Review of Quality Assurance and Quality Control in the SRA Macroinvertebrate Theme

John Hawking

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GPO, Box 409, Canberra ACT 2601

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For further information contact:

John Hawking
The Murray-Darling Freshwater Research Centre
PO Box 991
Wodonga VIC 3689
Ph: (02) 60582300; Fax (02) 60597531


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Summary

A review of Quality Assurance/Quality Control (QA/QC) procedures for the macroinvertebrate theme of the Murray–Darling Basin Commission's Sustainable Rivers Audit was undertaken by the Murray-Darling Freshwater Research Centre between March 2006 and July 2007. The review of macroinvertebrate procedures involved visiting the four different state survey teams in the field and in their laboratories to review procedures. The field visits involved visiting sites in each of the states to review differences between and within states. The operators from each agency were evaluated against a standard questionnaire.

All states conducted their field sampling, laboratory identifications and data enumerations in a very professional manner, generally to a very high standard. The organisation of the field component, compliance with Occupational Health and Safety requirements, allocation of resources to the project, laboratory facilities and staffing for the project were excellent for all states. Most operators were familiar with, and followed the methods described in their state AUSRIVAS manuals. There appeared to be no blatant breaches of the procedures, as the state agencies genuinely tried to follow the SRA methods or a modified version of their own methods. However, these methods were often subjected to variations and interpretations by individuals. These should be addressed by introducing standard QA/QC procedures. The methods in the AUSRIVAS manuals vary between states and this should be addressed by having a single SRA manual. The development and use of a single SRA set of procedures was strongly supported by the field operators.

There were five major areas where differences were identified between and within states agencies.

[1] Live Pick and Laboratory Sorting

It is important to mention the use of the two different methods, live picking and laboratory sorting, as the issue remains a major inconsistency between the states. However, the respective methods are documented in the respective state manuals and the states comply with these methods. This is an age old question, discussed in depth in many forums and will not be discussed further here. However, the question is important for the SRA and if consistency in picking / sorting is to be achieved, the matter should be addressed by the SRA.

[2] Sample collection

The methods undertaken in the field occasionally varied considerably between operators, within and between agencies. The variation was due to a difference in protocols, differences in interpretation of the protocols, or in some cases deviations from the protocols. The data collected from these methods is qualitative and the only way to maintain Quality Assurance over these data is to be consistent throughout all phases of the procedures undertaken. The problem areas were:

(a) In determining the habitat to be sampled some operators sampled a section of each of the available microhabitats, e.g. snags, vegetation, clear bank strictly in proportion to the abundance of the habitat in the reach. In contrast, other operators concentrated on sampling habitats known to possess large abundances of animals. Both the sampling techniques fit within the prescribed methods, but potentially collect a very different number of taxa. To alleviate the problem it is recommended that the method be standardised. The recommended method is for collecting effort to be in proportion to the available habitat.

(b) The agencies manuals stipulate a sweep should cover a distance of 10 metres. Checking of the operators in the field revealed an extremely large variation in the area sampled and a corresponding variation in the quantity of material collected. Initial checks showed that the areas sampled ranged from 7-12 m and the number of sweeps taken varied from 33 to 107. These large variations in the sweep netting method cause a high degree of inconsistency, which can readily be avoided by tightening the method. A logical solution is to set a standard number of sweeps that must be taken or a recommended time period to undertake sampling.
(c) There are slight variations in the “Live Pick” methods used by each agency, which will cause some variation in the number of taxa picked. This is a minor problem, but to ensure consistency it is recommended that a standard protocol for live picking is introduced. This should specify a minimum time of 30 minutes and a maximum time of 60 minutes and a set number of animals to be collected.

(d) Due to the following variations from the AUSRIVAS methods it is recommended that the SRA documentation should list (1) When a riffle is absent then an, second edge sample should be taken and (2) The minimum dimensions in which two edge samples can be performed.

(e) To enhance quality assurance it is suggested that the specific dates for sampling periods for SA and Vic should be documented in either the state AUSRIVAS manuals or as part of SRA Protocols.

(f) To alleviate variations in the collection of water samples it is recommended that a standard method should be drawn up, based on the NATA recommended method. The method should include more information on taking a water sample, where to collect the sample from and at what depth, and possible pitfalls to avoid. It is recommended that the collection of water samples be included in the annual workshops.

[3] Equipment

To date each state agency has used readily available commercial equipment for their field gear and this has led to a range of net shapes and sizes, and a range of sorting trays. To standardize the equipment it is recommended that:

(a) A standard (size and shape) net frame be introduced, which would comply with ISO 7828-1985, International Standard. The ISO is reproduced in Appendix 1. The MDBC has agreed to pay for a standard net for all states that are using the small triangular net.

(b) A range of tray sizes have been used for live picking, with 38-43 cm x 27-30 cm (inside dimensions) tray being the most practical and usable. For consistency it is recommended that a 38-43 cm x 27-30 cm (inside dimensions) tray should be used.


All laboratories had an extensive collection of taxonomic literature, which included the most current identification keys. However, laboratories had no standard list of the appropriate keys to use and the choice was left to individuals. This becomes an issue when several versions of a key exist or if a new key is published, resulting in different identifiers using different keys to identify the same animal. There is also much variation between laboratories as to which taxa should be included. Some agencies include the micro-crustaceans, where others don’t. Likewise many include semi aquatic bugs, other don’t. These discrepancies in the taxa recognised are another source of inconsistency. To standardize the keys and taxa it is recommended that:

[1] A list is drawn up of the most appropriate keys to be used, which would be used by all agencies.

[2] A standard list of the taxa to be identified is produced, with a defined taxonomic level to which each taxon is to be identified. Much of the discrepancy is from several agencies including Copepoda, Cladocera, Ostracoda and the others not including them. Other discrepancies emanate from some agencies combining species from two families as one group, others disregarding some families as they consider them semi-aquatic, and others including some of the primitive families. If the aim of the project is basin wide, then these groups should be included as they occur over the whole basin, not just the drier areas where they are more abundant. A list of the taxa involved is presented below.

[a] Groups inconsistently included:
• Copepoda
• Cladocera
• Ostracoda

[b] Families which are inconsistently combined as one group:

• Physidae and Planorbidae
• Corbiculidae and Sphaeriidae

[c] Families which are inconsistently considered semi-aquatic:

• Chrysomelidae
• Curculionidae
• Brentidae
• Heteroceridae
• Staphylinidae
• Carabidae

[d] Primitive families which are inconsistently included:

• Hydridae
• Clavidae
• Spongillidae

It is recommended that the above taxa be identified, along with mussels and snails to family level, and that all are included in the models.

[5] QA/QC

The agencies have, to varying degrees, documented procedures for Quality Assurance. Quality Control is only conducted routinely on training and identifications by one laboratory, and at another only when requested. Both of these agencies document the cross checking of new operators and routinely checked a percentage of the samples processed. The quality of all laboratories maybe satisfactory, but without documented proof of checking, it cannot be assumed to have been undertaken. This also applies to field collecting. To address these QA/QC issues the following recommendations are proposed:

[a] Establish a QA/QC procedure for checking of identifications and enumerations. This should include cross checking 5% of all samples by a senior operator and the long term implementation of an inter-laboratory check.

