of the rainforest?</p> <p>If so, where would you turn?</p>
WHAT TO DO?: ACTION	<p>You will need to become informed about what type of rainforest used to occur there.</p> <p>Where are your nearest reference sites (so you can understand and see what is missing)?</p> <p>Do you have the knowledge to begin and sustain a rainforest restoration project?</p> <p>Do you have the necessary resources to undertake such commitment?</p>
WHAT NEXT?	<p>There is a whole kit of information and tools that you will need to be across before you set out and start a rainforest restoration project.</p> <p>THE RAINFOREST RESTORATION MANUAL HAS BEEN PRODUCED JUST FOR YOU!</p>