



**Department of  
Environment and Conservation (NSW)**

**New South Wales (NSW)  
Australian River Assessment System  
(AUSRIVAS)  
Sampling and Processing Manual  
2004**



The "Crayfish from Snowy River"

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# 1: A brief summary of the protocol

## AUSRIVAS in New South Wales

- AUSRIVAS is a rapid assessment methodology for assessing river health using macroinvertebrates.
- A software package containing predictive models is used to obtain a river health assessment from biological samples (macroinvertebrates) and environmental data (physical & chemical variables) collected from a river site.
- This document provides the information necessary to enable the collection of the biological and environmental data required to obtain an AUSRIVAS river health assessment in New South Wales (NSW).
- ***Strict adherence to the protocol is essential if accurate, comparable river health assessments are to be obtained.***

## Collecting AUSRIVAS samples in New South Wales

- Samples are collected in Spring and Autumn.
- Sites should be chosen in accordance with the purpose of the sampling program being undertaken.
- Sampling at a site is conducted within a river reach with a length of 10 x the modal width of the river or, 100 metres, whichever is greater.
- A variety of chemical and physical variables (environmental data) are measured and recorded at each site to act as predictor variables in the AUSRIVAS models.
- Stream width should be the first environmental variable estimated upon arrival at a site as the length of river to be sampled is determined by the modal stream width (See section 3.2 & Stream Width in section 4.3).
- At each site macroinvertebrate samples are collected from two types of habitat, riffles and edges. Riffles are areas of broken water with rapid current. Edges are areas along the creek bank with little or no flow.
- All sub-habitats within an edge or riffle (i.e., each of the various types of instream structure present) should be represented in a macroinvertebrate sample.

- Macroinvertebrate samples must be collected with a kick net of 0.25 mm mesh size. How the net is used to collect samples differs between riffles and edges.
- Macroinvertebrates are live-sorted from samples following a strict protocol as soon as possible after collection, preferably in the field. The length of the time devoted to sorting individual samples is determined by a set minimum sorting time and, after this minimum, a decision process based on whether a new taxon has recently been collected and the time since that collection occurred.
- Most of the collected macroinvertebrates are identified to family level using available identification keys. Several groups are identified only to higher taxonomic levels.
- Special considerations apply to the sampling of sites in lowland sections of the western flowing rivers of the Murray-Darling basin and particular attention should be paid to sections detailing the specific requirements for these sites.
- This document should be taken on all sampling trips and used as a reference guide at all times.

## 2: Introduction

The Australian River Assessment Scheme (AUSRIVAS) is a software package that provides a river health assessment based on predictive models of macroinvertebrate distribution. These predictive models were developed from the sampling of reference sites across broad geographic regions and from all major river types (Davies 1994). Reference sites were those for a given region or river type that were determined to be unaffected or least affected by human influence. Physical and chemical data collected at a site (environmental or predictor variables) are used to determine the predicted (Expected) composition of the macroinvertebrate fauna if the site is in an undisturbed or reference condition. An AUSRIVAS assessment, therefore, represents a comparison of the macroinvertebrates collected at a site (Observed) to those predicted to occur (Expected) if the site is in an undisturbed or reference condition.

AUSRIVAS models have been developed in all Australian states and Territories under the National River Health Program (NRHP) (Davies, 2000). Some differences in the general approach and specific methodology exist among states and it is therefore essential that the appropriate sampling manual is used in each state. In New South Wales (NSW), seven large-scale AUSRIVAS models have been developed by the NSW EPA (now the Department of Environment and Conservation) using data collected between 1994 and 1999 during the Monitoring River Health Initiative (MRHI) and the Australia-Wide Assessment of River Health (AWARH) (Turak, 2002). In addition regional models for the South Coast have been developed by the Cooperative Research Centre for Freshwater Ecology (CRCFE). This document provides the information necessary to enable the collection of the biological and environmental data required to obtain an AUSRIVAS river health assessment using the seven models developed for NSW.

Obtaining reliable AUSRIVAS outputs by using this manual will require a certain level of experience, training and rigour in the application of the protocol. Access to expertise in macroinvertebrate identification at the family level is essential. If

AUSRIVAS outputs are to be used for formal assessments of river condition it is important that a certain level of proficiency in using the appropriate protocols is attained. Information about training requirements and accreditation procedures for AUSRIVAS can be found in the training section of the AUSRIVAS web site

(<http://ausrivas.canberra.edu.au/Bioassessment/Macroinvertebrates/Training/> ).

Furthermore, this document and the protocols contained here in represent an updated version of Turak & Waddell (2001). This modified protocol incorporates lessons learned during the sampling detailed in Johnstone *et al.* (2003) which concluded that the level of rigor with which these protocols are applied can affect the number of macroinvertebrate families collected at a site. Maximising the number of families collected is important if accurate estimates of river health are to be obtained, particularly in lowland rivers where macroinvertebrate densities may be low.

Operators should ensure a rigorous application of the protocols through adherence to the procedures set out in this manual. Several sections of this manual detail the special considerations necessary when sampling in western flowing lowland rivers where these issues are particular relevant. With the appropriate expertise, training and rigor in application it should be possible to obtain an AUSRIVAS assessment for almost any NSW river site by following the procedures set out in this manual.

It is also desirable that users of AUSRIVAS in NSW become familiar with the philosophy and methodology adopted in the development of the predictive models (Davies, 2000; Simpson, 2000; Turak, 2002) Details of the model development procedures in NSW are outlined by (Turak, 2002). Furthermore, it is important when undertaking sampling for AUSRIVAS that appropriate quality control and quality assurance procedures are followed, particularly when conducting large-scale monitoring programs. Details of quality control and quality assurance programs followed during the MRHI and AWAHR in NSW can be found in (Waddell, 2002). It may also be useful to refer to the sampling protocols prepared for the other states regarding aspects of the protocol that are compatible. In particular the ACT manual (Nichols *et al.* 2000) contains considerable detail and should be referred to if necessary.

## 3: Fundamentals of AUSRIVAS sampling in NSW

### 3.1: Sampling time

The samples collected for developing the NSW AUSRIVAS models were collected in either autumn or spring and hence cover only six months of the year. The models will only give reliable results if sampling is undertaken within these two seasons. The **autumn** sampling season runs from March 15 to June 15 and the **spring** sampling season from September 15 to December 15.

### 3.2: Definition of a site

The width of a river is used to define the section of that river that constitutes a site for the purposes of AUSRIVAS sampling in NSW. Importantly, samples collected from a site are assumed to represent the fauna of the edge and riffle habitats within the entire reach. Defining an appropriate reach length is therefore essential to ensure consistency across different river types.

Two steps should be taken to define the reach length to be used as a site. Firstly, assess the modal width of the river in the section of river around the access point. The modal stream width (further defined on page 21) is the most common width of the section of river being examined. The width of the river at the access point may be unrepresentative of that section of the river. Therefore, if the access point does not give a good view of the river it will be necessary to walk along the river for some distance before a decision regarding the modal width can be made.

Secondly, if the modal stream width you accessed is equal to or less than 10 meters, then a reach length of 100 metres is used as the site. If the modal stream width is greater than 10 metres then the site is defined as a reach with a length of ten times the modal river width. Therefore the shortest reach that should ever be sampled as a site in NSW is 100 meters. Reaches (and therefore sites) on the lowland, floodplain sections of rivers, may be several hundred metres in length. Samples collected from a site are assumed to represent the fauna of the edge and riffle habitats within the entire reach, whether it is 100 metres or several hundred metres in length.

### 3.3: Selecting sampling sites

Sampling sites need to be chosen in accord with the purpose of sampling. If sampling is being undertaken as part of a monitoring program to assess the general ecological health of rivers within a catchment or region, then sites should be selected to be as representative as possible of larger segments of the river. For example if sampling is done on a creek that flows over mostly rocky substratum for 10-20 kms but has a small reach of a few hundred metres of sandy bottom, it would be inappropriate to select the one site in the sandy area. For such programs it is best to aim to sample reaches that have both the edge and riffle habitats.

AUSRIVAS may be used to determine the ecological effects of point source discharges. In this case choosing a representative reach might not be appropriate and finding reaches that have both habitats might be difficult. However, consideration must also be given to the fact that the ecological effects of the discharge might be greater in one habitat than the other so special attention might need to be placed on including specific habitats.

### 3.4: Habitats sampled

For the purposes of AUSRIVAS a habitat is an instream environment within a sampling site that supports a distinct macroinvertebrate fauna. In NSW AUSRIVAS models were developed for **Riffle** and **Edge** habitats. These are defined below.

#### 3.4.1: Riffles

The riffle habitat is an area of broken water with rapid current that has some cobble or boulder substratum (Figure 1).





**Figure 1.** Good riffle habitat with both cobble and boulder substratum. Cockerawombeeba Ck, Hastings River catchment on the mid-north coast of NSW.

In cases where riffles do not have the type of substratum specified in this definition, the available habitat would generally be regarded as marginal or unsuitable. AUSRIVAS assessments from marginal and unsuitable habitats may be unreliable. For example samples may be collected from broken waters with only pebble, gravel, sand or bedrock substratum or a combination of any of these (Figures 2 and 3). The results obtained from such riffles may be assessed as poor by AUSRIVAS even at relatively undisturbed sites.

There is an advantage to this, however. In riffle zones where there is evidence to suggest an original cobble/boulder substratum has been covered by a pebble/gravel substratum as a result of human activities, AUSRIVAS assessments may give an indication of the taxa lost due to loss of instream habitat (Figure 3). In this case, the pre-disturbance substrata should be estimated and used for the assessment.



**Figure 2.** Broken water over solid bedrock also does not constitute an adequate riffle for AUSRIVAS assessments. Rocky Creek, Richmond River catchment on the far north coast of NSW.



**Figure 3.** Riffles with only pebbles or smaller sized substrata support poor macroinvertebrate communities. AUSRIVAS assessments from naturally occurring riffles of this type are unreliable. Nambucca River, mid-north coast of NSW. However, at this particular site there is some evidence that the substratum was dominated by bedrock, boulder and cobble until relatively recently and that extensive gravel extraction in the area has changed this. AUSRIVAS assessments for the riffle habitat indicated an impaired macroinvertebrate fauna suggesting loss of habitat caused by gravel extraction.

