APPENDICIES

Appendix 1. (a) Ecological Vegetation Class (EVC) description and dominant species list for Gippsland Plain bioregion and Lowland Forest EVC. All information from:

RFA (1999) *Regional Forest Agreements, Victoria* (online), http://www.rfa.gov.au/rfa/vic/gipps/raa/biodiv/index.html [Accessed April 2002].

Gippsland Plains Lowland Forest is only recorded from the pre-1750 mapping project. It would have occurred on the Tertiary and early Pleistocene terraces of the Perry land system, often in a mosaic with Damp Sands Herb-rich Woodland on the plains south and west of Moormung State Forest. This depleted floristic community is only found today in a few road reserves in the area where it has been mapped as Depauperate Lowland Forest due to a high fire frequency over time resulting in a very species depauperate understorey. Soils consist of aeolian and marine sands of low dunes with a clay base which can be penetrated by shrub and tree roots. Elevation is in the range of 5 to 120m above sea level and annual average rainfall is approximately 550-700 mm.

This floristic community would have had an overstorey dominated by White Stringybark *Eucalyptus globoidea* and But But *E. bridgesiana* with a dense understorey of smaller trees and shrubs including Blackwood *Acacia melanoxylon*, Lightwood *A. implexa*, Silver Wattle *A. dealbata*, Spike Wattle *A. oxycedrus*, Shiny Cassinia *Cassinia longifolia*, Hop Bitter-pea *Daviesia latifolia*, Burgan *Kunzea ericoides,* Silver Banksia *Banksia marginata* (tree-form), Purple Coral-pea *Hardenbergia violacea* and Smooth Parrot-pea *Dillwynia glaberrima*. A dense ground cover of bracken, grasses and forbs would have included Austral Bracken *Pteridium esculentum*, Grey Tussock-grass *Poa sieberiana*, Kangaroo Grass *Themeda triandra*, Weeping Grass *Microlaena stipoides*, Common Raspwort *Gonocarpus tetragynus,* Germander Raspwort *G. teucrioides*, Small Poranthera *Poranthera microphylla*, Common Lagenifera *Lagenifera stipitata* and *Glycine* spp. Thatch Saw-sedge *Gahnia radula*, Spiny-headed Mat-rush *Lomandra longifolia* and Wattle Mat-rush *L. filiformis* would also have been present.

Latrobe Valley Lowland Forest is found across the Gippsland plains but includes areas south of Traralgon at Gormandale. It grows on loose, light-grey to white sandy topsoil over a cemented gravel, clay or sand subsoil. The sandy topsoil promotes the occurrence of various healthy understorey species that reflects a floristic association with Heathy Woodland. Average annual rainfall is 800-900 mm and elevation is 180-220m above sea level.

The overstorey is usually dominated by Yertchuk *E. consideniana,* Narrow-leaf Peppermint *E.radiata* but *E. obliqua* and *E. viminalis* ssp. *pryoriana* may also be present. Species in the shrub layer include Sunshine Wattle *Acacia terminalis*, Burgan *Kunzea ericoides*, Showy Bossiaea *Bossiaea cinerea*, Prickly Tea-tree *Leptospermum continentale*, Common Heath *Epacris impressa,* Snow Daisy-bush *Olearia lirata*, Broom Spurge *Amperea xiphoclada* and scattered Saw Banksia *Banksia serrata.*

The ground layer includes dense Austral Bracken *Pteridium esculentum* in addition to Common Raspwort, *Gonocarpos tetragynus*, Thatch Saw-sedge *Gahnia radula* and Tussock-grass *Poa sp.*

Appendix 1. (b) Ecological Vegetation Class (EVC) description and dominant species list for Strezlecki Ranges bioregion and Damp Forest EVC.

Damp Forest is widespread in Gippsland in moderately fertile areas between Wet Forest, the drier end of Shrubby Foothill Forest and the driest forest types such as Lowland Forest, Herb-rich Foothill Forest, and Heathy Woodland. It develops on the drier sites in Wet Forest or on the margins of Warm Temperate Rainforest. It also occurs on protected slopes associated with *Tussocky* Herb-rich Foothill Forest, Lowland Forest or even Heathy Woodland, provided topographic protection is sufficient.

In the lowlands and dissected country below 700m Damp Forest favours gullies or eastern and southern slopes. Above this elevation and in higher rainfall zones the effect of cloud cover at ground level and the subsequent fog drip permits this class to expand out of the gullies onto broad ridges and northern and western aspects. It occurs on a wide range of geologies and soils are usually colluvial, deep and well-structured with moderate to high levels of humus in the upper soil horizons (Woodgate *et al*. 1994). Rainfall is approximately 800-1600 mm per annum and elevation ranges from sea level in South Gippsland to up to 1000m in the montane areas where it merges into Montane Damp Forest.

The dominant eucalypts are commonly Messmate *Eucalyptus obliqua* and Mountain Grey Gum *E. cypellocarpa*. A range of other species may be present as well such as Yellow Stringybark *E.muelleriana* (in South Gippsland with Sticky Wattle *Acacia howittii* present in the understorey), Silvertop *E.sieberi*, Gippsland Blue Gum *E .globulus* ssp. *pseudoglobulus*, Narrow-leaf Peppermint *E.radiata*, Gippsland Peppermint *E. croajingolensis*, Brown Stringybark *E. baxteri* and Swamp Gum *E. ovata* in the vicinity of poorer drainage. Trees of Blackwood *Acacia melanoxylon* and Silver Wattle *Acacia dealbata* are often present.

The understorey typically includes moisture-dependent fern species such as Common Ground-fern *Calochlaena dubia,* Gristle Fern *Blechnum cartilagineum*, Mother Shield-fern *Polystichum proliferum* and Rough Tree-fern *Cyathea australis*, and the presence of broad-leaved species typical of wet forest mixed with elements from dry forest types such as Lowland Forest.