[b] It is proposed to address some of the QA/QC issues relating to the field component by conducting a regular field workshop with operators from each state present. The workshop would involve a training component followed by a forum to discuss the relevant techniques with the aim of establishing a uniform approach. It is strongly recommended that this workshop be undertaken, as all operators interviewed in the field believed that it would be beneficial, and would help in eliminating many of the inconsistencies within and between the states.

[c] Another major issue emanating from this project is that many differences are caused by each state agency following their own state's AUSRIVAS manuals. If the project is to be long term, then a standard SRA protocol must be adopted. It is recommended that a SRA protocol for the macroinvertebrate theme be developed and used by all states.
The following points arise from the review, but will be held in abeyance and considered later when the Filters method is implemented:

- Standardise the sweep protocol by making a decision to include or exclude scraping of 3 rocks, and macrophytes
- The effects of inter-operator variability should be trialled
- Retain the sample residue for later QA/QC checking
- States to consider conducting aerial surveys in the dry parts of the basin to pre-determine suitability of site for sampling (Optional suggestion)
INTRODUCTION

A review of Quality Assurance/Quality Control (QA/QC) procedures for the macroinvertebrate theme of the Murray–Darling Basin Commission’s Sustainable Rivers Audit was undertaken by the Murray-Darling Freshwater Research Centre between May 2006 and July 2007.

The review of macroinvertebrate procedures involved visiting the four different state survey teams in the field and in their laboratories to review procedures. The field visits involved visiting sites in each of the states to review differences between and within states. The operators from each agency were evaluated against a standard questionnaire and the results are reported as a summary on page 5 and as a full transcript on page 9. A brief summary of the procedures and major findings of the interviews was presented at the SRAWG meeting on 27 June 2006, at Victor Harbour, South Australia. The following day, a presentation was used to facilitate a discussion regarding QA/QC, at a meeting of the staff engaged in SRA macroinvertebrate sampling.

Recommendations which should be implemented to improve the consistency between and within states are provided in the Summary section of this report (page 5).

The state agencies all conducted their field work and laboratory operations in a very professional manner. The field and laboratory visits have identified a range of discrepancies between and within agencies. Inconsistencies were identified between what is documented in the agencies manual and what is actually undertaken in the field and in the laboratory, much of which can be addressed through training and an on-going SRA QA/QC program.

FIELD VISITS

1 Agencies reviewed

Vic: EPA Vic, Melbourne
A field visit was conducted on 10-11 April 2006 to assess the operators while sampling the Moorabool River and Woady Yaloak River near Ballarat. The team consisted of two operators, led by Peter Rose. Unfortunately the EPA were not conducting SRA sampling during this period, but it was decided to assess the team sampling in the Ballarat Area, as it was deemed comparable with the other agencies. It must be remembered that the EPA also uses three consulting companies to undertake their sampling, resulting in the possibility that one or more may undertake SRA sampling at any given time. The laboratory visit was conducted on 2 August 2007.

Qld: NRM & W, Toowoomba
A field visit was conducted on 24-26 April 2006 in the Cunnamulla area. An assessment was undertaken at two sites, the Paroo River at Farnham Road and the Paroo River at Mooning. Two teams led by Minal Khan were present, however an assessment was conducted on one team only (led by Andrea Prior). The team were sampling in the proximity of Cunnamulla. The laboratory visit was conducted at the Toowoomba laboratory facilities on 25-26 April 2006.

NSW: EPA NSW, Sydney
A field visit was conducted on 21-24 March 2006 and assessed two teams (of two operators), in the Castlereagh River catchment around Coonamble and Coonabarabran. Teams were led by Sonia Claus. The laboratory visit was conducted on 31 July 2007.

SA: EPA SA, Adelaide
A field visit was conducted on 16 May 2006 and assessed one team, of two operators lead by Peter Goonan. The Australian Water Quality Centre (AWQC) conducted the processing and
identification of the samples for the EPA. The Laboratory visit was conducted on 9 May 2006, at AWQC, Bolivar Laboratory. The laboratory contact was Paul McEvoy.

Summary

- Teams from each state were visited in the field during autumn SRA sampling, except Vic EPA, who were conducting routine but non-SRA sampling.
- The Vic team members examined have previously participated in SRA sampling.
- The NRM&W and AWQC laboratories were visited in 2006. The DECC and EPA Vic laboratories were visited in 2007.

2 Project documentation

Vic: The project protocols were listed in the Vic EPA Guidelines for Environmental Management; Rapid bio-assessment methodology for rivers and streams 604.1 (2003) manual (81 pages), and SRA Protocol Manual SRA 394IP3. The manuals were included as part of the field equipment for reference when needed.

Qld: The project protocols were listed in the Qld AUSRIVAS Sampling & Processing Manual (MRHI Technical Report No. 12) (46 pages), and SRA Protocol Manual SRA 394IP3. The manuals were included as part of the field equipment for reference when needed.

NSW: The project protocols were listed in NSW Australian River Assessment System sampling and processing manual (2004) (50 pages), and SRA Protocol Manual SRA 394IP3. The manuals were included as part of the field equipment for reference when needed.

SA: The project protocols were listed in the SA Sampling and Processing manual (MRHI Technical Report No 17) (15 pages), and SRA Protocol Manual SRA 394IP3. The manuals were included as part of the field equipment for reference when needed.

Comment: Peter Goonan, SA EPA added the following comment “Since we did in fact change the protocol to include 2 edge habitats sampled in the 100m site, some mention of this is needed as a variation on the method. I had a look at the SRA394 IP3 SRA Protocol Manual from MDBC but it simply refers to the State protocols. I suggest that document is amended to include the method variation, and then refer to both documents”.

Summary:

- The MDBC’s SRA394 IP3 Protocol Manual simply refers to the State AUSRIVAS protocols. However, there are changes requested by the SRA, such as taking two edge sweeps, if the riffle is not present, which deviate from the state methods. It is recommended that all deviations from the states protocols, required by the SRA should be documented in a standard SRA manual.
- All states follow their own individual AUSRIVAS methods manuals, which was the major reason for differences in procedures between the states.
- The content and the depth of the details included in each state AUSRIVAS manual varied considerably. Vic has the most detailed manual (81 pages), with NSW (50 pages) and Qld (46 pages), containing just over half the amount of content and SA had considerably less detail (15 pages). This suggests that a standard manual be drawn up and information relative to each state inserted to enhance consistency between states.
- The participants interviewed would welcome a standard procedures manual which includes the areas where the methods deviate for individual states.

3 Trip preparation

Vic: QA protocols (section 2.2) and Equipment Check List (Appendix 1) are included in the AUSRIVAS manual. A trip itinerary is produced for each trip, with details of staff undertaking
the trip, proposed movements, sampling sites to be visited each day and contact details of 'On watch officer'.

**Observations:** Compliant. Well prepared.

**Qld:** Page 7 of AUSRIVAS manual has a paragraph on preparing for a field trip with 4 images of some of the major field equipment. The manual also includes an Equipment Check List (Appendix 1). The items of equipment were ticked off the list when the gear was assembled and placed in the vehicle.

**Observations:** Compliant. Well prepared (field trip of 10 days).

**NSW:** QA protocols are included in AUSRIVAS manual, as is an equipment check list (Appendix 1). Checking of equipment is not documented.

**Observations:** Compliant. The teams were well prepared (field trip of 10 days).

**SA:** A list of equipment to be taken on the field trip was not included in the AUSRIVAS manual. Checking was not documented, but the equipment was checked off against the field sheet, with extra containers as contingencies.