Unreliable AUSRIVAS assessments may also occur as a result of difficult or dangerous sampling conditions. For example sampling riffles where the substratum consists predominantly of large boulders may be difficult and potentially dangerous especially where flow is deep and fast (Figure 4). Also in situations where there are no riffles deeper than about 0.05 m it may not be possible to obtain an adequate sample because many of the invertebrates released from the substratum when disturbed will not enter the net. This situation often coincides with slow flows and if riffle samples are collected under such circumstances the results should be interpreted with this in mind.

Macroinvertebrate data collected from small streams where the water velocity is very slow, even though broken water may exist, should also be treated with caution as the riffle fauna in such streams may not be distinct from that found in the edge habitat.



**Figure 4.** Riffles where the substrate consists predominantly of large boulders may be difficult to sample adequately. Shoalhaven River on the south coast of NSW.

AUSRIVAS models in NSW are inappropriate for assessing riffle habitats that occur on the lowland sections of western flowing rivers. Natural riffle habitats are rare in the lowland sections of rivers in Western NSW. Consequently, the reference sites used to construct the riffle models in NSW are all from the eastern part of the state. Riffles, when they do occur in lowland rivers (See Figure 5 for an example), should still be sampled. However, any AUSRIVAS assessment generated from the sampling of these habitats should be treated with a great deal of caution. The edge habitat assessments in lowland rivers will be a much more reliable indicator of river health as they are based on edge models that were constructed from lowland river reference sites.



**Figure 5.** An unusual riffle on the Western Plains of NSW. It is not appropriate to assess this site using a riffle sample in AUSRIVAS as the closest reference sites used to develop the riffle models for NSW are more than 200 kms east of this site and in very different landscapes. Barwon River downstream from Brewarina Weir, Northwest NSW.

### 3.4.2: Edges

The edge habitat is an area along the creek bank with little or no flow (Figure 6).



**Figure 6.** A rich edge habitat with a variety of sub-habitats such as logs and overhanging vegetation. Headwaters of the Ellenborough River in the Hastings River catchment, mid north coast of NSW.

Suitable areas for sampling include an alcove or backwater with abundant benthic leaf-litter, fine organic/silt deposits, macrophyte beds, overhanging banks and areas with trailing bank vegetation. These areas are often indicated by the presence of surface-dwelling insects.

In lowland rivers the insides of sharp meander bends (point bars) and outside of sharp bends (steep eroded banks) should be avoided during sampling. A straight section is usually best, but suitable areas can sometimes be found just upstream or just downstream of point bars (sandbanks). Ideally sampling should be done at sections of the river that include an alcove/small bay between logs or red gums (on the lowlands of the Murray-Darling system) with logs and tree roots.

Some river reaches have no areas along the edge that meet the requirement of having “little or no flow” (Figure 7). Such cases should be noted on the field data sheets and the results from the edge habitats at these sites treated with caution.



**Figure 7.** Some river reaches may have no areas with little or no flow and therefore suitable edge habitat for AUSRIVAS sampling. Tolbar Creek in the Snowy River catchment, Snowy Mountains of NSW.

### 3.5: Sub-habitats

For the purposes of AUSRIVAS sampling in NSW, each of the various types of instream structure present in a habitat is considered a different type of “sub-habitat”. For example, one sub-habitat type may be all areas of overhanging bank in the edge habitat of a reach, whether overhanging banks are patchily distributed or form a continuous segment of the edge (see section 5.1.2 for further details). In riffle habitats all of the possible combinations of flow, depth, and substratum should be considered potentially different sub-habitats and each of these should be represented in a riffle sample (see section 5.1.1 for further details). Ensuring inclusion of all sub-habitat types in edge samples taken from lowland rivers is of particular concern (Johnstone *et al.* 2003) and, therefore, this issue will be addressed in greater detail in section 5.1.3.

### 3.6: Predictor variables

Details of the environmental data used as predictor variables for the 7 large-scale models for NSW are listed in Turak and Waddell (2001). Information regarding required transformations, units and names is also included in this document.

## 4: Collection of environmental data

### 4.1: Field data sheets

The purpose of the field data sheets is to ensure the collection of all information required for getting an AUSRIVAS output and interpreting the results. It is essential that all variables on the data sheet be recorded as missing data may prevent the testing of a site or make interpretation of the results difficult. Measurements of zero should be recorded as such and not left blank, as this will be interpreted as missing data. The NSW field data sheets contain four pages. Below are brief instructions/explanations to assist users in obtaining adequate and complete records for all variables. A copy of the datasheet can be downloaded directed from the AUSRIVAS web page at <http://ausrivas.canberra.edu.au/man/NSW/>. A list of equipment required for AUSRIVAS sampling in NSW is provided in Appendix 1.

### 4.2: NSW field data sheet page 1: Site location and access information

**Site code:** This is a reference code for a particular sampling site preferably no longer than 8 digits eg. TOWA571. The site code should be written at the top of every page of the data sheet. In this example the first four characters in this code indicate that the site is in the Towamba River catchment.

**Collection date:** Date of sampling should be included at the top of every page of the data sheet.

**Location name:** Record the river/creek name and a description of the location eg. Merrica River @ Merrica River Road.

**Sampling team:** Record all people who took part in the sampling.



**Site location:** On arrival at the site, refer to the appropriate topographic map and record the 6 and 7 digit Australian Mapping Grid (AMG) coordinates (easting and northing) to the nearest 100 metres. Recording the correct map zone is also essential for identifying site location and is usually recorded as 'Grid Zone Designation' on the back cover of the map in a box titled Universal Grid Reference (zone 54, 55 or 56 in NSW). This data should be confirmed at a later date and recorded as such. For example the correct site location for the Merrica River example (TOWA571) are as follows: 759200 E, 5867100 N, Zone 55 (Narrabarba 8823-2-N).

**Map details:** Record the name, number, scale and zone of the topographic map on which the site is located. Also note down any adjoining maps that are needed to access the site and record in Access Details.

**Site details:**

*Elevation:* Record site elevation in metres by estimating the value of the closest contour below the site on the topographic map (preferable using the smallest scale map available).

*Distance from source (DFS):* This is the longest distance that can be travelled along drainage lines (in metres) from a site to the top of the ridge delineating the catchment. Distance from source can be measured from topographic maps using measuring devices such as a map wheel. If available a GIS could also be used to measure distance from source using a suitable drainage data set such as AUSLIG drainage (Australian Surveying and Land Information Group).

*Slope:* Slope is recorded as the elevation difference (in metres) between the site and a point 1 km upstream from it along the river. If the river happens to fork between these points the main river branch should be followed. Slope can be measured by calculating the difference in elevation using topographic maps or a suitable DEM (Digital Elevation Model).

*Latitude and longitude:* The latitude and longitude of a site can be recorded in the field using a GPS. The GPS datum should also be recorded in this case. An alternative method for calculating latitudes and longitudes back in the office is by converting the AMG coordinates recorded from topographic maps.

*Mean annual rainfall:* The data source used to derive Mean Annual Rainfall for the NSW models is part of the Annual Mean Precipitation data set (ERIN 1996). To derive a suitable value for a site this data set can be accessed using a GIS or alternatively the maps provided in Appendix 2 can be used. To assist users in gaining accurate measurements for this variable 4 regional maps have been created showing mean annual rainfall with the 1:100 000 topographic map grid overlaid. To calculate mean annual rainfall for a site it is necessary to know its location and the 1:100 000 topographic map it is located on. This information can then be used to determine the location of the rainfall categories on the topographic map and therefore derive a value for mean annual rainfall for the site. Further instructions are provided in Appendix 3.

**Access details:** This constitutes a description of the route used to access the site. This information is essential for accurately locating the site on subsequent sampling events and therefore should be detailed and clear enough for anybody to use. It is advisable to start at an intersection of a highway and/or a major road. Set the car odometer to zero and then record the distances of each crossroad and/or major landmark (eg. bridges, farmhouses) until arriving at the site. Record any situation, which may change before the next visit (eg. unlocked gates that may be locked next time). Where long walking is involved, provide estimates of time taken to walk to the site and identify landmarks along the way. The following is an example good access details.

*From Eden travel south on the Princes Highway for about 25 km where you should see Ireland Timms Forest Road on the left. Zero the tripmeter and take this road then follow the instructions below.*

<b>10.2 km</b>	Keep left	The road becomes Mountain Forest Rd. Keep to it.
<b>13.8 km</b>	Right turn	Merrica River Rd
<b>16.4 km</b>	Left turn	Loop Road (there is a gate which may be locked, check with NPWS office at Merimbula)
<b>19.8 km</b>	Right turn	Merrica River Rd
<b>22.5 km</b>	Stop the car	Bridge over Merrica River

The site is downstream of the bridge and includes the deep pool about 100 metres from the bridge.

**Access route:** This constitutes a diagrammatic representation of the route used to access the site. Show the location of major towns, roads and highways. Indicate the location of turnoffs and landmarks leading to the site and the route direction (eg. north).

**Land owner/manager:** Occasionally there is a need to get the owner/occupiers permission to enter property and access a river site. If a situation arises while in the field where private property needs to be entered seek out the owner/occupier prior to sampling. Explain the purpose of the exercise and request permission to access the site (preferably more than once). Record their relevant details such as name, address, telephone and fax numbers on the field data sheet. If keys or prior notification of upcoming sampling events is required also note the details down on the data sheet.

#### **4.3: NSW field data sheet page 2: Attributes of the site**

This section aims to provide a general description of the environment within and immediately surrounding the site.

**Defining site boundaries:** Stream width should be the first environmental variable estimated upon arrival at a site as the length of river to be sampled is determined by the modal stream width (Refer to section 3.2 and the Stream Width section below for further details). Once the boundaries of the site (i.e., the length of river reach to be sampled) have been established all other environmental variables can be measured and recorded.

**Topography:** This is recorded to provide a general idea of the shape of the river valley around the site. Please choose only one of the 4 categories given on the data sheet. Note any reservations or comments in the Comments section on page 3.

**Water level:** This is to determine whether flow in the river at time of sampling is comparable to base flow. If flow at the river site appears to be equivalent to base flow then Water Level should be recorded as Moderate. If considerable sections of the streambed and banks that would normally be submerged are out of water then the water level is Low (Figure 8). Conversely if considerable sections of the within-bank riparian zone are submerged then the water level is High. Flood is used to represent a situation where water has gone over the banks (Figure 9). Any evidence to suggest that a recent flood has passed through the site should be recorded in the Comments section on page 3. Recent floods can affect macroinvertebrate communities and therefore AUSRIVAS assessments. Sampling should take place at least 2 weeks after any recent flood event.