Broad-leaved species include Hazel Pomaderris *Pomaderris aspera*, Victorian Christmas-bush *Prostanthera lasianthos*, Snow Daisy-bush *Olearia lirata*, *Cassinia* spp, Hop Goodenia *Goodenia ovata*, Elderberry Panax *Polyscias sambucifolia* and White Elderberry *Sambucus gaudichaudiana*. Sweet Pittosporum *Pittosporum undulatum* is often present in South Gippsland. The wet forest shrub, Prickly Currant-bush *Coprosma quadrifida,* and Fireweed Groundsel *Senecio linearifolius* are also common. Drier shrubby elements include Prickly Moses *Acacia verticillata,* Prickly Bush Pea *Pultenaea juniperina*, Narrow-leaf Wattle *Acacia mucronata* and Varnish Wattle *Acacia verniciflua*. Other species commonly present are Austral Bracken

Pteridium esculentum and Forest Wire-grass *Tetrarrhena juncea*, Broad-leaf Stinkweed *Opercularia ovata,* Tall Sword-sedge *Lepidosperma elatius,* Wonga Vine *Pandorea pandorana* and Mountain Clematis *Clematis aristata*.

At the drier end of Damp Forest a number of species start to appear such as Narrow-leaf Peppermint *Eucalyptus radiata*, Narrow-leaf Wattle *Acacia mucronata*, Cherry Ballart *Exocarpos cupressiformis*, Grey Tussock-grass *Poa sieberiana*, Prickly Tea-tree *Leptospermum continentale* and Thatch Saw-sedge *Gahnia radula*. At Wilsons Promontory, the shrub Blue Olive-berry *Elaeocarpus reticulatus* is a common species which indicates its close affinities with *Wilson's Promontory Overlap* Warm Temperate Rainforest.

Riparian habitats in Damp Forest contain indicator species of Riparian Forest such as Soft Water-fern *Blechnum minus,* Fishbone Water-fern *Blechnum nudum,* Austral King-fern *Todea barbara*, Scrambling Coral-fern *Gleichenia microphylla*, Tall Saw-sedge *Gahnia clarkei* and Tall Sedge *Carex appressa.*

Appendix 1. (c) Ecological Vegetation Class (EVC) description and dominant species list for Strezlecki Ranges bioregion and Wet Forest EVC.

This EVC includes a very wide range of structural variation ranging from tall old-growth forest up to 60m in height through to regrowth forest and scrub which has the potential to support tall forest. It also includes treeless areas dominated by wet scrub and even "oldfields" which were once cleared but are now dominated by native vegetation.

Wet Forest is dominated by Mountain Ash *Eucalyptus regnans* but may be dominated locally by Blackwood *Acacia melanoxylon* or Silver Wattle *A. dealbata*. A range of other eucalypt species can be present but these tend to be on the periphery of extensive areas dominated by Mountain Ash *E. regnans*. These include Manna Gum *E. viminalis* (often occurring along major river flats and on associated slopes), Strzelecki Gum *Eucalyptus strzeleckii*, Gippsland Blue Gum *E. globulus* ssp. *pseudoglobulus*, Messmate *E. obliqua,* and Mountain Grey Gum *E. cypellocarpa* which occurs on the edges of Wet Forest stronghold areas immediately before Damp Forest becomes more developed. Tree-ferns are sometimes present, particularly Rough Tree-fern *Cyathea australis* on the slopes and Soft Tree-fern *Dicksonia antarctica* along the creek lines as well as some of the "wet-ferns" such as Mother Shield-fern *Polystichum proliferum* and Hard Water-fern *Blechnum wattsii*.

Common understorey species are the broad-leaved shrubs such as Snow Daisy-bush *Olearia lirata*, Musk Daisy-bush *O. argophylla,* Blanket Leaf *Bedfordia arborescens*, Hazel Pomaderris *Pomaderris aspera, Cassinia* spp., Tree Lomatia *Lomatia fraseri* and Austral Mulberry *Hedycarya angustifolia.* The prickly shrub, Prickly Currant-bush *Coprosma quadrifida,* and the vines Mountain Clematis *Clematis aristata* and Wonga Vine *Pandorea pandorana* are also often present. Other shrubs sometimes include Sweet Pittosporum *Pittosporum undulatum*, Tree Lomatia *Lomatia fraseri* and Victorian Christmas-bush *Prostanthera lasianthos*. At the drier end of this group the understorey becomes very low in stature (less than 2m) and broad-leaved species

other than Snow Daisy-bush *Olearia lirata* are notably absent. This variant tends to occur on the most exposed, drier northerly aspects.

Wet Forest develops extensively around the localised areas of Cool Temperate Rainforest in the study area. At the dry end of its range it changes to Damp Forest and Shrubby Foothill Forest, which tends to first appear on the drier, steeper aspects associated with Wet Forest in the more protected sites.

There are two floristic communities of Wet Forest: *Gippsland 1* Wet Forest and *Gippsland 2* Wet Forest.

Floristic Community: *Gippsland 1* Wet Forest
Gippsland 1 Wet Forest occurs across the study area along creeks and on south-facing slopes and gullies. It grows on a variety of geologies, which combine with high rainfall and moist loamy organic soils to provide a fertile environment for tall trees, broad-leaf shrubs and ferns. Average rainfall is high ranging from 700–1200mm, with high effective rainfall on protected southerly slopes. It grows at a range of altitudes from 500-1100m above sea level.