**Observations:** Compliant. All the relevant field equipment was taken and trip adequately prepared.

**Summary:**
- All states were well equipped
- All states have well documented equipment lists, with SA slightly less formal.
- Qld also has an additional tick off box, which is an added safe guard.

### 4 Field OH&S requirements

**Vic:** Field safety listed in AUSRIVAS manual (section 2.1) outlines hazards associated with field sampling. Field schedule sheets list all trips and associated vehicles, kits, meters, contact phone numbers and phone number of on watch officer. All procedures were followed and the team reported in daily.

**Observations:** Compliant.

**Qld:** Guidelines for remote area operations (Safe Practices, AD17, pp15) are available at the laboratory. A ‘Trip notification and Approval Form’ is submitted to the project supervisor with a copy of the ‘Trip Itinerary Form’. A ‘Risk Assessment’ memo to list all possible hazards that could be encountered in the field is also used. All forms are submitted to the supervisor and the trip approval form is signed by a supervisor. All procedures were followed and the team reported in daily

**Observations:** Compliant.

**NSW:** A ‘Risk Assessment’ form was completed prior to the field trip. They have a special protocol for the use of life jackets. Link Safety (an external company) is used to report in on a daily basis (at a designated time at end of shift). All forms are submitted to the supervisor. A trip approval form was signed by supervisor and the team leader reported daily.

**Observations:** Compliant.

**QA - SA:** The majority of the sites sampled were reasonably close to Adelaide so the team conducted day trips. Overnight procedures were therefore not required. The sampling team followed EPA day trip procedures. They also followed EPA OH & S procedures that included the preparation of risk documents prior to field work in non metro locations, provision of sample locations and a call-in to an experienced staff member (minimum call-in requirement is once at the end of the day). For the Upper Murray field trip, a form was filed with the EPA office, with location details, an expected itinerary outlined, and call-in times designated for the end of each days field work. There was very poor mobile phone coverage when sampling was carried out, so future work will include a satellite phone and Epirb in the field gear.

**Observations:** Compliant. The OHS requirements need to be documented in the EPA manual.
Summary:
- Qld, NSW and Vic had detailed OHS procedures which were documented and strictly followed.
- SA should incorporate their OHS procedures into the EPA manual

5 Sampling timing and frequency

Vic: AUSRIVAS protocol requires sampling to be conducted in consecutive autumn and spring seasons (Point 3. Biological Sampling, page 7). The Vic team conducted sampling within the designated AUSRIVAS time frames; however, no specific dates are mentioned in the manual.

Qld: AUSRIVAS protocol requires sampling on a ‘seasonal’ basis from May – June (late wet – recessional base flows when flow has declined to a sample-able level, without flood peaks) and October – December (early wet – when flow has been established for at least four weeks). Sampling was conducted within the designated time periods.

Observations: Compliant with protocols in the autumn 2006 sampling trip. Delay in commencing sampling was caused by drought conditions, which left the rivers as water holes. An aerial survey was conducted to find the water holes prior to sampling, thus time was saved by not visiting dry sites.

NSW: AUSRIVAS protocol states that sampling is to be conducted in autumn (March 15\textsuperscript{th} – June 15\textsuperscript{th}) and spring (September 15\textsuperscript{th} – December 15\textsuperscript{th}). The NSW team sampled within the designated time periods.

Observations: NSW had not conducted an aerial survey of the sites in the north western and north central areas and therefore the teams spent an enormous amount of time visiting sites which were dry. This added many days to the trip. An example is the first day spent with team ‘A’ which resulted in none of the sites visited having water (Castlereagh R., Coonamble area). This was frustrating for the team as they passed sites with water.

SA: AUSRIVAS protocol does not specify sampling period. Sampling was confined to autumn due to the concerns that future flooding would impact on spring sampling, by making sites inaccessible for adequate sampling using the protocols developed for the State.

Observations: Need to document the periods for sampling in the AUSRIVAS protocol or as an extra, under SRA requirements.

Summary:
- Qld conducts their sampling slightly later than the other states to accommodate the rainfall events that occur during the wet season. However this was within the time limits set down by the SRA.
- NSW face the lack of water at many of their sites in the northern section of the basin and it would be recommended that they investigate aerial surveys of the sites to determine the presence of water. Advice received from Paul Wilson (VIC DSE) on 03 December 2007 confirmed that Victoria began aerial surveys in the 2007/2008 sampling season.
- Specific dates for sampling periods for SA and Vic should be documented in either the state AUSRIVAS manuals or as part of SRA Protocols.
- Only NSW and Qld have the sampling dates in their manuals.

6 Site selection, validation and rejection policy

SRA Protocol: The field site is to be within 500m either side of the given SRA coordinates. A site can only be sampled if a minimum of 4 weeks have passed since the last flood event.

Vic: Agency followed SRA Site Validation Protocols, v 1.2 (14 Nov 05), except for a slight variation on when a site can be sampled. The Vic method states that a site can be sampled during or after a flood event (with no minimum waiting period), but is not to be sampled for
four weeks, if the river is ‘in-spate’. If a heavy rainfall event or significant flow has occurred at a site sampling may still take place as long as details of the rainfall or flow event are marked on the field sheet. The site can be rejected if it takes longer than 60 minutes to walk to the site or the distance is greater than 1 km.

Comment: The EPA Vic staff stated “EPA does not specify a fixed distance limit to which samplers should go, but suggests that staff should not walk long distances carrying sampling gear. We leave the decision to the sampling team taking into account factors such as terrain, vegetation cover and weather”.

Observations: Vic protocols allow sampling to be conducted after heavy rain or other significant flow event, as long as the rain event is recorded on the field sheet. However, a river is not to be sampled if it is ‘in spate’ which they feel is more relevant than setting a set time period after a substantial rain event. This is the major variation from the SRA protocol.

Qld: Followed SRA Site Validation Protocols, v 1.2 (14 Nov 05). The site is only sampled if it is 4-6 weeks after a flood event. The site must not be a greater distance than 500 m longitudinally or laterally from the SRA coordinate and have a minimum size not less than 100 sq m. The decision to sample is determined by the team leader.

Observations: Comply with the SRA protocols.

NSW: Followed SRA Site Validation Protocols, v 1.2 (14 Nov 05). When a site was outside the 500m limit of the SRA coordinates (either longitudinally or laterally); it was only moved if it was less than 100m. However, if it was moved further it was documented on the field sheet. Protocol states that shortest reach is 100 metres, however, if the site is only a pool, then a minimum reach must be greater than 20 m, so two 10 m sweeps can be done. These rules were followed, but have not been updated in the agency’s manual.

Observations: Comply with the SRA protocols.

SA: Followed SRA Site Validation Protocols, v 1.2 (14 Nov 05) with slight modification, so that a sample can be collected, i.e. if the site is a pool, then it must be greater than 20m, so that two 10 m sweeps can be taken.

Observations: Comply with the SRA protocols.

Summary:
- All agencies complied with the SRA Site Validation Protocol, when undertaking sampling. However; Victoria deviated slightly in regards to the waiting period following heavy rain or significant flow events. Victoria has no minimum waiting period but do require details of flow event to be recorded on field sheet. They do not sample when the river is ‘in spate’.
- However, if all agencies follow the SRA requirements, it would provide a greater level of consistency.