Normally the None water level category is an extreme situation and indicates greater stress than the Low category. In some streams, however, the base flow is just a trickle and therefore a no-flow situation occurs very frequently and does not represent an extreme condition for the river. Such cases should be noted in the Comments section on page 3. Again it is important to choose only one Water Level category. Record any reservations or comments. These observations can be confirmed by contacting the relevant water management authority for the region.



**Figure 8.** Low flow. Coffs Creek upstream of Pacific Hwy.



**Figure 9.** Not a good time to sample! Mann River at Mann River Reserve in flood. Floods can affect the presence of macroinvertebrate communities at a river site and therefore sampling should not take place during or immediately following a flood event. It is best to wait at least 2 weeks after the flood has subsided.

**Shading of river:** This is the amount of water surface across the whole site that would be shaded when the sun is directly overhead. Where deciduous plants (eg. willows) dominate the riparian vegetation it should be noted whether the observations are made before or after leaf fall. If shading has been reduced by a recent fire or other such event this should also be added to the Comments section on page 3.

**Riparian vegetation:** The riparian zone includes the area of adjoining land that directly influences or is influenced by a body of water (Boulton and Brock, 1999). The edge of the riparian zone can usually be identified by a change in vegetation. Record the percentage cover of the 3 vegetation categories in the riparian zone as specified on the data sheet. These categories include small trees, shrubs/vines/rushes and the grass/herb/fern layer. Percentage cover should be recorded as an estimate of the ground covered by each category. This does not have to add up to 100%. Typically riparian vegetation includes a few tall trees, a reasonable cover of small trees and shrubs with a good ground cover of grasses, sedges and ferns. Trees greater than 10 metres are recorded as either present or absent. Try to identify as many of the plants as you can. Most important are the common trees, shrubs, sedges and grasses. If names are unknown it is worth recording whether the plants are native or exotic.

**Percentage cover of algae, moss and macrophytes:** These should be recorded as a percentage cover of the total streambed of the site. Algae should include only filamentous algae. All types of macrophytes i.e. submerged, floating and emergent should be included in the macrophyte estimate.

**Stream width:** As noted above, stream width should be the first environmental variable defined upon arrival at a site. Estimate the minimum, maximum, and mode stream width in the section or river to be sampled (See section 3.2 for further details). Visual estimates of stream width are usually acceptable but it is necessary to calibrate your estimates regularly using a measuring tape. If the stream or river is multi-channelled at your site estimate the stream width across all channels.

**Water quality:** Measure water quality variables using available meters and record values in the designated box on the data sheet. Use only properly calibrated instruments and pay special attention to the units required (see below). Dissolved oxygen meters in particular need to be checked regularly using 100% saturated water and may also need to be adjusted for changes in altitude at each site. Check manual for correct operation procedures. The time of day should also be recorded as values of some water quality variables can change during the course of the day.

Water quality variables to be measured in the field are:

Water temperature	°C
Conductivity	µS/cm
Turbidity	NTU
pH	
Dissolved Oxygen	mg/L
Alkalinity	mg CaCO <sub>3</sub> /L

Water quality measurements should be taken prior to macroinvertebrate sampling in a flowing section of the stream. Avoid very fast turbulent areas, backwaters and still areas close to the edge of the stream and always place the instrument/s upstream of where you are standing. If it is not possible to take water measurements prior to macroinvertebrate sampling find a suitable location upstream of the river section disturbed during sampling.

Alkalinity can be measured in the field using a small sample of river water and an alkalinity kit (refer to sampling equipment list in Appendix 1). Follow the instructions provided. Alkalinity refers to the buffering capacity of the water (Boulton and Brock 1999) and is expressed as the concentration of CaCO<sub>3</sub> in milligrams per litre of water. If measuring kits are not available, an alternative method is described in the AUSRIVAS Sampling Manual for the ACT.

A water sample for nutrient analysis should also be taken prior to macroinvertebrate sampling. The sample should be collected from a flowing section of the stream, preferably a good distance from the edge. For total nitrogen, oxidised nitrogen and total phosphorus a water sample should be taken using a clean 500 ml sample bottle. Rinse the bottle three times in the river before filling. The bottle should be fully submerged to avoid collecting floating matter and should be filled to the brim, to avoid including air bubbles. If filtered samples are to be taken (for ammonia, nitrate and nitrite) rinse the sample bottle first with filtered water before filling. Avoid touching the inside of any sample bottles, lids or filters.

Keep all water samples cool and if they are not to be transported that day to the laboratory for analysis they should be frozen (in this case leave an air gap to allow for expansion). Tick the appropriate box when the samples have been taken.

**Birds eye view:** This should diagrammatically represent details of the entire reach sampled. In the drawing show the shape of the stream and pools, the location of riffles and other prominent features such as sandbars, sand and/or pebble beaches. Also, show the location of large areas of bedrock, large logs, macrophyte beds and distinct patches of riparian vegetation. Indicate the direction of flow, the north compass bearing and the site access point (try to relate this to the access diagram on page 1).

**Land use:** Assess and record the major uses of land on both sides of the river at your site. Try to be as specific as possible by following the examples presented on the data sheet. Elaborate in the Comments section if you think the options provided do not adequately reflect the land use at your site or if a combination of different land uses is evident.



#### 4.4: NSW field data sheet page 3: Attributes of the riffle and edge habitats

**Collector and Sorter:** The name of the person who collected and sorted each macroinvertebrate sample collected at the site should be recorded in the space provided.

**Picked at the site Yes/No:** Whether a sample was sorted at the site or not should be recorded on the data sheet by circling Yes or No in the relevant habitat box. This information is very important as this may affect sorting ability and hence quality of the data. If not sorted at the site information on the location of sorting and time after collection should be recorded in the Comments section at the bottom of the page. Samples should always be sorted as soon as possible after collection in a suitable location preferably during daylight hours. Please note that sorting ability can be significantly reduced if samples are sorted under poor light conditions such as fading sunlight or indoors under artificial lights. Keeping samples for a considerable length of time prior to sorting can also affect sorting ability and hence data quality as animals begin to die and destroy each other. If it is necessary to keep samples for a few hours prior to sorting keep cool and moist with a small amount of water (do not drown the samples) either in the sampling net or transfer to a container or plastic bag. Samples carried just a few hundred metres away from the site to a more suitable sorting location soon after collection can still be considered as picked at the site.

**Description of natural substrate:** Visual estimates of the composition of the river substrata should be recorded separately for the two different habitats. Percentage cover of each of the given substrate categories should be estimated and recorded on the data sheet for the habitats sampled. It is important to record zeros where applicable and the sum of all substrate categories must add up to 100%. Dimensions for each of the substrate categories are provided on the data sheet. Familiarise yourself with the range of sizes within each substratum category. Regularly use a ruler or measuring tape to check the threshold size for boulders, cobbles and pebbles, and use sieves to calibrate estimates for small particle sizes.

For riffles include only the main submerged substrata within riffles that were sampled. For example do not include your guess of the substrata of 1.5 m deep riffles as this information is of little use and might lead to inappropriate assessments for the site. For edges record percentage estimate for the substrata present on the streambed only. Do not include the makeup of the banks in your estimates. For example if a stream has a rocky/sandy bed but silty/clay banks, silt and clay should not be recorded in the substrate estimates for the edge habitat. Thin layers of fine sediment (silt, sand) covering all substrata should not be counted for either habitat.

It is important to remember that these estimates are used to represent the natural substrate composition of the site. Therefore if you feel this has changed significantly at your site as a result of human disturbance eg. the deposition of sand and gravel in riffle zones as a result of land clearing, your estimates should be adjusted accordingly. Values recorded at similar reference sites in the area can be used for this purpose.

**Depth (riffles):** Measure and record the maximum, minimum and mode depths of riffles within the site. Mode depth is defined as the most common riffle depth found at the site. Visual estimates are usually acceptable but it will be necessary to calibrate your estimates regularly using a ruler.

**Detritus cover:** Percentage cover of detritus should be recorded as a percentage cover of the streambed for each habitat. Detritus includes all leaves, twigs and bark present on the streambed. In riffles these can be caught among the cobbles, pebbles and boulders and may cover a small percentage of the riffle substrata.

**Bank overhang (edges):** This refers to the percentage of bank edge that overhangs the water at the site. A single figure should be estimated to include both banks.

**Trailing bank vegetation (edges):** This refers to the percentage of bank vegetation that is trailing into or close to the water surface at the site. A single figure should be estimated to include both banks.

**Macrophytes** (edges): Record the percentage cover of submerged, emergent, floating and total macrophytes in the edge habitat. This should represent the percentage cover of the streambed. Total macrophyte cover may therefore be less than the total given for the individual macrophyte types where these are layered in the water column.

**Comments:** Comments regarding unusual sampling conditions, habitat conditions or water quality results are critical for interpreting AUSRIVAS outputs. Any information that may potentially affect the quality of the data collected should be recorded in this section. Some examples of unusual or difficult sampling conditions that may affect the ability of an operator to collect an adequate sample are listed below. For collecting these include the presence of fast flowing deep riffles, large slippery boulders, slippery steep banks, deep pools or heavy rain. For sorting these include poor light, rain or distractions such as lots of mosquitos. Unusual habitat conditions such as marginal habitats (i.e. less than 10 m of suitable sampling areas), very shallow slow flowing riffles, fast flowing edges and riffles with a naturally high percentage of sand, gravel and/or pebble substratum may also lead to poorer than expected results. Reasons why are provided above in the Habitats Sampled section of this document. Malfunctioning water quality instruments and suspect readings should also be noted as comments in this section.

#### **4.5: NSW field data sheet page 4: A visual assessment of disturbance related to human activities**

This assessment is aimed at summarising evidence available at the site of alteration caused by human activities to different components of the stream ecosystem. Some evidence is objective, easy to identify and valid for all stream types. Other evidence, however, may be specific to the type of river in question and harder to identify. The operator is required to use her/his knowledge of streams in the nearby area and decide how much this site has changed as a result of human activities.

For example, turbid waters do not necessarily indicate human disturbance for all rivers. In some river systems such as the Paroo River in the far north-west of NSW (Figure 10) high suspended sediments are natural and high turbidity in these rivers should not lead to a high disturbance score.