The overstorey may carry a range of eucalypts including Messmate Stringybark *Eucalyptus obliqua,* Gippsland Peppermint *Eucalyptus croajingolensis*, Narrow-leaf Peppermint *E. radiata* in the west of the study area and *E. croajingolensis* to the east of the study area. Manna Gum *Eucalyptus viminalis* and *E. obliqua* may co-dominante in some areas

Silver Wattle *Acacia dealbata* is the ubiquitous understorey tree in this EVC. A diversity of tall broad-leaved shrubs are prominent and often form a complete cover, although this may be broken by an equally dense layer of tree ferns. The most common tall shrubs include Hazel Pomaderris *Pomaderris aspera*, Blanket Leaf *Bedfordia arborescens*, Musk Daisy-bush *Olearia argophylla*, and Rough Coprosma *Coprosma hirtella*. Common Cassinia *Cassinia aculeata*, Prickly Currant-bush *Coprosma quadrifida,* Elderberry Panax *Polyscias sambucifolia*, Snow Daisy-bush *Olearia lirata* and Dusty Daisy-bush *O. phlogopappa* form a shorter layer beneath the taller shrub layer.

Tree ferns are often present with Soft Tree-fern *Dicksonia antarctica* at the wettest sites and Rough Tree-fern *Cyathea australis* at lower elevations and on slightly drier sites. Ground ferns include Austral Bracken *Pteridium esculentum*, Mother Shield-fern *Polystichum proliferum* and Fishbone Water-fern *Blechnum nudum*.

The ground layer is equally rich in species, dominated by large moisture-loving herbs, and graminoids such as the large tussocks of Tasman Flax-lily *Dianella tasmanica*, Tussock-grasses *Poa* spp. and Tall-headed Mat-rush Lomandra longifolia. The diverse array of smaller forbs include Ivy-leaf Violet *Viola hederacea*, Soft Cranesbill *Geranium potentilloides,* Bidgee Widgee *Acaena novae-zelandiae,* Hairy Pennywort *Hydrocotyle hirta* and Common Lagenifera *Lagenifera stipitata*. Forbs indicative of Wet Forest include Mountain Cotula *Leptinella filicula*, Scrub Nettle *Urtica incisa* and Forest Starwort *Stellaria flaccida*.

Floristic Community:*Gippsland 2* Wet Forest

Gippsland 2 Wet Forest grows in similar environments to *Gippsland 1* Wet Forest. Rainfall is very high, ranging from 950–1350mm per annum and effective rainfall extremely high. It ranges in elevation from 700 to 1160m above sea level, thus reaching montane environments.

Gippsland 2 Wet Forest is the wettest of the eucalypt-dominated vegetation types. At higher elevations Alpine Ash *Eucalyptus delegatensis* dominates the overstorey whilst at lower elevations Mountain Ash *E. regnans* dominates wetter sites and Manna Gum *Eucalyptus viminalis* and species of the narrow-leaved peppermint group are prominent (for example, Narrow-leaved Peppermint *Eucalyptus radiata* s.s., Monaro Peppermint *Eucalyptus radiata* ssp. *robertsonii* and Gippsland Peppermint *Eucalyptus croajingolensis*). The understorey tree layer is well developed with Silver Wattle *Acacia dealbata* and Blackwood *A. melanoxylon* dominating.

The shrub layer is usually very dense and may form an almost impenetrable thicket, especially after disturbance. It is most often dominated by Soft Tree-fern *Dicksonia antarctica* and a mixture of large mesic shrubs including Banyalla *Pittosporum bicolor*, Mountain Tea-tree *Leptospermum grandifolium*, Blanket-leaf *Bedfordia arborescens*, Victorian Christmas Bush *Prostanthera lasianthos*, Mountain Pepper *Tasmannia lanceolata,* Hazel Pomaderris *Pomaderris aspera* and Musk Daisy-bush *Olearia argophylla*. Several smaller shrubs are also common including Common Cassinia *Cassinia aculeata*, Elderberry Panax *Polyscias sambucifolia*, White Elderberry *Sambucus gaudichaudiana* and Dusty Daisy-bush *Olearia phlogopappa*..

The ground layer is also very dense and is dominated by ferns. Mother Shield-fern *Polystichum proliferum*, Fishbone Water-fern *Blechnum nudum*, Hard Water-fern *B. wattsii*, Ray Water-fern *B. fluviatile* and Austral Bracken *Pteridium esculentum* commonly form a complete cover.

Common herbs and graminoids including Tussock-grasses *Poa spp*, Scrub Nettle *Urtica incisa*, Shade Nettle *Australina pusilla* and Bidgee Widgee *Acaena novae-zelandiae* may reach high densities in open patches, often created by local disturbance, or where the substrate is rocky. Other herbs and graminoids include Tall Sedge *Carex appressa*, Tasman Flax-lily *Dianella tasmanica*, Small-leaf Bramble *Rubus parvifolius*, Hairy Pennywort *Hydrocotyle hirta*, Ivy-leaf Violet *Viola hederacea,* Mountain Cotula *Leptinella filicula*, Forest Mint *Mentha laxiflora* and Forest Starwort *Stellaria flaccida*. Forest Wire-grass *Tetrarrhena juncea* is also common.

Vines are particularly rich in this community of Damp Forest. Mountain Clematis *Clematis aristata* is most common with Common Apple-berry *Billardiera scandens*, Love Creeper *Comesperma volubile*, Austral Sarsaparilla *Smilax australis*, Wombat Berry *Eustrephus latifolius* and Wonga Vine *Pandorea pandorana* often present. Climbers and scramblers are very prominent and the presence of Wombat Berry *Eustrephus latifolia* and Austral Sarsaparilla *Smilax australis* emphasises floristic links for Warm Temperate Rainforest.

Appendix 1. (d) Ecological Vegetation Class (EVC) description and dominant species list for Strezlecki Ranges bioregion and Shrubby Foothill Forest EVC.

Strzelecki's Shrubby Foothill Forest is found mainly on the northern and western aspects of the higher slopes of the Strezlecki Ranges. It occurs in habitats at the drier end of Damp Forest extending from Carrajung on the eastern flank of the Strzelecki's to Loch in the west. Soils are fertile, well-drained, grey-brown loams and clay loams of Cretaceous origin. This EVC has been even more extensively cleared than Wet Forest in the Strzelecki's with some of the few remaining intact remnant patches being found at the Karl Harmann Reserve north-east of Leongatha and at Dickies Hill near Mirboo North. It is floristically and geographically closely associated with Herb-rich Foothill Forest. Elevation ranges from 100-500m above sea level and average annual rainfall is 900-1100 mm.