7 Site access

Vic: The agency followed their AUSRIVAS protocol (2.2) that states “Obtain any permits needed for accessing or sampling at a site. These may include permits, keys for access to closed catchments, or permission for entering private property.” Access to the sites was relatively easy, as they were close to the road and sites selected for the Victoria’s own assessment program. Advice received from Paul Wilson (VIC DSE) on 03 December 2007 confirmed that privacy laws prevent access to landholder details prior to visits. Sample teams make all efforts to contact the landholder when they are on site.

Observations: Team appeared to be well prepared prior to coming into the field.

Qld: AUSRIVAS protocol requires that the property owner of a site be contacted prior to the visit. The property owners were contacted before commencement of the field trip.

Observations: Qld had surveyed the available water holes by air, and then randomly chose their sites.

NSW: AUSRIVAS protocol requires the team to contact the property owner before undertaking sample collection. Staff wore department shirts, which allowed them to be readily recognised by property owners. The property owners were contacted and asked for
permission. Many sites in the Castlereagh River region were dry and checking each site was very time consuming.

**Observations:** NSW had not undertaken an aerial survey of the proposed sample sites and so each site had to be visited on the ground. This took a considerable amount of time and caused much frustration for the sampling teams. A suggestion to avoid this situation in the future is for NSW to undertake aerial surveys of these outback areas prior to future sampling, as Qld did.

**SA:** Although not documented in the AUSRIVAS protocol permission from property owners was requested during visit, when required. Access issues were resolved for most sites at the planning stage, to determine if the site was accessible via public roads and crown land, or had previously been sampled by EPA staff during the MRHI/AUSRIVAS program or other studies. When uncertain, access and landowner details were discussed with other government agency staff, and follow-up phone calls were made to specific landowners where access across their lands away from public roads was required and where locked gates were involved. Access to sites over the border, up to Mildura were discussed with SA Water, relevant landowners and Victorian NPWS staff prior to the field work being undertaken.

**Summary**
- Qld notified the land holder by phone prior to the visit. This was possible as the sites had been determined by aerial surveying. Aerial surveying would save NSW a considerable amount of time if they employed this method in the dry parts of the basin.
- All states had their respective state government logo on their vehicles which clearly identified them to property owners
- NSW staff wore official shirts with the department’s logo.

### 8 Site description and assessment

**Vic:** Staff used the AUSRIVAS 7 page “Field habitat assessment sheets” (v.14, Feb06) which is filled in fully by the recorder, including their name or initials. Vic recorded a full and detailed site description including information on habitat type, vegetation cover, stream velocity and substrate type. Another staff member fills in their name (or initials) to indicate that they have checked that all entries are completed.

**Observations:** Sheets are checked and signed by a second staff member in the field.

**Qld:** Staff used the AUSRIVAS 2 page sheet “SRA Macroinvertebrate Sampling Field Sheet”. Habitat type, vegetation cover, stream velocity and substrate are not recorded, as it is not required by the Qld model. The sheets were checked by both team members, with the second member counter signing after checking. The sheets were printed on water proof paper.

**Observations:** Sheets are checked and signed by a second staff member after data entry.

**NSW:** Staff used the 4 page AUSRIVAS “Field assessment sheet” which is completed in the field by the recorder, who signs the document. Field sheets are printed on water proof paper.

**Observations:** The sheets are checked by a second person after data entry.

**SA:** Staff used the 2 page AUSRIVAS “Habitat assessment field data sheet” (Appendix A) and the 4 page ‘Field data sheet’. Both sheets were completed by the operator with their names recorded on each sheet. They also had waterproof paper, if required, included in the field gear.

**Observations:** The field sheets are not checked or signed.

**Summary**
- Vic has their field sheets checked and counter signed in the field.
- NSW and Qld have their field sheets checked and counter signed after the data has been entered into the computer.
- SA do not have their field sheets checked or signed.
- The field sheet used by each agency differed considerably, as each was linked to the particular field data required for each agencies model.
9 Water sample collection methodology

Vic: The AUSRIVAS manual lists the parameter to be tested and which parameters need water samples to be taken. Page 20 has some notes on collection of water samples. In the field there was variation in the area chosen, flow condition of the water body and depth of the samples taken.

Qld: Water samples are not taken as physical/chemical parameters are not required for the Qld model.

NSW: Page 22 of the AUSRIVAS manual provided information on ‘Water Quality’ measurements and gives some suggestions on QA of calibration of meters. Page 23 provides information on where to collect sample. Water samples were satisfactorily collected.

SA: AUSRIVAS manual lists the parameter to be tested and which parameters need water samples to be taken. How and where to collect samples is not documented. However, water samples were satisfactorily collected. SA agree that the manuals should be updated to include how and where to collect water samples, and details on calibration of field meters.

Summary:
- Qld don’t collect water samples, as it is not required in their models.
- Vic, NSW and SA collect samples, but the collection methods vary between states, in terms of the area of the stream the sample is collected from, and at what depth the sample is taken. Many operators quizzed in the field, really didn’t know what the correct collection method was. There appears to be a lack of knowledge of the method and a need for a more descriptive method.

10 Macroinvertebrate sample collection methodology

Vic: Sampling was conducted under Vic EPA Guidelines for Environmental Management; Rapid bio-assessment methodology for rivers and streams 604.1(2003). Sampling was conducted as per the methods, using non-continuous sampling.

Qld: Sampling was conducted under NRM IRM (WP) DOCUMENT WM-20 – Macroinvertebrate Sampling, which lists the protocols for collecting macroinvertebrates. The particular methods used are detailed in the water monitoring document Sampling Aquatic Macroinvertebrates using a dip net AEMF005 (Field Methods). Sampling was conducted as per the methods, using non-continuous sampling.

NSW: Sampling was conducted under the NSW DNR and DEC - SRA (NSW) Macroinvertebrate Sampling Procedure. This document includes details which are additional to the NSW AUSRIVAS manual, and are specifically relevant to the SRA. Sampling was conducted as per the methods, using non-continuous sampling.

SA: Sampling was conducted under NRM IRM (WP) DOCUMENT WM-20 – Macroinvertebrate Sampling, which lists the protocols for collecting macroinvertebrates. Both riffle and edge samples were described. Both sampling methods (kick and sweep) involved scrubbing rocks (3 rocks in the net sample and an undefined number in the kick). Sampling was conducted as per the methods, using non-continuous sampling.

Comment: Peter Goonan, SA EPA, provide the following comment: “We should obviously include more details in the bug sampling methods because we do in fact scrub 3 rocks into the edge samples if present, noting down the number of rocks washed and the major bug taxa seen attached to the rocks. We added this to ensure that caddis flies were at least noted in the collection when present, even though they may be missed in the 10% subsample and scanned for rare individuals in the residue. Note that the area that is intended to be covered for edge samples is 10m x 1 m sweeps = 10 sq m. But for riffles the normal kick method is employed walking backwards disturbing rocks...
and sediment with a kicking action, and particularly where there are large cobbles, boulders and bedrock rubbing the surfaces with hands. And note that the area intended to be covered for riffles is 10 m x width of the net which is 0.33 = 3.33 sq metres”.