One of the most important factors to consider when making judgements on the level of disturbance for a site is consistency. If disturbance rankings are allocated in a consistent manner between sites, sampling events and other team members within your project, meaningful information can be extracted from these observations. It is also important to include as much detail as possible in the comments section as this will be useful for making adjustments or indicating where changes might have taken place from one sampling event to another.



**Figure 10.** The Paroo River in the North-West of the state is naturally very turbid.

## 5: Collection of biological data

### 5.1: Collection of macroinvertebrate samples

All macroinvertebrate sampling must be done with a kick net of 0.25 mm mesh size. The preferred net frame is one with a pentagonal shaped opening with a base of 35 cm or greater. The net should be long enough to not cause backwash (60 cm or more) and the net handle should be long enough (1.2 m) to reach animals and sub-habitats that are not immediately near the operator. Nets should be rinsed well prior to each sampling occasion to ensure no animals collected from another habitat or site remain stuck to the net.

#### 5.1.1: Riffle sampling

Locate the downstream end of the riffle zone within the site and begin sampling there. Disturb the substratum with your feet while holding the net downstream with its mouth facing upstream (Figure 11). Vigorously move the substratum about by digging your feet well into the cobbles and boulders. If necessary, turn and rub the boulders and cobbles by hand to dislodge organisms. Continue this process until you have sampled a total of 10 metres of riffle habitat. Depending on the extent and structure of the riffle habitats being sampled this may be a continuous 10 metres or consist of a number of discrete segments totalling 10 metres. In rivers where there is little variation in riffle type or where only 10 metres of riffle is available, you may have to sample a continuous 10 metres of riffle. However, in most rivers, to ensure the inclusion of all riffle sub-habitat types available in that reach, it will be necessary to sample a number of discrete segments, 1 to 2 metres in length. All available combinations of flow (fast, moderate, and slow flowing), depth (shallow to deep), and substratum (boulder, cobble, pebble, etc) should be considered potentially different sub-habitats and each sub-habitat should be represented in a sample.

It may be necessary to stop and rinse the net a couple of times during sampling to remove fine particles that can block the flow of water through the net which can cause backwash and loss of captured macroinvertebrates. It is also a good idea to

thoroughly rinse the sample again once sampling is completed. This will assist in the sorting process by removing fine particles that can cloud water in the tray and obscure the animals present.

### **5.1.2: Edge sampling**

As for riffles, a total length of 10 metres is sampled in edge habitats. Once again, these 10 metres need not be continuous and can be composed of a number of discrete segments, 1 to 2 metres in length, that ensure the inclusion of all edge sub-habitat types available in the reach. Samples in edge habitats are collected by using two types of sweeping motions with the net. The first type, sequential, short sweeping movements at right angles to the bank (Figure 12), dislodges benthic animals and suspends them in the water column. This movement includes scraping of hard surfaces such as submerged logs, bedrock or boulders as well as the upper parts of soft surfaces such as clay banks and the instream parts of sandy beaches, etc. The second type of movements, when the net is swept through the cloud of suspended material, collects macroinvertebrates in the net. This procedure (combining both types of net sweeping) should be repeated in each of the discrete segments sampled in the edge habitat.

Attempts should also be made to collect surface dwelling insects such as water striders and whirligig beetles. This may not be easy, particularly for water striders (family Gerridae). If surface dwellers are observed at a site but can not be caught in a net, mark a record of their presence on the field data sheet. It is also worthwhile writing the name of the surface dweller (i.e., Gerridae) on a label and placing it in the jar containing the live picked macroinvertebrate sample for the edge habitat.

When sampling the edge habitat, try to sample all sub-habitats present in the reach. Sweep the net in amongst tree roots, trailing bank vegetation, under overhanging banks and along logs if present. Do not, however, work into log crevices or use your hands or any means other than the net to extract animals. Macrophytes can be included in the edge habitat and should be sampled if abundant, however, small patches of macrophytes should not be deliberately sought for while sampling. As mentioned for the riffle it is recommended to thoroughly rinse the sample in a clear water area once sampling is completed. This will assist in the sorting process by

removing fine particles that can cloud water in the tray and obscure the animals present.

### **5.1.3: Sampling edge habitats in western flowing, lowland rivers**

The efficiency of the AUSRIVAS techniques in lowland rivers depends on sampling all available sub-habitat types in each reach (Johnstone *et al.* 2003). Special attention must be given to rigorously sampling all of the different types of sub-habitat available in the edge habitats of lowland reaches. The lower density and diversity of sub-habitats in lowland rivers means that it is essential to represent all sub-habitats in samples to maximise the diversity of macroinvertebrates collected. Operators are therefore required to make judgements about the separation between the sub-habitat types present in each reach. Sub-habitats may include (but are not limited to), tree roots, overhanging banks, trailing vegetation, mud banks, macrophyte patches, logs, and patches of leaf and woody debris. Refer to Johnstone *et al.* (2003) for a detailed discussion of the issue of AUSRIVAS sampling in lowland rivers in NSW.

Upon arriving at a new lowland site a survey of the reach should be conducted. After inspecting the entire reach all operators present should discuss the types of sub-habitat available and agree upon an appropriate sampling strategy. It may be necessary to use a small rowing boat or canoe to access both banks if a particular type of sub-habitat is not represented on the access bank. Sampling the far bank by boat or canoe may also be necessary if a sub-habitat type that represents a large area of the far bank only covers a very small area of the access bank and would therefore be under-represented if only the access bank was sampled. While sampling from a boat or canoe, samples should only be collected from areas that are strictly edge habitats. Avoid sampling any structures away from the bank, such as snags, that do not constitute edge habitat. Appropriate safety precautions should be taken at all times while collecting samples from a boat or canoe and either activity should be avoided in strong winds.



**Figure 11.** Sampling the riffle habitat, Tuena Creek downstream Bears Gully.



**Figure 12.** Sampling the edge habitat, Upper Hastings River at Werrikimbee.



## 5.2: Macroinvertebrate sample processing

In NSW a live-pick sorting procedure is used. Samples should be sorted as soon as possible after collection. Edge and riffle samples must be processed separately. Sorting should be conducted in a comfortable position (Figure 13) preferably close to the site and during daylight hours. If this is not possible and the sample must be transported a considerable distance from the site the contents of the net should be transferred into a labelled container or bag and kept cool and moist with a little water.

The aim of the live-sorting procedure is to pick as many macroinvertebrate taxa from the sample as possible. An ability to recognise macroinvertebrate families will be of great help in this process. Standardisation of picking effort and performance during the live picking procedure is achieved by meeting set criteria as detailed below.



**Figure 13.** A suitable set up for sorting macroinvertebrate samples.

### 5.2.1: Criteria for live-picking

Maximising the diversity of macroinvertebrates collected is the main objective of live-picking. In NSW, there is no set minimum or maximum number of animals to be

collected. **The minimum picking time is 40 minutes.** How much time, if any, should be spent picking in excess of this minimum is dependent upon the time elapsed since a new taxa has been collected and should be determined in accordance with the following criteria.

- Empty the contents of the net into a sorting tray and pick progressively through the sample using forceps and/or a pipette. Rinse the net to remove all material and check for remaining animals. Ensure no animals are lost from the sample by jumping or crawling out of the tray. If fine clay particles are clouding the sample in the tray return it to the net and rinse thoroughly in the river to remove these before sorting. Where there is a large amount of material in the tray it may be more efficient to sort through a portion of this material at a time using a number of different sorting trays. All material should be examined at least once in the first 30 minutes.
- For the first 5 minutes, collect the active, common taxa while trying to avoid being biased towards the larger, more colourful ones.
- For the next 20 minutes, concentrate on getting new taxa.
- If by 25 minutes no new taxa are found, concentrate on getting more animals for the next 5 minutes.
- At 30 minutes make a mental note of what has been collected and continue for at least 10 more minutes taking note as to whether any new taxa (i.e., taxa not collected in the first 30 minutes) are found.
- If new taxa **are** collected between 30 and 40 minutes, continue picking for 10 more minutes.
- If new taxa **are** collected between 40 and 50 minutes, continue picking until 60 minutes has elapsed.

- **Maximum picking time is 60 minutes.** If new taxa were collected between 50 and 60 minutes, this should be indicated on the data sheet and on the label placed in the sample jar.
- Place picked animals into a jar of 70% ethanol (with 2% glycerol). A label, which should be placed inside the sample jar, should contain the site code, location, sampling date, habitat sampled and the name of the collector and sorter. Writing in pencil on waterproof paper makes the most effective label.

**During the entire live-picking procedure detailed above:**

- Actively search for cryptic and/or small taxa, a selection of which is shown in Appendix 3.
- Attempt to pick at least 20 Chironomids to ensure that an adequate representation of all subfamilies is obtained.
- Check the bottom of the sorting tray when discarding any sample residue to ensure that previously undetected taxa are not attached to the tray. Taxa commonly found stuck to the tray include flat worms, water pennies, leeches, freshwater limpets and other gastropods. Any new taxa found at this stage should still be added to the live-pick sample.

### **5.3: Macroinvertebrate identification**

Macroinvertebrate samples need to be identified to family level with the exception of Oligochaeta (to class), Polychaeta (to class), Ostracoda (to subclass), Nematoda (to phylum), Nemertea (to phylum), Acarina (to order) and Chironomidae (to subfamily). All macroinvertebrates should be identified using the taxonomic keys listed in Hawking (2000).

For the purpose of AUSRIVAS, however, it may be necessary to use the former taxonomic classification indicated by *Formerly ...* in brackets after the current taxa name in Hawking 2000. This is because new taxonomic names were adopted during the course of the project and it was not possible to re-identify all relevant material collected prior to this time. As a consequence, the AUSRIVAS models for NSW were built using the most recent classification available in 1994 and will therefore not recognise some of the latest taxa names listed in Hawking 2000. A list of the taxa for which the former family name should be used in AUSRIVAS for NSW include:

Ephemeroptera

Teloganodidae (formerly Ephemerellidae)

Odonata

Hypolestidae (formerly Lestoideidae)

Cordulephyidae (formerly part of Corduliidae)

Austropetaliidae (formerly Neopetaliidae)

Pseudocorduliidae (formerly part of Corduliidae)

For example if you have identified Cordulephyidae in your sample this record needs to be changed to Corduliidae before running your data through any of the NSW AUSRIVAS models.