The overstorey is dominated by Narrow-leaf Peppermint *Eucalyptus radiata*, Messmate *E. obliqua*, Mountain Grey Gum *E. cypellocarpa* and to a lesser extent Silver-top *E. sieberi*. A diverse, shrubby understorey characterises this EVC with a limited range of herbs and grasses in the ground layer.

Characteristic shrubs include Narrow-leaf Wattle *Acacia mucronata*, Dusty Miller *Spyridium parvifolium,* Prickly Currant-bush *Coprosma quadrifida,* Hazel Pomaderris *Pomaderris aspera,* Snow Daisy-bush *Olearia lirata,* Shiny Cassinia *Cassinia longifolia,* Hop Goodenia *Goodenia ovata,* Handsome Flat-pea *Platylobium formosum* and Wiry Bauera *Bauera rubioides.*

The ground layer is very species poor and helps distinguish this EVC from Herb-rich Foothill Forest. It includes Ivy-leaf Violet *Viola hederacea,* Forest Wire-grass *Tetrarrhena juncea,* Austral Bracken *Pteridium esculentum* and Tall Sword-sedge *Lepidosperma elatius.*

Appendix 2. Interview sheet used by the interviewer for on-farm management practices on dairy farms in west and south Gippsland

LANDHOLDER INTERVIEW – On-farm Management

(For interviewer's use only)

Points to remember to tell farmer:

- What project is about
- What is riparian area in simple terms
- All information completely confidential, names not used in reports (and you will be provided with a copy of the reports)
- Do you mind of I take photos of your creek for my future reference (your name will not be placed with the photograph)?
- I am going to ask you questions about: stocking rates and management as well as streambank management
  (inform of what questions are coming using subheadings)

Owner/Manager:	Interview Date:
Property Name:	Location:
Interviewees:	Ph. Number:
Mailing Address:	Creek Name:

General Questions

- How big is your property?
  _____Hectares/acres
- How long have you owned/managed this property?
  _____Months/years
- Is this a family property (passed down through generations)?
  YES/NO
- If YES, for how long has it been in the family?
  _____Years
- Has the property always operated as a dairy farm?
  YES/NO
- If NO, what is the farm's history (if known)?

Stocking Rates and Paddock Sizes

- What is the annual total stocking rate on your property?
  _____Total or Cow/Ha
- Do your stocking rates vary by large numbers throughout the year (with seasons)?
  YES/NO
- If YES, by how many does it vary through the year (give a number or %)?
  _____No. or %
- Has your farm ever carried more stock than the annual stocking rate in the past?
  YES/NO
- If YES, what was the maximum number it ran in the past?
  _____Total or Cow/Ha

- Of the current amount, how many cows constitute:
    - Milking herd? _____
    - Heifers? _____
    - Dry cows? _____
    - Calves? _____
    - Beef herd? _____
- What approximate % maximum area of the farm do the milking herd occupy throughout the year?
  _____% area
- How many paddocks are there on your property?
  _____No. Paddocks
- What is the average size of your paddocks
  _____Avg.
- How many of your paddocks have rivers/creeks running through them
  _____No. Paddocks
- What rotational grazing practices do you employ for your milking herd?

  Day v.'s night ❑
  12 hour ❑
  24 hour ❑
  Other ❑ please specify

- Is the on/off grazing procedure on wet paddocks familiar to you?
  YES/NO
- If YES, how often do you employ this method of grazing?

  Regularly ❑
  As needed ❑

Streambanks and watering points

- Is there more than one river/creek running through your property (if so how many)?
  YES/NO
  _____No. Rivers/creeks
- Are the rivers/creeks on your property the main watering point for your stock
  YES/NO
- If NO, on average, how far are the watering points from the streambanks?
  _____Metres
- Does flooding ever affect the movement/rotation of stock by loss of paddock use?

  YES/NO
- If YES, how often does this *usually* occur and for what length of time (duration)?
  _____How often
  _____Length of time
- If flooding occurs, how far out of the creek channel do waters usually spread?
  _____Metres
- How far are your dairy sheds located from your closest river/creek frontage?

_____Meters

- Do you graze your river/creek frontage paddocks continuously or on a rotational basis?
  Continuous/rotation
- Approximately how many metres/kilometres of your land have river/creek frontage?
  _____Metres/Kilometres
- Have any areas of your river/creek frontage been fenced to exclude livestock?
  YES/NO
- If YES, what was your primary reason for fencing off your river/creek frontage?
  Prevent stock loss ❑
  Improve condition/health of waterway/water quality ❑
  Prevent stock accessing neighboring paddocks ❑
  Prevent banks destabilizing ❑
  Increase presence of flora and fauna species ❑
  Better Stock Management ❑
  Other (please specify) ❑

- Approximately how many metres/kilometres have been fenced?
  _____Metres/kilometres
- How long has this areas(s) been fenced off for?
  _____Months/Years
- Have you planted the fenced area with trees or understorey in any way?
  YES/NO
- What methods of weed management (if any) do you employ in these fenced waterway areas?
  Mechanical (hand removal) ❑
  Spot spraying ❑
  Broad herbicide treatment ❑
  Crash grazing ❑
  No treatment ❑
  Other ❑ please specify

- Do you allow stock into these fenced areas for any period of time?
  YES/NO
- What do you think is the ideal fencing width of waterways?
  _____Width

Effluent, Irrigation and Stock Loss

- Are any irrigation methods employed on your property?
  YES/NO

- If YES, on average how often is irrigation used?
  - Daily ❑
  - Weekly ❑
  - Monthly ❑
  - 2-3 time per year ❑
  - As needed ❑
  - Other ❑ please specify

- What is your primary method of irrigation?
  - Spray irrigation ❑
  - Flood irrigation ❑
  - Lateral sprinkler ❑
  - Other ❑ please specify

- Do you apply fertilisers to your river/creek frontage paddocks?
  YES/NO
- Do you use your dairy shed effluent on river/creek frontage paddocks for irrigation purposes?
  YES/NO
- What best describes your current dairy effluent system?
  - Single pond ❑
  - Two pond system ❑
  - Direct to pasture ❑
  - No system ❑
  - Other ❑ please specify
- Are you happy with your current dairy effluent system?
  YES/NO
- Would you like to change your current management of dairy shed effluent in the future?
  YES/NO
- If YES, what would you like to do in the future?