SUMMARY:

- SRA documentation should list the following variations from the AUSRIVAS methods (a) When a riffle is absent then an, second edge sample should be taken and (b) The minimum dimensions in which two edge samples can be performed.
- All states conducted non-continuous sampling.
- Each state held views on continuous verses non-continuous sampling.
- Presently the edge method collects from a ten square metre area and the riffle method samples a 3.3 sq metre area.
- Variation between operators within a state, and to a lesser degree between states was observed in terms of the degree of effort and number of sweeps undertaken (see 17 Sweep Net Operator Repeatability). It is suggested that training will aid in eliminating these variations in collecting, and will lead to more consistency in the collecting techniques used.

11 Field macroinvertebrate sampling equipment

Vic: EPA 604.1 lists information on net type - dimensions 300 X 300mm, mesh size 250 µm, net length 1m.
Observations: Currently using two nets (a kick and a sweep), both have a pentagon frame, base 350mm, sides 270mm, height 380mm and mesh size 250 µm, with kick net length 1300mm and sweep net 480mm.

Qld: Net dimensions are listed on page 4 in method document Sampling Aquatic Macroinvertebrates using a dip net AEMF005 (Field Method).
Observations: Currently using one net for both kick and sweep. The net has a triangular frame, sides 250mm, net length 740mm and mesh size 250µm.

NSW: Net dimensions are listed in the NSW AUSRIVAS manual on page 28.
Observations: Currently using one net for both kick and sweep. The net has a pentagon frame, base 350mm, net length 600mm and mesh size 250um.

SA: Net dimensions are listed under ‘Macroinvertebrate Sampling’ in SA EPA manual.
Observations: The net has a triangular frame with 250 µm mesh; dimensions are 350 x 300 x 300 mm]. Net is 20mm shorter across the bottom.

SUMMARY

- Two types of net frames were used; Vic and NSW use a pentagon shaped net. Qld and SA use a triangular framed net.
- All use a standard mesh size of 250 µm.
- Vic kick sampling net is considerably longer than other states.
- Solution: MDBC has agreed to provide money to standardise the nets including the use of a standardised pentagonal frame (Appendix 1).

12 Proficiency level of officers undertaking sampling

Vic: Protocols on staff competence are documented in the EPA manual, 604.1, section 8.1 pages 48-49. Training consists of extensive ‘on the job’ instruction, in-house training programs and/or specialist training courses. Vic EPA conducts an AUSRIVAS training course, which accredits operators.
Observation: The proficiency of each operator is logged.
Comment: The following is a reply from the Victorian EPA: In Victoria, there are at least 2 or 3 organisations involved in SRA sampling, with maybe 15 – 20 people. Probably an
impractical number to attend the annual meeting just to fine tune some differences. As Victoria has training, accreditation and auditing this is only really necessary if a standardised protocol is established and then requires training. A small number getting together may still be useful for aligning small differences, with the Victorian contingent amongst them reporting back to all those involved in SRA sampling.

Qld: Although all officers are to be accredited for AUSRIVAS and have satisfactorily passed the training course, this is not documented. There is a proposal to conduct an in-field sampling day, once per year, in conjunction with the main Brisbane laboratory. Currently the Brisbane group conduct training sessions annually.
Observation: Proficiency of officers not logged. A hydrographer was used to help undertake picking during the April 2006 trip. This arrangement was changed for the June 2006 trip with an extra certified AUSRIVAS operator, from Brisbane in attendance.

NSW: Sampling during the field trip was undertaken by AUSRIVAS accredited staff and only AUSRIVAS accredited staff is allowed to undertake sampling. A register of accredited staff is maintained.
Observation: Proficiency of operators is logged.

SA: The same two AUSRIVAS accredited staff members have undertaken the sampling for many years. The accreditation is not documented.
Observation: Proficiency of operators is not logged.
Comment: The following is a reply from the SA EPA: We have been the lead agency representative for SA for many years and have not agreed with the accreditation process adopted so far for the AUSRIVAS work, so have not listed any accredited staff for SA and do not see records of participation equating to competence in field sampling

Summary:
- States generally require operators to be accredited.
- Operators suggested that in-house, cross state or external training programs should be conducted as part of the SRA program.
- Operators suggested a demonstration / comparison session on the field component should be conducted just prior, during or immediately after the SRA AGM, when staff from all states are present.

13 Macroinvertebrate habitats sampled

SRA Protocol: If no riffle is present a second edge sample should be taken.

Vic: The AUSRIVAS protocol requires a riffle and edge sample to be taken at each site and if a riffle is not present then no other sample is taken. However, for the SRA sampling the agency sampled two edges if the riffle was absent which complies with the SRA protocol.

Qld: The AUSRIVAS protocol states that if a habitat accounts for more than 10% of the stream reach then it should be considered for sampling. Two habitats are sampled: an edge and a bed sample (riffle; rocky bed; or sandy bed) (NRHIN0 12, page 4). If a riffle is not present then a second edge sample is taken as required by SRA protocol.

NSW: The AUSRIVAS protocol states that the model requires that both riffle and edge habitats be sampled (3.4, page 7 -13). If a riffle is not present, an extra edge sample is taken as required by SRA Protocol. The agency’s protocols state that above 400m elevation, a riffle and an edge sample are to be taken, and below 400m elevation a riffle and two edge samples are to be taken.
Comment: The AUSRIVAS riffle models in NSW are based on sites above 400m. Therefore, riffles collected below 400m maybe outside the experience of the models. To obtain an O/E score for 2 samples at each site, 2 edge samples are collected below 400m even if a riffle is sampled.

SA: Two habitats were sampled, an edge and a riffle. When a riffle was not present, an extra edge sample was taken as required by SRA protocol.
Summary:

- All states follow the SRA Protocol to collect two edge sweeps when a riffle is not present.
- NSW differed slightly; above 400m elevation, a riffle and an edge sample are taken, and below 400m elevation a riffle and two edge samples are taken.

14 Sample collection – kick sample– habitat sampled

**Observation:** Sampling depth 100 -200 mm in gravel / cobble stretch and included washing animals off rocks.

Qld: Protocols in AUSRIVAS manual. Riffle habitat not encountered during field visit.

NSW: Protocols in AUSRIVAS manual. Compliant with protocols, only one sample checked.


Summary:

- The two states who had riffles used a similar technique and sampled a similar habitat – probably because riffle habitats were small confined areas or absent from many sites, due to drought year.
- The standard sampling practise appeared to be along the riffle.
- The sample collection was semi-continuous.

15 Kick sample operator competency

Vic: The operators were trained and accredited in the AUSRIVAS sample collection method. The kick and sweep sampling techniques of operators were checked by the ‘EPA Accreditation and Audit programs’, which compares samples collected by the operator with samples collected by an experienced auditor.
**Observation:** The operator checked conducted the sampling in accordance with the set EPA protocols.

Qld: Operators are trained in the AUSRIVAS sample collection method; however, no protocols exist for checking operator competency.
**Observation:** Riffle habitat not encountered.

NSW: Operators are trained and accredited in the AUSRIVAS sample collection method however; no protocols exist for checking operator competency.
**Observation:** Only one riffle was encountered in a very slow flowing stream. The operator conducted the sampling in accordance with the set protocols.

SA: Operators are trained in the AUSRIVAS sample collection method however; no protocols exist for checking operator competency.
**Comment:** The following is a comment from SA EPA: SRA sampling in 2006 was conducted by experienced AUSRIVAS operators from the EPA and lead agency for SA. And in SA, riffles are unlikely to be seen along the main channel and floodplain sites, but during wet years the Eastern Mt Lofty sites are likely to have some riffle habitat present.
**Observation:** Riffle habitat not encountered.