Another family that needs to be changed prior to entry into AUSRIVAS is Sphaeriidae. In the NSW models Sphaeriidae has been combined with the other molluscan family Corbiculidae. Therefore all specimens from these two families should be combined and entered as Corbiculidae when using the NSW models.

A list of taxa used in model development in NSW can be found in Appendix 4 and should be referred to ensure the appropriate taxa name is used in AUSRIVAS for specimens collected.

## 6: Further information

Enquiries on all aspects of the state-wide AUSRIVAS models for New South Wales may be directed to Eren Turak on (02) 9995 5506 or by emailing [turake@epa.nsw.gov.au](mailto:turake@epa.nsw.gov.au)

Many of the techniques used in the collection of macroinvertebrate samples and environmental data and the identification of macroinvertebrate samples are similar to those of the other states. The Australian Capital Territory (ACT) AUSRIVAS sampling Processing Manual provides a detailed coverage of all the sampling and sample processing procedures and can be used as reference by AUSRIVAS users in NSW in relation to procedures that are the same in NSW and the ACT.

## 7: Acknowledgments

AUSRIVAS models in NSW would not have been completed without the contribution of a large number of people. A list of those who participated in the project is given in a document titled Contributors to the Development and Testing of AUSRIVAS Models in NSW (<http://AUSRIVAS.canberra.edu.au/man/NSW/>).

## 8: Field guides

Gooderham J, and Tsyrlin E. 2002. The Water Bug Book: A guide to the freshwater macroinvertebrates of temperate Australia. CSIRO Publishing, Canberra.

Hawking J. H. and Smith F. J. 1997. Colour guide to invertebrates of Australian inland waters. Identification Guide No. 8. Cooperative Research Centre for freshwater Ecology: Albury.

Sainty G.R. and Jacobs S.W.L. 1994. Water Plants in Australia: A field guide. 3<sup>rd</sup> Ed., CSIRO, Canberra.

## 9: References

- Bennison G.L., Hillman T.J. and Suter P.J. 1989. Macroinvertebrates of the River Murray (Survey and Monitoring: 1980-1985). Murray-Darling Basin Commission. Water Quality Report No 3.
- Boulton A.J. and Brock M.A. 1999. Australian Freshwater Ecology. Processes and Management. Gleneagles Publishing.
- Davies P.E. 1994. River Bioassessment Manual. Version 1.0, Monitoring River Health Initiative. National River Processes and Management Program. Canberra, February 1994.
- Hawking J.H. 2000. Key to Keys. A guide to keys and zoological information to identify invertebrates from Australian inland waters. Identification Guide No. 2 2<sup>nd</sup> Edition. Cooperative Research Centre for Freshwater Ecology.
- Johnstone G.J, Turak E, Mawer D, Gillies C, & Theischinger G, 2003. Macroinvertebrate QA/QC sampling for the Sustainable Rivers Audit pilot study of the Lachlan River. A report to the Murray-Darling Basin Commission by the NSW Environment Protection Authority, Sydney.
- Nichols S., Coysh J., Sloane P., Williams C. and Norris R. 2000 Australian Capital Territory (ACT) AUSRIVAS Sampling and Processing Manual. (<http://ausrivas.canberra.edu.au/man/ACT/>)
- Turak E. and Waddell N. 2001 Development of AUSRIVAS models for New South Wales. (<http://ausrivas.canberra.edu.au/man/NSW/>)
- Turak E., Flack L., Norris R.H., Simpson J, Waddell N. 1999. Assessment of river condition at a large spatial scale using predictive models. *Freshwater Biology* **41**, 283-298.

Waddell, N. 2001 Quality Control and Quality Assurance Programs for the NRHP in NSW. (<http://ausrivas.canberra.edu.au/man/NSW/>)

## Appendix 1: Equipment required for AUSRIVAS sampling

### General

- Data sheets including field data sheets, master sampling sheets and photo sheets
- NSW AUSRIVAS Sampling and Processing Manual
- Clipboard
- Forestry and topographic maps
- Camera and film
- Tape Measure, 100 m
- First aid kit
- Sunscreen
- Hard hats
- Recovery equipment
- Fire blanket
- GPS
- Mobile Phone
- Ruler, 1 m
- Distress beacon
- Wet weather gear
- Dolphin torch
- Axe
- Table and chairs

### Water Quality

- Yeokal 611 water quality meter (or similar)
- Alkalinity measuring kits, HIGHS and LOWS (supplied by Edwards Instruments, Narellan)
- Car fridge/freezer or large esky and ice
- 500ml PET bottles for nutrient samples
- 30mL vials for filtered nutrient samples
- Filters and syringe
- Calibration kit including:
  - DO membranes and electrolyte
  - pH standards
  - Calibration instructions and tools required
  - Distilled water and calibration cups

### Macroinvertebrate sampling

- Handheld kicknets 250 mm mesh
- Waders
- White sorting trays
- Sample jars filled with 70% ethanol
- Large plastic bags
- Watering can or plastic bucket
- Large jars for QA/QC residues
- Packing tape
- Jerry can ~95% Ethanol
- Sampling box including:
  - Labels: macroinvertebrate and water samples
  - Jewellers forceps
  - Plastic pipettes
  - Counters
  - Pencils
  - Pencil sharpener and eraser
  - Elastic bands
  - Marker pens
  - Adhesive labels



## **Appendix 2: Calculating mean annual rainfall for AUSRIVAS in NSW**

Mean Annual Rainfall is currently required for all the eastern edge and riffle models for NSW. The data source used to derive Mean Annual Rainfall for these models is part of the Annual Mean Precipitation data set (ERIN 1996) (see Figure 1). Mean annual rainfall for a site can be derived using this data set and a GIS. If not available, however, the following maps can be used to derive a suitable value for mean annual rainfall for a given site. Follow the instructions given below.

### **Instructions for calculating Mean Annual Rainfall for a given site.**

1. Locate and mark the position of your site on the relevant 1:100 000 topographic map. For example the site location details of the Merrica River example used in the main document are as follows: Merrica River at Merrica Road (TOWA571) 759200 E, 5867100 N, Eden 8823.
2. Establish which regional map to use (Figures 4-7) with the assistance of the NSW map provided in Figure 2. For example the South Coast Regional Map would be the correct one for the Merrica River example.
3. On the appropriate regional map locate the name of the 1:100 000 topographic map on which your site is located. For example locate the Eden map grid for the Merrica River example.
4. Copy the displayed rainfall contours for the map grid on the topographic map and determine the mean annual rainfall categories by referring to the legend displayed in Figure 3. A value for mean annual rainfall can then be derived for a site by noting the rainfall category in which it lies. For example the Merrica River site has a mean annual rainfall of 750 mm, indicated by the dark violet area.

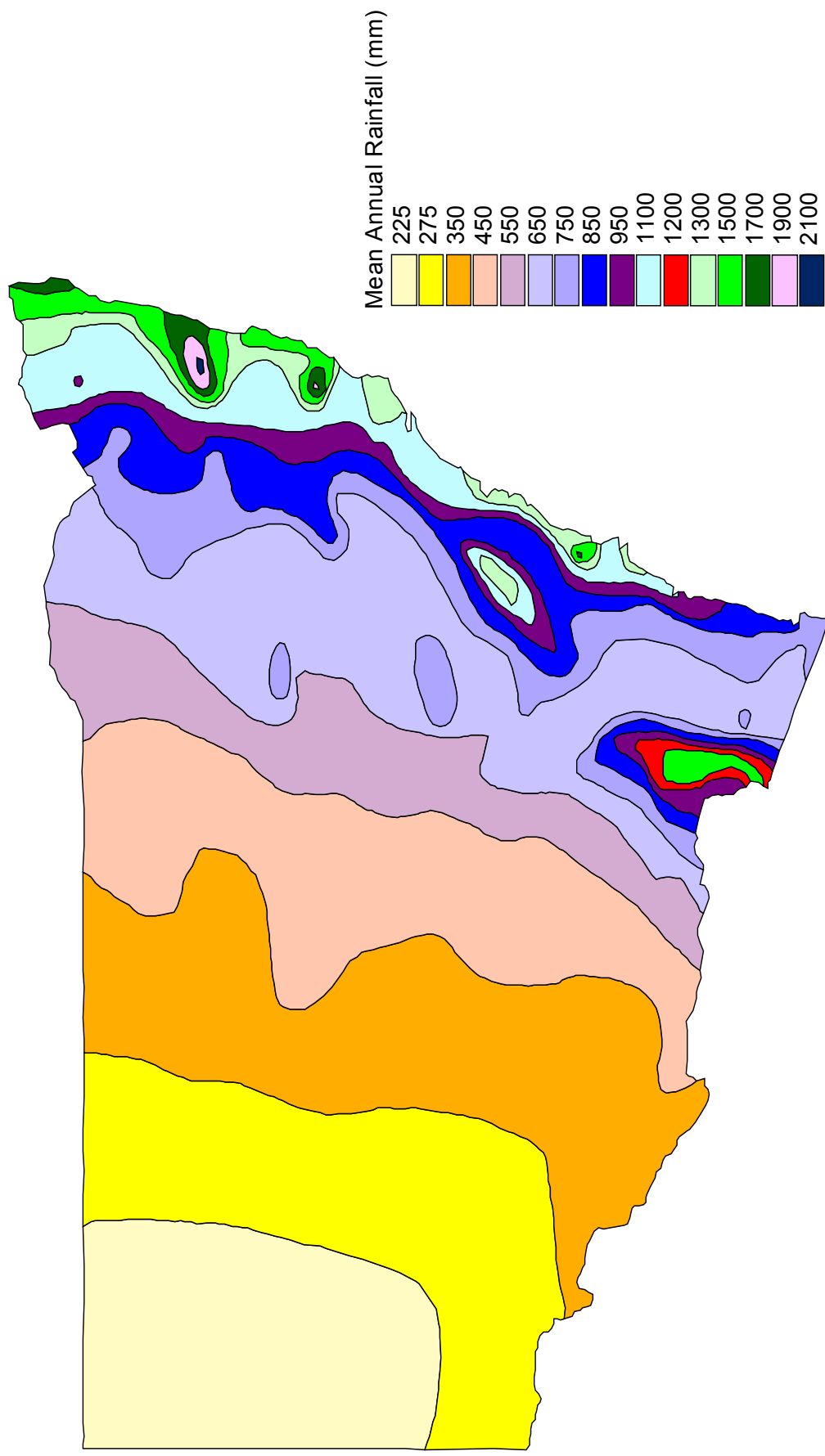


Figure 1. Mean Annual Rainfall for New South Wales (data set part of the Annual Mean Precipitation, ERIN, 1996)