- How often are your dairy effluent systems usually drained and/or cleaned?
  - Daily ❑
  - Weekly ❑
  - 2-3 times per year ❑
  - Once yearly ❑
  - Less than annually ❑
- If you fenced off the stream banks on your farm would this reduce your time needed for stock surveillance and stock mustering?
  YES/NO

- If YES, how much time would you save in an average week on the farm?
  _____Hours/Mins
- What is the estimate of cow deaths on your farm each year in the following three water associated areas:

  Creeks and rivers ❑
  Dams and swamps ❑
  Erosion gullies and tunnels ❑

Conservation and New Management Regimes

- What new land management practices has your farm adopted recently that has resulted in an improvement in the farm environment?

  Fencing remnants ❑
  Fencing rivers/creeks/drainage areas ❑
  Tree planting ❑
  Grazing techniques ❑
  Fertiliser plans/soil tests ❑
  Other (please specify) ❑

- What has been the effect of this new land management practice?

- Do you think these new land management practices were:

  Cost positive ❑
  Cost negative ❑
  Cost neutral ❑
- Is there a Landcare group in your local area?
  YES/NO
- If YES, are you a member of the Landcare group in you area and which one is this?
  YES/NO
  Group? _____

Appendix 3. Field data sheet for rapid assessments of riparian condition on dairy farms in west and south Gippsland.

PROPERTY ID ☐ SITE ID ☐

Riparian Habitat Condition Score Sheet

Site:
Phone: Date:
Creek name: Observer:
Cowpat count: Northing:
Bed Composition: Easting:
Slope range:
Comments:

Longitudinal continuity of riparian overstorey vegetation (≥ 5m canopy width) Score

0 = <30% vegetated bank, **1** = 30-49%, **2** = 50-69%, **3** = 70-94%, **4** = >95% (mark exotic sections)

Width of riparian vegetation

Measurement	Channel Width (m)	Vegetation Width (m)
1		
2		
3		
4		

Vegetation cover: UpperCanopy >20m, SubCanopy>5m, Understorey 1-5m, Ground cover (GC) <1m

Transect	Upper Canopy	% Native	Sub Canopy	% Native	Understorey	% Native	GC	% Native	# Layers
1									
2									
3									
4									

Cover: **0** = absent, **1**= 1-25%, **2** = 26-50%, **3** = 51-75%, **4** = >75%
% Native: **0** = none, **1** = 1-25%, **2** =26-50 %, **3** = 51-75%, **4** = >75%

Debris

Transect	Leaf litter	% Native	Snags	Coarse Woody Debris	% Native
1					
2					
3					
4					

Leaf litter: **0** = none, **1** = 1-30%, **2** = 31-60%, **3** = >60%
% Native: **0** = none, **1** = 1-25%, **2** =26-50 %, **3** = 51-75%, **4** = >75%
Standing dead trees: **0** = absent, **1** = present
CWD (≥10cm diameter): **0** = none, **1** = small quantity, **2** = medium quantity (removal), **3** = abundant

Special Features

Transect	Canopy spp. regeneration	Grazing damage to regeneration	Reeds	Tree Ferns	Weed Species
1					
2					
3					
4					

Seedlings <1m tall: **0** = none, **1** = scattered, **2** = abundant
Damage: **0** = all damaged**, 1** = some damaged, **2** = no damage
Reeds: **0** = absent, **1** = present
Ferns: **0** = absent, **1** = present
Weed Spp: **0** > 6 spp., **1** = 4-6 spp., **2** = 1-3 spp., **3** = no weed spp.

Bird Species List (score for ecological diversity)

Appendix 4. Subindices (and their weighting in the final score) and indicators of the index of riparian condition, the range within which each was scored, the method of scoring for each indicator, and the number of measurements per site for each indicator (*n*)