Summary:

- Victoria is the only state with an established proficiency protocol (‘EPA Accreditation and Audit programs’) for checking the kick sampling technique of operators.
• The dry conditions meant that riffles were absent from most sites. Only a couple of operators were checked so no basin-wide comparison can be made.
• The limited results showed that the two operators checked appeared to conduct their sampling in accordance with the set protocols.

16 Sample collection – sweep net – habitat sampled

Vic: Sample a variety of slow flowing or no current areas; overhanging vegetation, snags and logs, backwaters, leaf packs, bare edges, and macrophyte beds. These were sampled in accordance with the AUSRIVAS protocols. Vic EPA has an ‘Accreditation and Audit Program’.

Qld: Sample edges with little or no flow or aquatic vegetation (stands of Paragrass are acceptable). Where there were aquatic plants (macrophytes), they were not sampled. The sampling was in accordance with the AUSRIVAS protocols. No QC checks were undertaken.

NSW: Sampling includes tree roots, trailing bank vegetation, under overhanging banks and along logs. Macrophytes were sampled when abundant. Operators sampled in accordance with the AUSRIVAS protocols. No QC checks were undertaken.

SA: Conduct sweeping through the water column as the sampler moves along the bank, kicking the sediment to disturb benthic organisms. Three rocks were also collected, hand scrubbed and included in the sample. Aquatic vegetation including overhanging or emergent vegetation or root mats is included in the edge sample. Operators sampled in accordance with the AUSRIVAS protocols. No QC checks were conducted.

Summary:
• SA included 3 rocks in their sweep net sample and the number of rocks scrubbed is documented on the field sheet along with the major taxa added to the sample.
• Qld don’t include macrophytes.
• The difference in sampling technique in SA and Qld as outlined above raises the need for a uniform sampling protocol for all states to follow, if there is to be consistency between states.
• Sweep methods appear to vary considerably between some states and within some states. Two criteria for sample collection are involved - the collection of a maximum number of taxa, and the collection of a representative sample of the available habitat. The observed problem was variation between operators with some operators attempting to meet only one of these criteria while others attempted to meet both. A suggested solution is to set a minimum number of sweeps or a minimum time period depending on whether the preferred criteria is to sample in proportion to the available habitat or to obtain the maximum number of taxa.
• Victoria is the only jurisdiction with a program to check compliance.

17 Sweep net operator repeatability

This formed part of a trial to evaluate the amount of effort used by operators, and to check consistency within and between states in terms of operators collecting a sample representative of the stream fauna at a particular site. This is based on a very small sample and must be used as a first cut guide.

Vic: The number of sweeps was not documented in the agency manual. Sweep netting was conducted within the AUSRIVAS requirements. **Observation:** The following sweeps were taken - 54 sweeps covering 9m, 65 sweeps covering 11.5 m and 46 sweeps covering 9.8 m. Sampling included bare bank, rushes, reeds, sedge, logs and tree stumps, with long strokes to a reasonable depth. Net was rinsed during sampling.
**Qld:** The number of sweeps was not documented in the agency manual. Sweep netting was conducted within the AUSRIVAS requirements.

**Observation:** The following sweeps were taken - 81 sweeps covering 9m, 83 sweeps covering 8m, 107 sweeps covering 9m, and 95 sweeps covering 7m. Netting consisted of short, sharp sweeps close to the surface, incorporating roots, backwater, bare bank, logs. Net was rinsed at completion of sampling.

**NSW:** The number of sweeps was not documented in the agency manual. Sweep netting was conducted within the AUSRIVAS requirements.

**Observation:** For Sampler (A) the following sweeps were taken - 63 sweeps covering 9m, and 60 sweeps covering 12m. Sampling included roots, logs twigs, bare edge. Long and deep netting strokes were used with the net being washed several times.

For Sampler (B) the following sweeps were taken – 66 sweeps covering 9m and 43 sweeps covering 6m. Sampling included overhanging vegetation, undercut bank, open bank, bog, bottom deep water, roots. The net was washed into a bucket after every two sweeps. Sweeps were long and deep. Net was rinsed during sampling.

**SA:** The number of sweeps was not documented in the agency manual. Sweep netting was conducted within the AUSRIVAS requirements.

**Observation:** For Sampler (A) the following sweeps were taken - 33 sweeps covering 8.5m, 45 sweeps covering 10m and 49 sweeps covering 10m. Long and medium strokes were used. Sampling included vegetation, bottom, open bare edge, open water and rocks scraped. Sweeping was equally conducted from both banks.

For Sampler (B) the following sweeps were taken - 47 sweeps covering 12m, 41 sweeps covering 9.5m and 56 sweeps covering 9m. Medium strokes were used and sampling included vegetation, bottom, open bare edge, open water and rocks scraped. Sweeping was equally conducted from both banks. Net was rinsed during sampling.

**Summary:**

- States generally don’t have checking protocols to evaluate the proficiency of the sweep operators; however, Vic EPA has an on-going ‘Accreditation and Audit Program’.
- Repeatability of individual operator is generally good, however variation does exist between operators.
- Large variation in the number of sweep taken ranging from a maximum of 107 sweeps to a minimum of 33 sweeps, with minimum number of sweeps returning a low number of taxa (from field count). This raises the question about the reliability of the catch from the low number of sweeps and does it collect a representation of the taxa present. Perhaps a minimum number of sweeps of a prescribed distance is needed? The large variation in the method is emphasised in a comments from the Vic team “What about the length of each sweep or the “vigour” of each sweep and the effect this has on out welling at the mouth of the net. Is a sweep of a 6 foot tall person equivalent to a sweep of a 5 foot tall short person? This should be taken into account and adds weight to introducing a minimum number of standard sweeps.
- An alternative is to set a recommended time period to conduct the sampling. A problem that arises is that samples with clay need to be washed many times during collection, to avoid out welling, often after every second sweep). Vic EPA raised an interesting solution “a usual range should be given i.e. a sample should usually take between 10 –20 mins to collect”.
- This discussion should be taken further as it involves all states and will aid in introducing consistency to the sampling procedures.

18 Protocols for sample sorting (live pick field and field preserve, lab sort)

**QA - Vic:** The AUSRIVAS manual devotes 2.5 pages to sample sorting, which gives clear directions on the methodology to follow. A minimum (30 minutes) and maximum (60 minutes) sorting time is given with the overall aim to collect a maximum of 200 animals.
QC – Vic: The sorters were familiar with, and followed the prescribed methods.

QA – Qld: A sorting time period of 40-60 minutes is given on page 4 of *Live Picking Aquatic Macroinvertebrates for QLD rapid assessment (QRAM) AEMF015 (Field Method).*

QC – Qld: The sorters were familiar with and followed the prescribed methods, except on one occasion when a hydrographer was used. All future sorting has been conducted by AUSRIVAS trained staff. Residues are kept for laboratory checking.

QA – NSW: The AUSRIVAS manual does not include a minimum or maximum number of animals to be collected. Samples are picked for a maximum of 60 minutes and a minimum of 40 minutes.

QC – NSW: The sorters were familiar with and followed the prescribed methods. The residues of 10% of samples are kept for laboratory checking.

QA – SA: AUSRIVAS protocols require the samples to be collected, preserved and sorted in the laboratory.