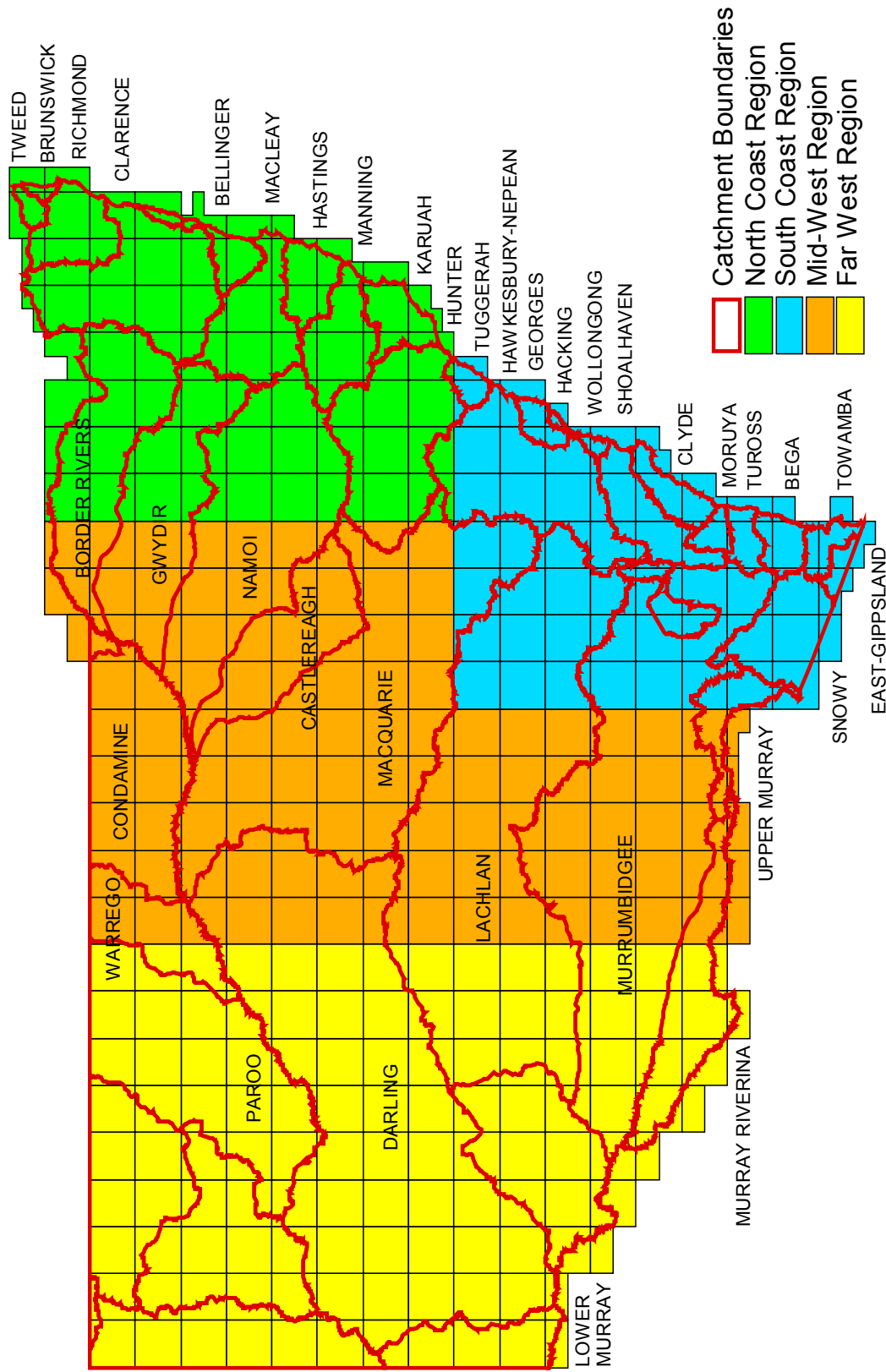
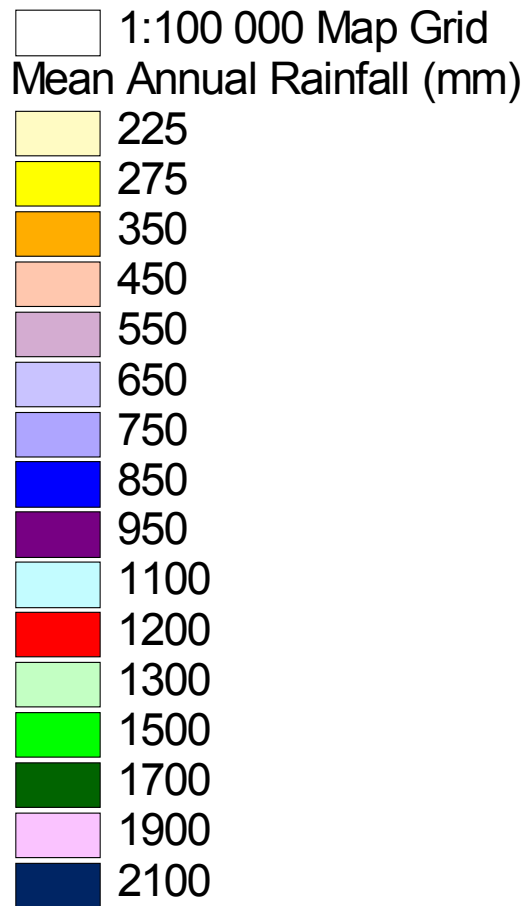
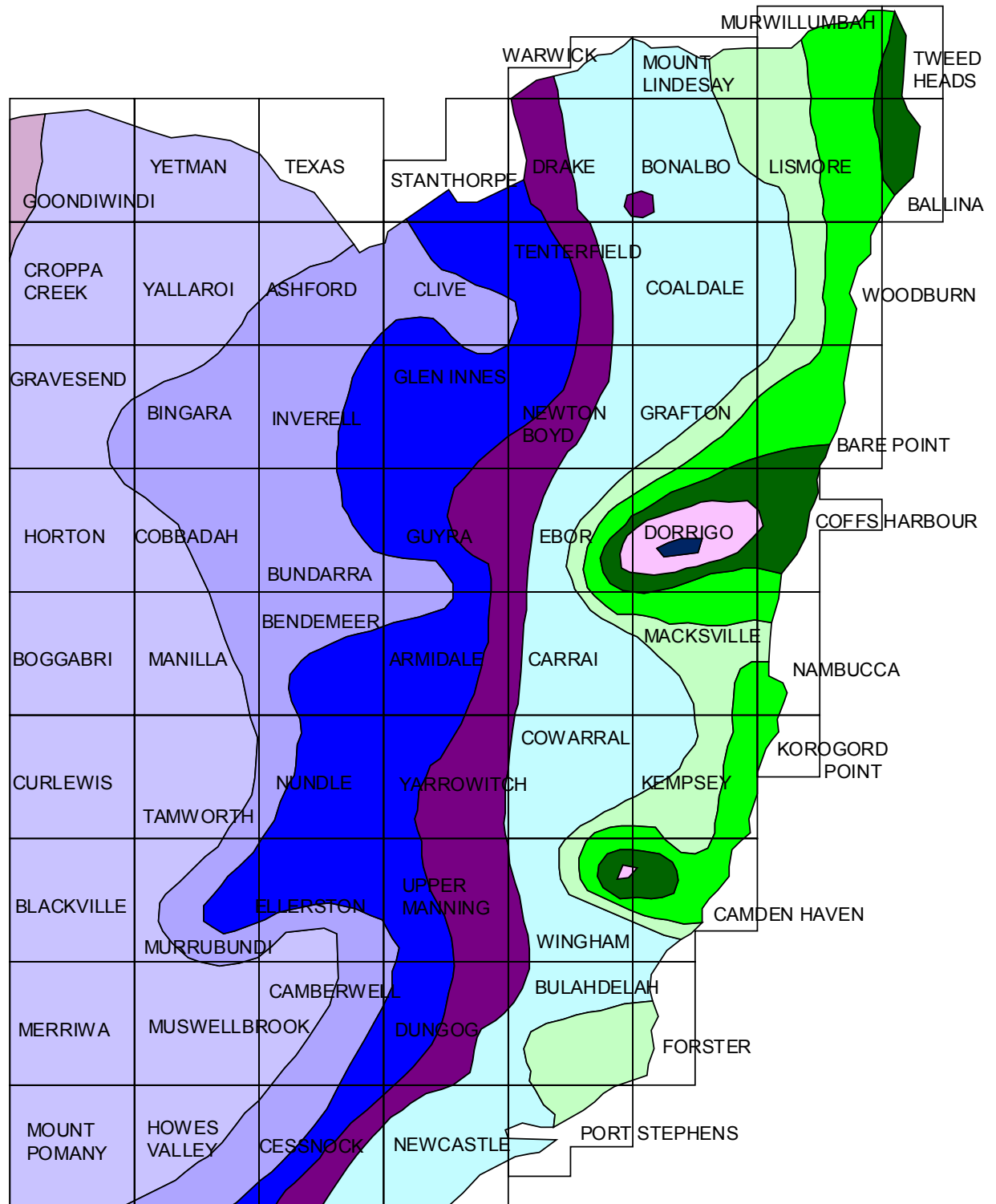