Sub-index	Indicator	Range	Method of scoring	*n*
HABITAT (10/50)	Width of riparian vegetation	0-4	Width standardised by channel width (CW): 0 = < 0.25 * CW, 1 = 0.25-0.49 * CW, 2 = 0.5-1.49 * CW, 3 = 1.5-2.9 * CW, 4 = ≥ 3 * CW	4
	Longitudinal continuity of riparian vegetation	0-4	0 = < 30% vegetated bank, 1 = 30-49% vegetated bank, 2 = 50-69% vegetated bank, 3 = 70-94% vegetated bank, 4 = ≥ 95% vegetated bank, with one point taken off for each significant discontinuity	1
COVER (10/50)	Canopy cover	0-4	0 = absent, 1 = 1-25%, 2 = 26-50%, 3 = 51-75%, 4 = >75% cover	4
	Sub canopy cover	0-4	0 = absent, 1 = 1-25%, 2 = 26-50%, 3 = 51-75%, 4 = >75% cover	
	Understorey cover	0-4	0 = absent, 1 = 1-25%, 2 = 26-50%, 3 = 51-75%, 4 = >75% cover	4
	Ground cover	0-4	0 = absent, 1 = 1-25%, 2 = 26-50%, 3 = 51-75%, 4 = >75% cover	4
	Number of layers	0-4	0 = no vegetation layers to 4 = ground cover, understorey, sub canopy and upper canopy layers	4
DEBRIS (10/50)	Leaf litter	0-3	0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60% ground cover	4
	Standing dead trees	0-1	0 = absent, 1 = present	4
	Terrestrial coarse woody debris	0-3	0 = none, 1 = small quantities, 2 = abundant but some removed, 3 = abundant with no signs of removal	4
NATIVES (10/50)	Canopy	0-4	0 = none, 1 = 1-25%, 2 = 26-50%, 3 = 51-75%, 4 = >75% cover	4
	Sub canopy	0-4	0 = none, 1 = 1-25%, 2 = 26-50%, 3 = 51-75%, 4 = >75% cover	
	Understorey	0-4	0 = none, 1 = 1-25%, 2 = 26-50%, 3 = 51-75%, 4 = >75% cover	4
	Ground cover	0-4	0 = none, 1 = 1-25%, 2 = 26-50%, 3 = 51-75%, 4 = >75% cover	4
SPECIES (10/50)	Canopy species regeneration	0-2	0 = none, 1 = scattered, and 2 = abundant seedlings	4
	Damage to regeneration	0-2	0 = all damaged, 1 = some damaged, 2 = no damage	4
	Reeds	0-1	0 = absent, 1 = present	4
	Tree ferns	0-1	0 = absent, 1 = present	4
	Noxious weed species	0-3	0 = >6 species, 1 = 4-6 species, 2 = 1-3 species, 3 = no weed species	4

Appendix 5. Relationships between condition index scores and in-stream metabolism.

Measurements of river metabolism are fundamental to the understanding of how ecosystems function (Bott *et al*. 1978; Bunn & Davies 2001). Metabolism is essentially the movement of carbon; a basic building block of ecosystems and the element most modified by human activities within agricultural catchments. Carbon movement is described by gross primary production (GPP) and respiration (R) which represent the amount of organic carbon produced and consumed within an ecosystem respectively (Davies 1999).

In the Gippsland study, field-based measurements of benthic metabolism were determined by measuring the net change in dissolved oxygen within clear dome-shaped perspex chambers (diameter = 29.5cm, height = 35cm) over a 24 hour period. For measurements from these habitats, chambers were pushed into the sediment enclosing a water volume of five litres. A consistent insertion depth was achieved by making sure a rim on the outside of the chamber was flush with the sediment surface (Figure A6).

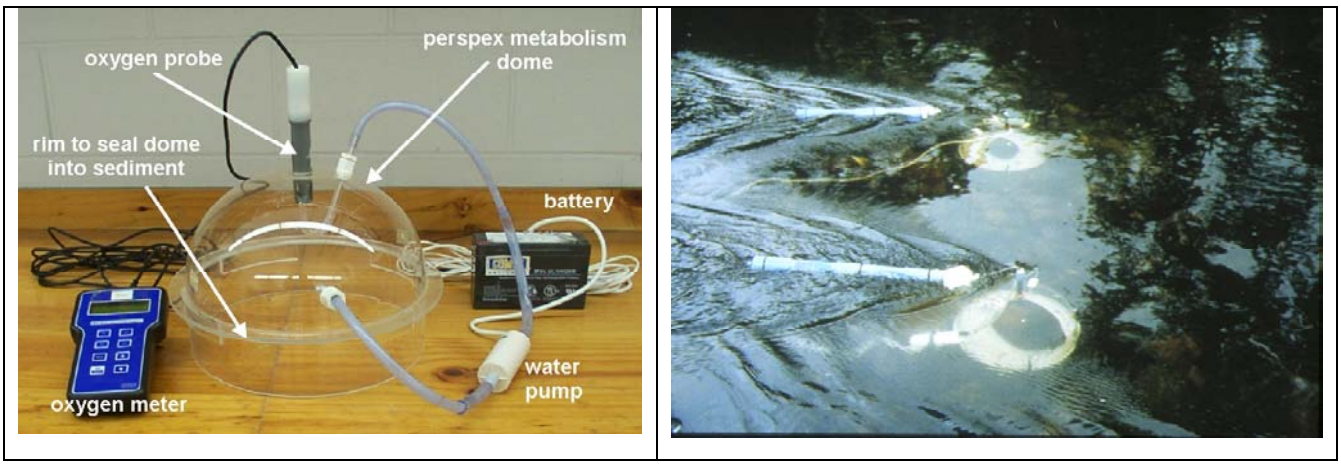

Figure A5. Components of the metabolism chambers (left) and their use *in situ.*

An oxygen sensor (YSI 5739, USA) and attached data-logger (TPS 601) was attached in the top of all chambers and a 12V pump recirculated water within the chamber to reduce boundary layer effects at the sediment water interface and ensure flow saturation across the membrane of the oxygen probe. An adjustable valve ensured flow did not unduly disturb the sediment in the chamber. All oxygen probes were calibrated in the laboratory prior to the field trip and checked in the field immediately prior to and after the 24h deployment when the probes were collected. Changes in dissolved oxygen concentrations over time (mg O_2 $l^{-1}hr^{-1}$) were converted to units of carbon assuming that 1 mole of C is fixed for every mole of O_2 produced (*i.e.* 1 mg O_2 = 0.375 mg C, Davies 1999).

Metabolic parameters

Different aspects of benthic metabolism were calculated by comparing the rate of O_2 change in the chambers at different times of the day. These are the daily respiration (R_{24}; taking the night time respiration rate and assuming this rate is constant over 24h), gross primary productivity (GPP; the daily O_2 production plus the O_2 consumed

by respiration during the day, calculated using the night time respiration rate), net daily metabolism (NDM; equal to GPP - R_{24}) and the P/R ratio (GPP divided by R_{24}). If a system has NDM (*i.e*. P/R > 1), it is a net producer of organic carbon *i.e*. accruing biomass and termed "autotrophic". If P/R = 1 the system is in steady state (NDM = 0) and, if NDM (*i.e.* P/R < 1) the system is a net consumer of organic carbon or "heterotrophic". The photoperiod was determined as the part of the day when GPP exceeded net respiration.