QC – SA: Total sample was collected, preserved and returned to the laboratory to be sorted. The laboratory protocol requires subsampling until a minimum of 200 animals are identified.

**Summary**

- Vic has a minimum sorting time of 30 minutes, whereas NSW and Qld have a minimum of 40 minutes. All have a maximum of 60 minutes.
- Vic and Qld try to collect a maximum of 200 animals.
- Qld and NSW retain the sample residues for later QA/QC checking.
- Different size sorting trays were used and a suggestion is to standardise the size of the tray used, to gain more consistency. A suggested standard size is 38-43 cm x 27-30 cm (inside dimensions). The Victorian team suggested that a minimum size should be sufficient as there should be no concerns with using a bigger tray.
- SA is the only state that conducted laboratory sorting procedures.
- There is a need to have a group discussion to determine what “live pick protocols” can be implemented to reflect a standardised SRA protocol.

**19 Field taxonomic procedures**

**Vic:** Cladocera, Copepoda and Ostracoda were not identified, as they are not used in the Vic model; ten of each taxon was collected, except, for chironomids where 30 were collected. The cryptic taxa were thoroughly searched for. Operators were familiar with the respective techniques and appeared to know the taxa that were encountered.

**Qld:** Cladocera, Copepoda and Ostracoda were identified. Ten of each taxon were collected, except, for chironomids, where 30 specimens were collected. The cryptic taxa were thoroughly searched for. Operators were familiar with the respective techniques and appeared to know the taxa that they found.

**Observations:** Cladocera, Copepoda and Ostracoda are used in the Qld model.

**NSW:** It is not in the AUSRIVAS protocol to collect Cladocera or Copepoda. However, if these taxa are collected they are identified and added to the MDBC database. Ostracoda were collected. At least 20 chironomids were picked. The cryptic taxa were thoroughly searched for and any taxa which adhered to the bottom of sorting tray was added as new taxa to the live pick sample (as per page 34 of NSW AUSRIVAS manual). Operators were familiar with the respective techniques and appeared to know the taxa that they found. Images of cryptic taxa are included in Appendix 3 of AUSRIVAS manual

**SA:** The sample is collected and preserved in the field. In the laboratory the sample is sub sampled until a minimum of 200 animals have been identified. The Cladocera, Copepoda and Ostracoda are identified for use in the SA model. Sorting and identifications were conducted by Australian Water Quality Centre (AWQC), Bolivar. The AWQC macroinvertebrate laboratory is NATA accredited for macroinvertebrate identification and enumeration.

**Summary:**
• Qld picked out Cladocera, Copepoda and Ostracoda. NSW picked Ostracoda and they are used in their models.
• Cryptic taxa should be included in the manual and field sorters instructed on how to detect them.
• The SA field preserve and laboratory sort, while Vic, Qld and NSW all live pick.
• The AWQC macroinvertebrate laboratory is NATA accredited for macroinvertebrate identification and enumeration.

LABORATORY PROCEDURES

20 Staff training and experience

20.1 Staff and experience

**Vic:** Staff consists of fifteen bug identifiers, with six randomly picked staff from the pool undertaking identification of SRA samples. Consultants from two companies are also used. Agency staff was trained on the job. Most have previous experience and two experienced mentors oversee the project.

**NSW:** Staff of three trained identifiers and two trainees.

**SA:** The AWQC has four identifiers with extensive macroinvertebrate experience, who also are trained to identify to generic and species or morphospecies level.

**Qld:** Team of two identifiers with macroinvertebrate experience.

**Summary:** The Qld, NSW and SA teams have a small number of identifiers, some of which have a very extensive knowledge of identifications. The Vic EPA has a larger number of identifiers with a range of experience. There is a large amount of taxonomic / identification knowledge in the agencies.

20.2 Training

**Vic:** Staff undertake identification training until they consistently achieve 3% or less error rate. During training each sample is completely checked by a mentor who is responsible for the training and following a set program. The Vic EPA conducts in-house accreditation programs that are conducted by two senior mentors.

**NSW:** In house training is conducted, but no formal training program exists. A senior identifier checks identifications when requested. Advice received from Jan Miller (NSW DECC) on 23 November 2007 was that approximately 10% of trainees’ identifications are regularly checked for accuracy.

**SA:** AWQC conduct an in house training matrix, which has a series of competency procedures that staff must meet. The training is conducted through a mentoring program consisting of various specialists. The training records are maintained. The procedures are documented in their “Training in macroinvertebrate sample processing and identification” Test Method (TBI-012).

**Qld:** In house training is conducted, but no set training program exists. Training resources exist at the Brisbane Laboratory and these should be utilised.

20.4 Sample cross-checking procedures

**Vic:** 10% of all samples are cross-checked by mentor/senior staff, results are documented and action is taken if required on an on-going basis.
NSW: Documented procedures, however, there is currently no cross-checking undertaken.

SA: Currently no cross-checking is undertaken, as the SRA did not request checking of the SA samples, instead only requesting a “Quality Statement” to be submitted. AWQC will conduct a check of 3 or 5% of samples, but this is at the customer’s request.

Qld: Documented procedures are available however; no cross-checking is currently undertaken.

Summary: It appears that only Vic presently undertake QA/QC checking of identifications and enumerations, which is part of their ongoing QA/QC procedures. It is recommended that all agencies implement a QA/QC cross-checking program to determine the proficiency level of the laboratory.

20.5 Accreditation

Vic: Victoria has dedicated two senior staff to undertake training and accreditation of all laboratory staff and contractors to a competence level determined by the EPA.

NSW: Presently no provision for staff to be assessed. All operators are AUSRIVAS accredited. The senior officer has lengthy experience in macroinvertebrates.

SA: The AWQC Laboratory is NATA accredited and training is conducted as per NATA requirements, but only for identification, which they perform. The staff training on identifications is conducted according to the laboratory “Procedures Manual” and all assessment results are maintained. The field component is conducted by EPA officers

Qld: Presently no provision for staff to be assessed. All operators are AUSRIVAS accredited. The senior officer has lengthy experience in macroinvertebrates within the Brisbane Laboratory.

20.6 Documentation of laboratory methods

Vic: Victoria has included a section on laboratory processing of invertebrate samples in Chapter 5 (pages 35-38) in Rapid Bio-assessment Methodology for River and Streams (EPA Victoria 2003). The chapter has sections on “Sorting and identifying invertebrates” and “Creating a Voucher Collection.”

NSW: QA/QC for macroinvertebrate theme of the SRA audit in NSW was issued in 2006 to act as a guide for Quality Assurance (DEC 2006).

SA: The AWQC Laboratory is NATA accredited and all methods are documented in their procedures manuals as per NATA requirements.

Qld: Pages 17-19 of the Queensland Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual have details on the procedures for conducting “Laboratory macroinvertebrate sampling processing” and “Sample identification and enumeration”.

Summary: All agencies have their own individual methodologies, which are well documented and generally followed. However, many points are missed by individual agencies, therefore to alleviate this problem a SRA manual should be produced, which would combine all relevant procedures in one document.