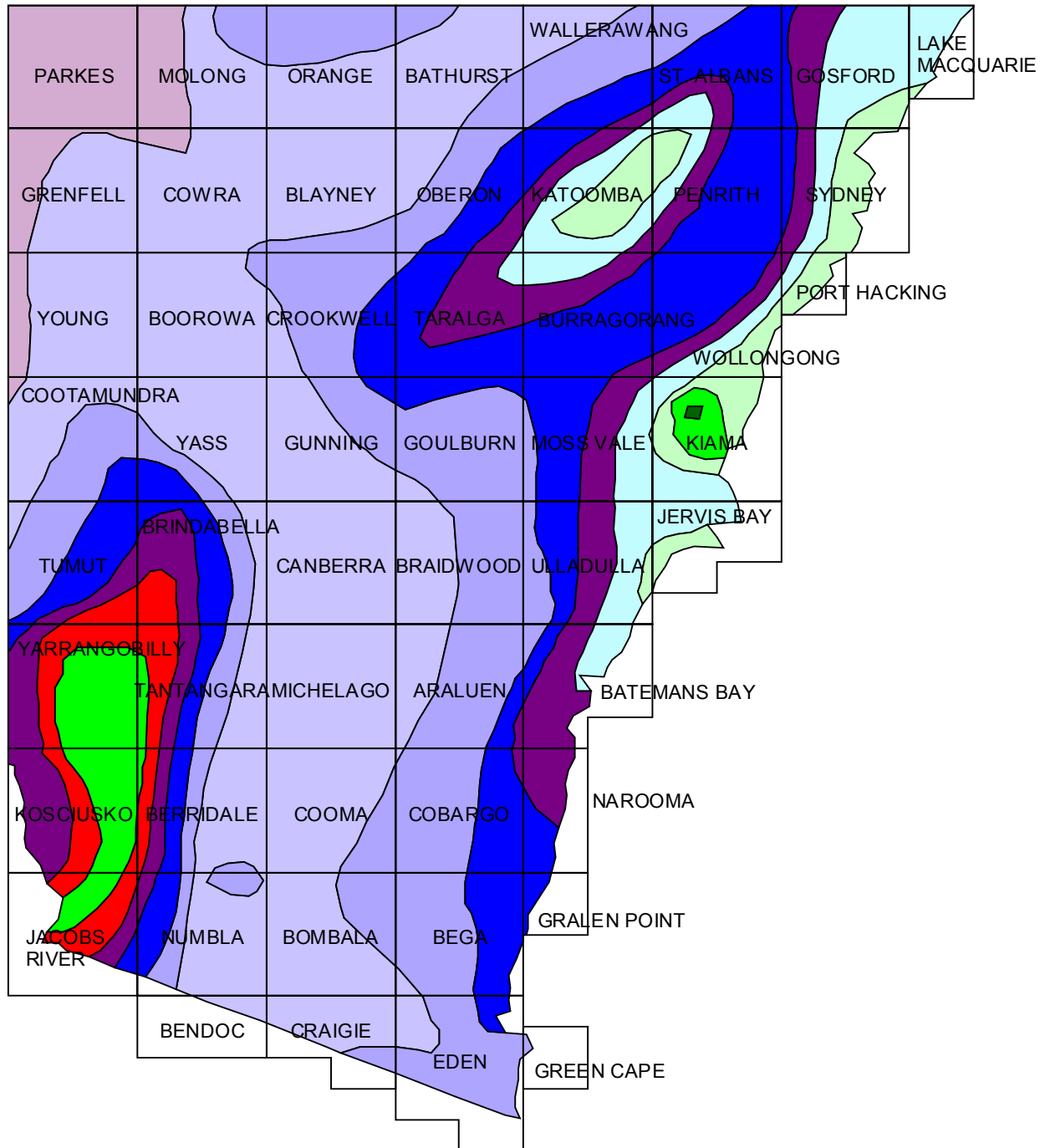
Figure 2. Location of the 4 geographic regions used to create regional rainfall maps for NSW. (note catchments labelled)



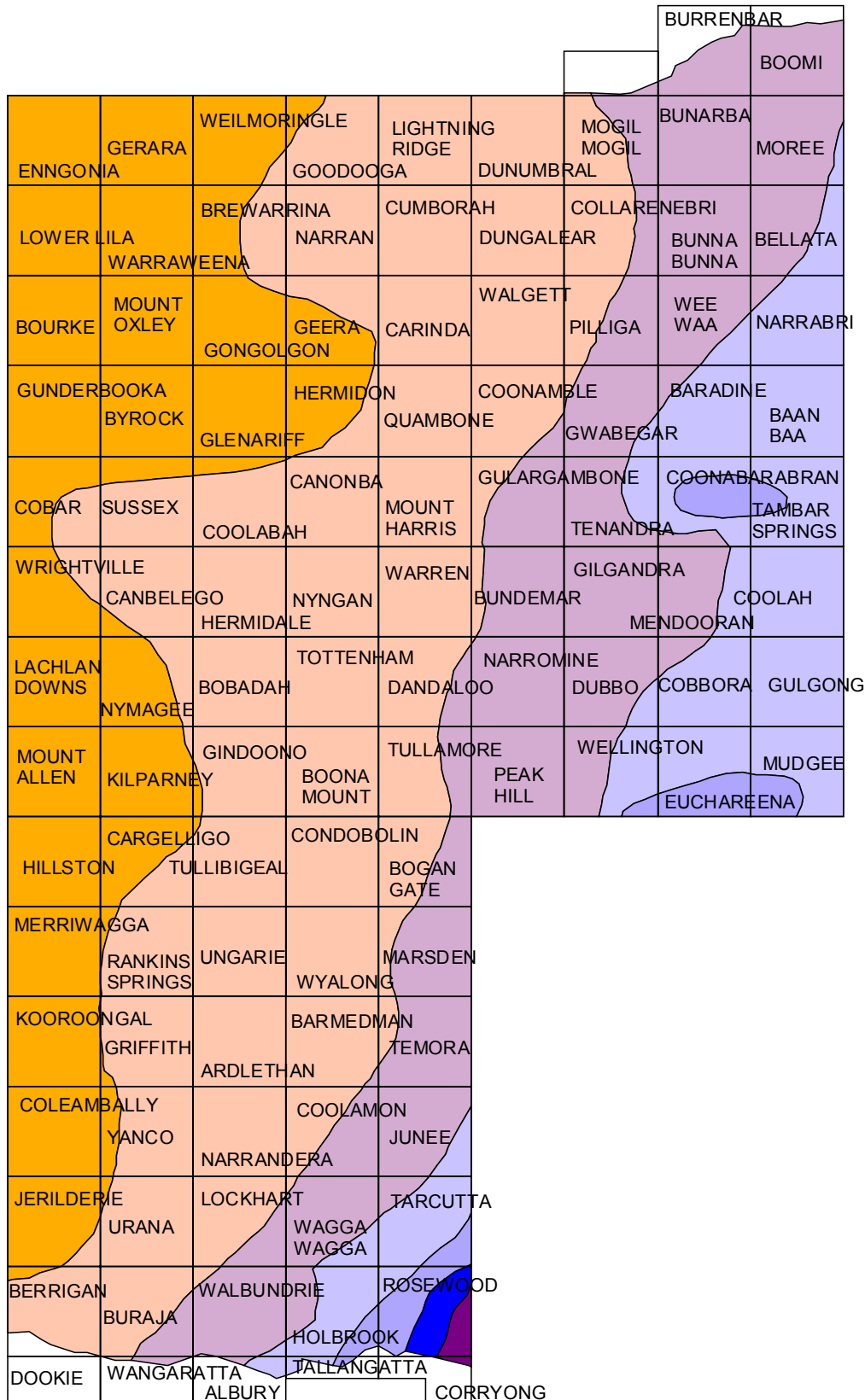
**Figure 3.** Legend for Figures 4-7 Mean Annual Rainfall for the North Coast, South Coast, Mid West and Far West Regions of NSW with the 1:100 000 topographic map grid (data set include part of the Annual Mean Precipitation, ERIN 1996).



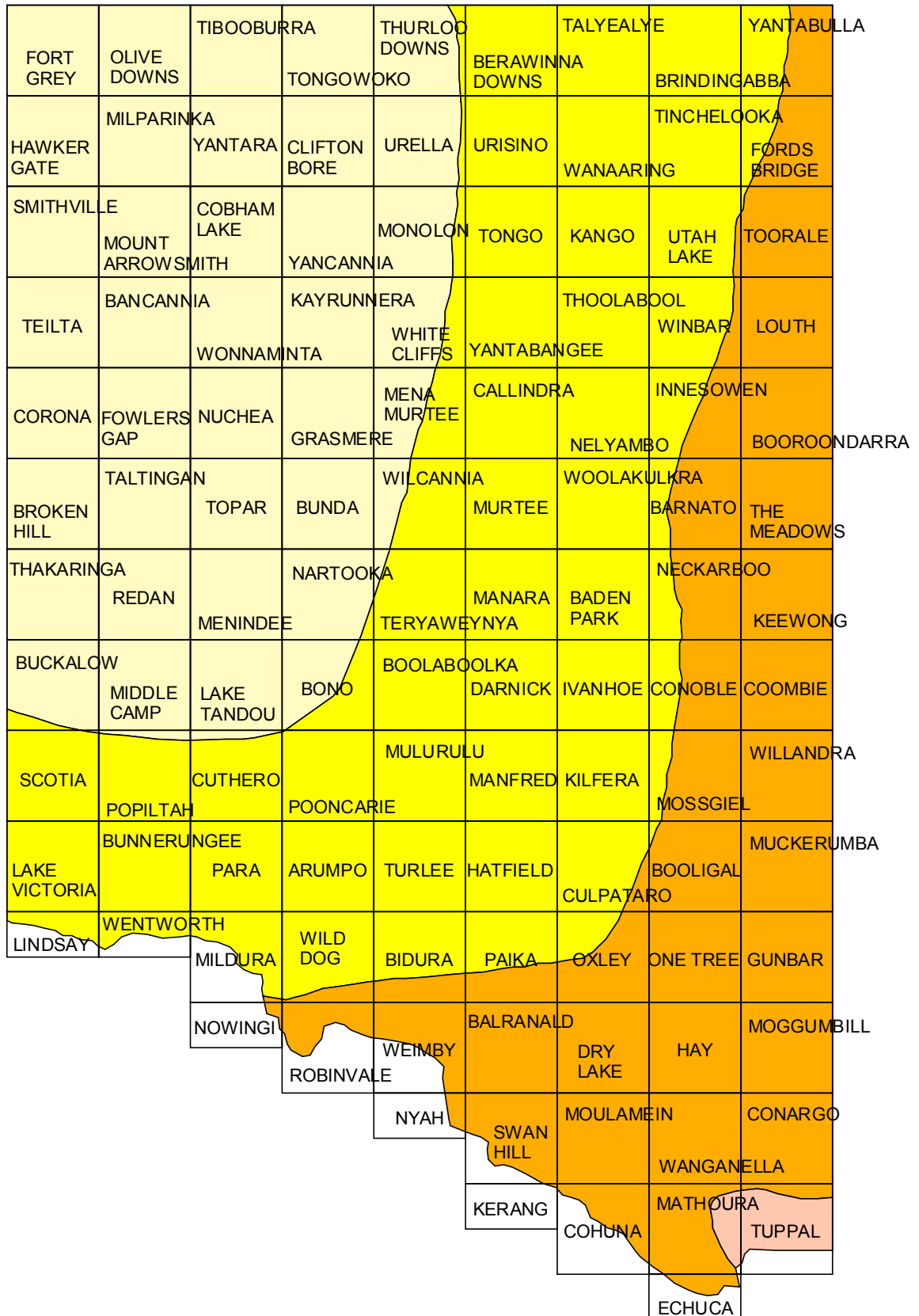
**Figure 4.** Mean Annual Rainfall for the North Coast Region of NSW with the 1:100 000 topographic map grid (data sets include part of the Annual Mean Precipitation, ERIN 1996 and 1:100 000 topographic map grid, NSW EPA, 2000). Legend is provided in Figure 3.