Results

All the sites studied were net consumers of carbon (*e.g*. negative NDM) except one site that had slightly positive rates (85mgC.m^{-2}.day^{-1}). The dominance of heterotrophy (negative NDM) is typical of upland streams across of arrange of Australian biomes (Bunn & Davies 2000). Overall, rates of all metabolic processes measured in the study sites were elevated compared to forested systems elsewhere in Australia (Bunn *et al*. 1999); this undoubtedly reflects the nutrient-enriched status of the streams in Gippsland.

Gross Primary Production

Mean rates of GPP (in mgC.$m^{-2}day^{-1}$) ranged from 12-26 through to 1083-2105. This represents a considerable gradient of metabolism values and indicates fundamental changes in ecosystem processes across the study sites. Rates of GPP were positively correlated to measurements of the natives sub index ($r=0.65$, $p<0.001$). In small streams, GPP is typically regulated by below canopy light (Bunn *et al*. 1998; Mosisch *et al.* 2001).

Respiration

Rates of respiration (R_{24}) were elevated at most sites; reflecting the dominance of heterotrophy. Rates ranged from 487 mgC.$m^{-2}day^{-1}$ to 3880 mgC.$m^{-2}day^{-1}$. Again, this is a range of values across an order of magnitude, which represents a gradient of ecosystem conditions.

Net Daily Metabolism

Net daily metabolism (NDM) is the absolute rate of metabolism. NDM values were all negative indicating sites as net consumers of carbon. Values ranged from positive values to substantial negative values (-2309 mgC.$m^{-2}day^{-1}$). NDM was correlated to respiration; indicating respiration dominated overall NDM.

Temperature range

Daily ranges in temperature were highly variable amongst sites. Lowest diel difference was 1.3 ^{o}C. Highest diel differences in temperature were recorded at two sites 8.3 ^{o}C and 5.1 ^{o}C respectively. Elevated temperatures can directly impact on the temperature-tolerance of aquatic species and through reduction of dissolved oxygen (DO) able to held in solution (as % saturation).

Conclusions

Overall rates of metabolism were relatively elevated undoubtedly reflecting the ambient conditions of elevated nutrient status. The strong relationship between the dominant metabolic process (respiration) indicates the rapid assessment technique is related to river health. In contrast to the rapid assessment approach, the measurement of metabolism can be technically-difficult.

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Appendix 6. Relationships between grazing, riparian condition and bird communities.

Bird communities differed significantly between ungrazed (fenced and planted, fenced but unplanted and remnant sites) and grazed sites (DISTLM: pseudo-$F_{1,104}$=3.25, p<0.001). This difference was accounted for by the strong relationship between riparian condition and associated bird communities (DISTLM: pseudo-$F_{1,104}$=8.33, p<0.001). Figure A8 shows the 106 sites at which bird communities were recorded – the relative locations of sites on the figure reflects the similarities in the bird communities of each site (thus sites with similar bird communities are close together while those with very different bird communities are far apart). Superimposed on the sites' locations are the condition score categories recorded at those sites. It is clear that there was a strong trend of changing bird communities as condition scores varied.

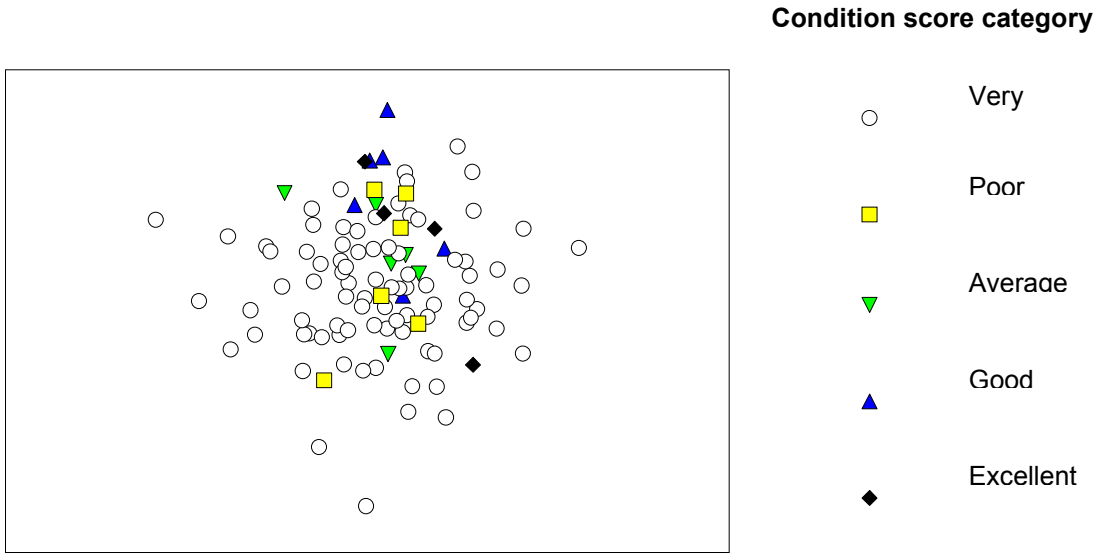


Figure A6. Non-metric multi-dimensional scaling plot of 106 riparian sites according to their bird communities (Stress=0.28).

Bird communities varied significantly with all sub-indices of the riparian condition index, but most strongly with the proportion of native species and the amount of woody debris and leaf litter, and quite strongly with the amount of habitat and the amount of vegetation cover. Thus the most significant aspects of riparian habitat condition for healthy bird communities include dominance by native species of plants, and good quantities of fallen timber and leaf litter on the ground.

Particular species of birds were characteristic of sites with different riparian condition scores. Those characteristic of sites in good to excellent condition, and those characteristic of sites in poor to very poor condition, are shown in Table A8.

Table A6. Bird species characteristic of riparian sites in good to excellent condition, and those characteristic of sites in poor to very poor condition (these 20 species contribute 60% of the dissimilarity between the two sets of sites, using a Similarity Percentages Analysis).

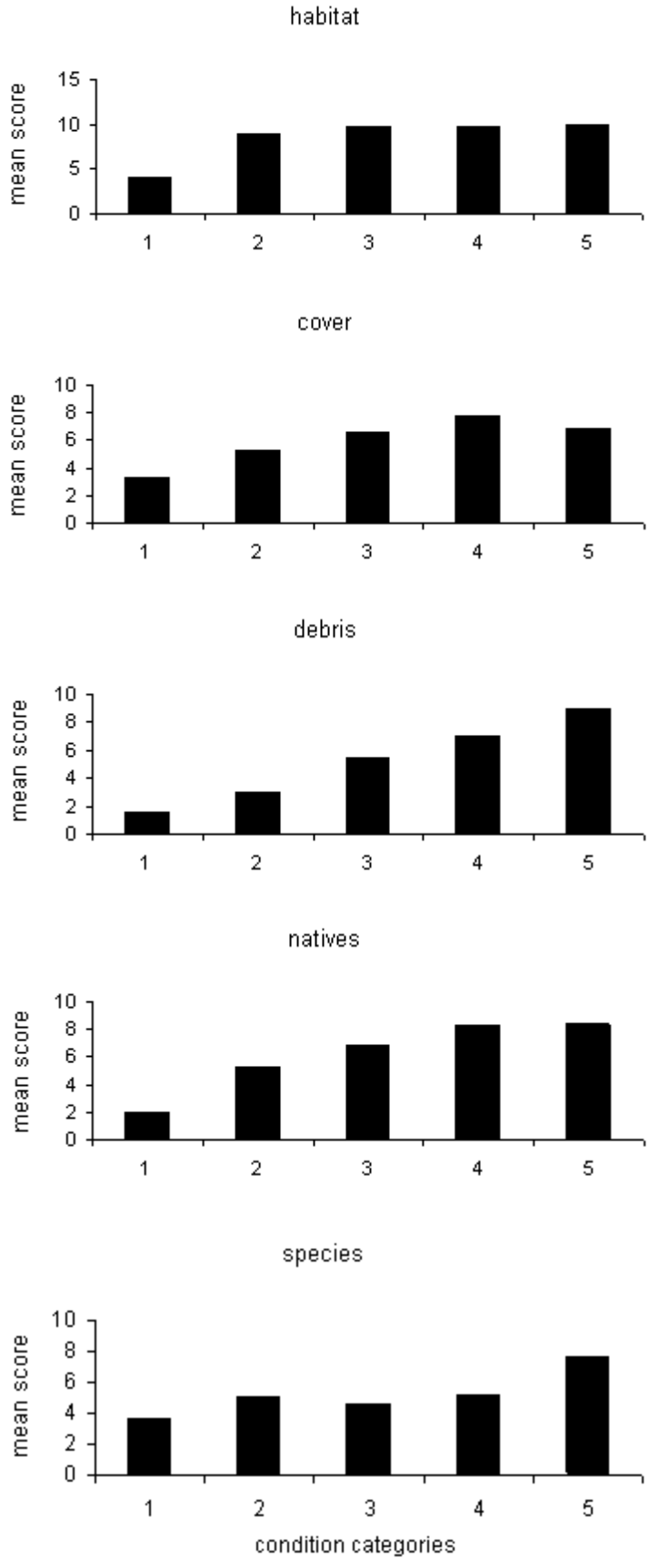
Poor and very poor condition	Good and excellent condition
Australian Magpie	Crimson Rosella
Australian Raven	Red-browed Treecreeper
Welcome Swallow	White-browed Scrubwren
Common Starling	Brown Thornbill
	Common Blackbird
	Red-browed Finch
	Grey Shrike-thrush
	Laughing Kookaburra
	Eastern Yellow Robin
	Rufous Whistler
	White-plumed Honeyeater
	Striated Thornbill
	Grey Fantail
	Bell Miner
	Red Wattlebird
	Lewin's Honeyeater

It can be seen that the majority of birds characteristic of riparian sites in good condition were small, forest-dwelling species while those characteristic of sites in poor condition were typical open paddock species. Of the species characteristic of riparian sites in good condition, the Crimson Rosella, White-browed Scrubwren and Grey Fantail were relatively abundant, making them good candidates as indicators of the health of riparian zones, and potentially as indicators of the success of restoration efforts in riparian zones in the Gippsland region.

Appendix 7. Dry Sheep Equivalents (DSE) conversion rates used for the Gippsland Dairy Riparian Project (after McLaren 1997).

STOCK	DSE		
	JERSEY	FRESIAN/ HOLSTEIN	SHEEP
Weaned calves	6	7	
Heifers	8	9	
Dry cows (maintaining weight)	6	8	
Dry cows (last 3 months pregnancy)	8	11	
Milking cows – 15L/day	18	19	
20L/day	23	23	
Cow and calf unit	15	17	
Bulls	8	11	
Rams			2
Wethers			1
Ewes			1.5
Weaner lambs			1.5

Appendix 8. (a) Mean scores for condition sub-indices against overall condition categories. See below for statistical analysis of data.



Appendix 8. (b) Stepwise regression of sub-indices on total condition index scores

Model	Adjusted R square	SE of the estimate	Predictors
1	0.896	3.091	NATIVES
2	0.934	2.457	NATIVES, HABITAT
3	0.970	1.686	NATIVES, HABITAT, DEBRIS
4	0.994	0.770	NATIVES, HABITAT, DEBRIS, SPECIES
5	1	0	NATIVES, HABITAT, DEBRIS, SPECIES, COVER