**Figure 5.** Mean Annual Rainfall for the South Coast Region of NSW with the 1:100 000 topographic map grid (data sets include part of the Annual Mean Precipitation, ERIN 1996 and 1:100 000 topographic map grid, NSW EPA, 2000). Legend is provided in Figure 3.



**Figure 6.** Mean Annual Rainfall for the Mid West Region of NSW with the 1:100 000 topographic map grid (data sets include part of the Annual Mean Precipitation, ERIN 1996 and 1:100 000 topographic map grid, NSW EPA, 2000). Legend is provided in Figure 3.



**Figure 7.** Mean Annual Rainfall for the Far West Region of NSW with the 1:100 000 topographic map grid (data sets include part of the Annual Mean Precipitation, ERIN 1996 and 1:100 000 topographic map grid, NSW EPA, 2000). Legend is provided in Figure 3.



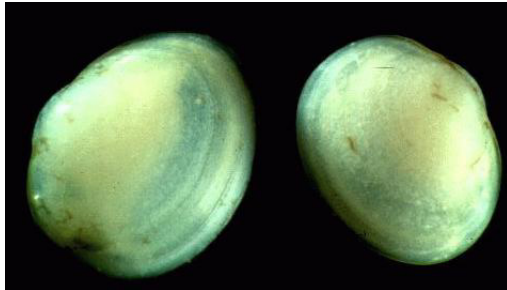
### Appendix 3: A selection of cryptic or commonly missed macroinvertebrates



Ancyliidae (freshwater limpet) <6 mm



Dugesiiidae (flatworms) <5 mm



Sphaeriidae (clams) <10 mm



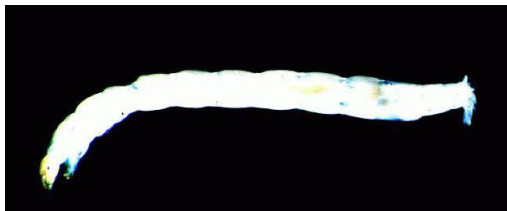
Elimidae larvae 3-10 mm



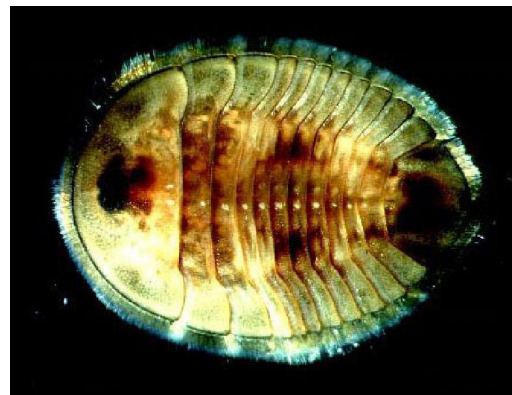
Hydroptilidae (caddisfly larvae) <5 mm



Elmidae adult <5 mm



Chironomidae (midge fly larvae) 1-20 mm



Psephenidae (water penny) 2-150 mm



Oligochaeta (worms) 1-150 mm

## Appendix 4: List of macroinvertebrate taxa used in the development of AUSRIVAS models for NSW.

Phylum	Order/Class	Family	AUSRIVAS Taxacode	
Arachnida	Hydracarina	Hydracarina	MM999999	
Annelida	Hirudinea	Erpobdellidae	LH059999	
		Glossiphoniidae	LH019999	
Nematomorpha	Oligochaeta	Oligochaeta	LO999999	
	Gordioidea	Gordiidae	IJ019999	
	Platyhelminthes	Temnocephalidea	IF499999	
Diplopoda	Turbellaria	Dugesiidae	IF619999	
	Diplopoda	Siphonotidae	PD999999	
Mollusca	Bivalvia	Corbiculidae	KP029999	
		Hyriidae	KP019999	
		Gastropoda	Ancylidae	KG069999
			Glacidorbidae	KG099999
			Hydrobiidae	KG029999
			Hydrococcidae	KG129999
			Lymnaeidae	KG059999
			Physidae	KG089999
			Planorbidae	KG079999
			Thiaridae	KG049999
			Viviparidae	KG019999
	Crustacea	Amphipoda	Ceinidae	OP029999
			Corophiidae	OP059999
			Eusiridae	OP039999
			Paramelitidae	OP069999
Perthiidae			OP089999	
Talitridae			OP019999	
Decapoda			Atyidae	OT019999
		Grapsidae	OX619999	
		Hymenosomatidae	OX019999	
		Palaemonidae	OT029999	
		Parastacidae	OV019999	
Isopoda		Cirolanidae	OR129999	
		Janiridae	OR189999	
		Mesamphisopidae	OR029999	
		Oniscidae	OR259999	
	Phreatoicidae	OR059999		
	Sphaeromatidae	OR139999		
	Ostracoda	Ostracoda	OH999999	
	Insecta	Lepidoptera	Pyralidae	QL019999
Mecoptera		Nannochoristidae	QK019999	
Megaloptera	Corydalidae	QM019999		
	Sialidae	QM029999		
	Neuroptera	Neurorthidae	QN049999	
		Osmylidae	QN039999	
		Sisyridae	QN059999	

<b>Phylum</b>	<b>Order/Class</b>	<b>Family</b>	<b>AUSRIVAS Taxacode</b>	
<b>Insecta</b>	<b>Coleoptera</b>	Brentidae	QCAM9999	
		Dytiscidae	QC099999	
		Elmidae	QC349999	
		Gyrinidae	QC109999	
		Haliplidae	QC069999	
		Heteroceridae	QC369999	
		Hydraenidae	QC139999	
		Hydrophilidae	QC119999	
		Hygrobiidae	QC079999	
		Limnichidae	QC359999	
		Microsporidae	QC039999	
		Noteridae	QC089999	
		Psephenidae	QC379999	
		Ptilodactylidae	QC399999	
		Scirtidae	QC209999	
		Staphylinidae	QC189999	
		<b>Hemiptera</b>	Belostomatidae	QH629999
			Corixidae	QH659999
			Gelastocoridae	QH649999
			Gerridae	QH579999
	Hebridae		QH539999	
	Hydrometridae		QH549999	
	Mesoveliidae		QH529999	
	Naucoridae		QH669999	
	Nepidae		QH619999	
	Notonectidae		QH679999	
	Ochteridae		QH639999	
	Pleidae		QH689999	
	Saldidae		QH609999	
	Veliidae		QH569999	
	<b>Trichoptera</b>		Antipodoeciidae	QT169999
		Atriplectididae	QT239999	
		Calamoceratidae	QT249999	
		Calocidae	QT189999	
		Conoesucidae	QT159999	
		Ecnomidae	QT089999	
		Glossosomatidae	QT029999	
		Helicopsychidae	QT179999	
		Hydrobiosidae	QT019999	
		Hydropsychidae	QT069999	
		Hydroptilidae	QT039999	
		Leptoceridae	QT259999	
		Limnephilidae	QT109999	
		Odontoceridae	QT229999	
		Philopotamidae	QT049999	
Philorheithridae	QT219999			
Polycentropodidae	QT079999			
Psychomyiidae	QT099999			
Tasimiidae	QT139999			

<b>Phylum</b>	<b>Order/Class</b>	<b>Family</b>	<b>AUSRIVAS Taxacode</b>	
<b>Insecta</b>	<b>Ephemeroptera</b>	Ameletopsidae	QE049999	
		Baetidae	QE029999	
		Caenidae	QE089999	
		Coloburiscidae	QE059999	
		Ephemerellidae	QE079999	
		Leptophlebiidae	QE069999	
		Oniscigastridae	QE039999	
		Siphonuridae	QE019999	
	<b>Odonata</b>	Aeshnidae	QO129999	
		Amphipterygidae	QO099999	
		Coenagrionidae	QO029999	
		Corduliidae	QO169999	
		Gomphidae	QO139999	
		Isostictidae	QO039999	
		Lestidae	QO059999	
		Lestoideidae	QO069999	
		Libellulidae	QO179999	
		Megapodagrionidae	QO079999	
		Petaluridae	QO159999	
		Protoneuridae	QO049999	
		Synlestidae	QO089999	
		<b>Plecoptera</b>	Austroperlidae	QP029999
			Eustheniidae	QP019999
			Gripopterygidae	QP039999
			Notonemouridae	QP049999
	<b>Diptera</b>	Aphroteniinae	QDAA9999	
		Athericidae	QD229999	
		Blephariceridae	QD049999	
		Ceratopogonidae	QD099999	
		Chaoboridae	QD059999	
		Chironominae	QDAJ9999	
		Culicidae	QD079999	
		Diamesinae	QDAB9999	
		Dixidae	QD069999	
		Dolichopodidae	QD369999	
		Empididae	QD359999	
		Ephydriidae	QD789999	
		Muscidae	QD899999	
		Orthocladiinae	QDAF9999	
		Podonominae	QDAD9999	
		Psychodidae	QD129999	
		Sciomyzidae	QD459999	
		Simuliidae	QD109999	
		Stratiomyidae	QD249999	
		Syrphidae	QD439999	
		Tabanidae	QD239999	
		Tanyderidae	QD039999	
		Tanypodinae	QDAE9999	
		Thaumaleidae	QD119999	
		Tipulidae	QD019999	