21.0 Sample processing procedures

21.1 Sample chain of custody procedures
All agencies had procedures for routine “logging in” of samples and all used the SRA site code and date as the laboratory identification number to ensure traceability of samples and results. All laboratories had a structured system to process the samples from adequate temporary storage prior to sample processing through to the identification phase to long term storage. Qld had sample processing procedures for Rocklea Laboratory and these were being adopted at the Toowoomba Laboratory. SA had documented procedures in their Macroinvertebrate sample chain of custody method which covers the entire process and was followed by staff.

**Summary:** The process appears to be working within each laboratory; however, to be consistent throughout the operation a uniform “Chain of custody method” should be adopted and recorded in the SRA methods and / or added to the various states manuals.

### 21.2 Taxa to be identified

**Vic:** Organisms identified to Family, except the Chironomidae, which is identified to subfamily and Oligochaeta, Acarina and Temnocephalidea which are identified to a higher level. The following taxa are not identified - Nematoda, Rotifera, Gastrotricha, Bryozoa, Polychaeta, Collembola, all millipedes and spiders, isopods in the family Oniscidae, beetles belonging to Staphylininae, Scaribidae and terrestrial families, terrestrial caterpillars and terrestrial snails, and planktonic crustaceans Cladocera, Ostracoda and Copepoda. Snails from the families Physidae and Planorbidae are lumped together.

**NSW:** Organisms identified to Family, except the Chironomidae which are identified to subfamily and Nemertea, Nematoda, Oligochaeta, Polychaeta, Ostracoda, Acarina Cladocera and Copepoda which are identified to a higher level. The Corbiculidae and Sphaeridae are identified separately, but lumped in the NSW AUSRIVAS models.

**SA:** All organisms identified to lowest taxonomic level. Laboratory manual detailing all procedures available in laboratory, with all staff aware of the procedures and follow the procedures.

**Qld:** Organisms identified to Family, except the Chironomidae which are identified to subfamily, and Nemertea, Nematoda, Oligochaeta, Acarina, Ostracoda, Cladocera and Copepoda which are identified to a higher level.

**Summary:**
- Discrepancies exist in which taxa are identified by each state and this can be attributed to differences in AUSRIVAS manuals and agency practices. Although this amounts to a small percentage of the taxa collected, to achieve consistency across the basin a recommended list of taxa should be created to be used by all agencies.
- The discrepancies are as follows: Cladocera, Copepoda and Ostracoda, which are some consider as microinvertebrates and are not included (Vic EPA); some primitive groups like the Hydridae, Clavidae are inconsistently included between states (Only included by SA); the families Physidae and Planorbidae are lumped (Vic EPA), as are the families Corbiculidae and Sphaeridae (NSW EPA).

**Recommendation:** It is proposed that a common list is established which lists all taxa to be identified including the taxonomic level that each animal is to be identified to and reported as. This will help gain taxonomic consistency, which was a major issue in Chris Walsh’s report (Walsh 2006).

### 22.0 Identification reference materials

#### 22.1 Taxonomic keys
Vic: Possess a range of the available taxonomic literature. Although a list of the keys for current use was not documented, the keys to be used are kept separately on a bench.

NSW: Possess a range of the available taxonomic literature however a list of keys for current use was not documented at the time of the review. However, the ‘Keys’ were available, filed with other resources under the particular Order. The agency AUSRIVAS manual (page 34) stated that the keys listed in Hawking (2000) should be used. The AUSRIVAS manual (page 49) has a list of the taxa used in their models. Advice received from Jan Miller (NSW DECC) on 23 November 2007 confirmed that the list of keys in the AUSRIVAS manual is the list of keys used for identification to family level.

SA: Possess a range of the available taxonomic literature, and a list of keys for current use is documented.

Qld: Possess a range of the available taxonomic literature however; a list of keys for current use is not documented.

Comment: All states had a wide range of taxonomic keys, which were available for all staff. However, most agencies hadn’t documented which keys are currently to be used, relying on the discretion of the identifier or their memory. Therefore having a current list of key to families would be valuable for individual laboratories particularly for refreshing staff members’ memories, and in the training of new staff.

Recommendation: An updated list of the most recent and appropriate key should be established specifically for the SRA. This should include the most appropriate and up-to-date information, which would eliminate discrepancy with old names and old keys, and add consistency to the identifications, especially between agencies.

22.2 Voucher collection

All agencies maintained a voucher collection of all recognised species and morphospecies for reference and/or training purposes. There was considerable variation between the status of the collections, especially with the addition of new species collected and upgrading new taxonomic determinations.

Comment: The voucher collection is essential for comparison of new taxa, however, it requires the identifier to physically hop up and retrieve the voucher, especially when the collection is housed in a separate room. An intermediate step to this solution is the maintenance of a digital photographic record of both common and uncommon specimens, which is invaluable for reference and/or training purposes. Some laboratories are already undertaking this procedure. This should be encouraged.

23.0 Laboratory processing

23.1 Subsampling

SA EPA is the only agency which doesn’t use the AUSRIVAS “live pick” method in the field and preserves the sample in the field. Sample processing is conducted by AWQC for the SA EPA. The sample on return to the laboratory is subsampled, taking 10% subsamples until a minimum of 200 animals are taken or the whole sample is sorted. The method is described in the SA AUSRIVAS Sampling and Processing Manual and the AWQC Laboratory manual. The AWQC laboratory conducted the laboratory tests in accordance with the documented procedures for subsampling of samples, and sorting to family level. The laboratory is NATA registered.

Comment: SA is the only agency which conducts laboratory subsampling of samples.
23.2 Documented procedure for calculating, recording and reporting

All agencies had a good system for calculating, recording and reporting results of identification and enumeration. All agencies had their data checked after it had been entered onto the computer.

23.3 Equipment calibration and maintenance

All agencies had good microscopic equipment for conducting identifications and all microscopes were serviced regularly by external qualified contractors.

**Comment**: Some microscope users were unfamiliar with the recommended set up procedures of their microscopes, so it is suggested that the agencies contact the supplier for the correct set up procedure, which should be pinned up near the microscope, as well as being added to their laboratory manuals.

24.0 Recording and reporting of results

All agencies had a high standard for entering primary data records, with checking of all entries by a second person (to checks for transcription errors). All agencies had personnel that were fluent with management of the models and were proficient with reporting results to the SRA.

25.0 Laboratory environment

All laboratories provided facilities which were suitable testing environments, with suitable microscope benches which minimised vibration. Ergonomic chairs were supplied for each operator; there was effective separation of work-stations and adequate bench-space for sample receipt, testing, clean-up and database entry. The housekeeping in all laboratories was satisfactory.
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Appendix 1.


INTERNATIONAL STANDARD
ISO 728-1985 (E)

Water quality – Methods of biological sampling – Guidance on handnet sampling of aquatic benthic macro-invertebrates

0 Introduction
A handnet is probably the most versatile sampler for benthic macro-invertebrates and can be used in a large variety of shallow waters. The methods of sampling with a handnet specified are appropriate when qualitative results are required. A handnet will not give absolute results (i.e. numbers of individuals of different species per unit area of river bed). However, it is usually possible to give some indication of the relative abundance of taxa within a sample but the results should be interpreted with caution.

1 Scope and field of application
This International Standard specifies equipment and procedures for the sampling of benthic macro-invertebrates by handnet in shallow waters (down to a depth of about 1.5 m) which are accessible either by wading or from a bank or boat.

The procedures are applicable to the sampling of all accessible aquatic habitats in rivers, streams, ponds, estuaries and lake shores. They provide qualitative data on the presence, absence, diversity and relative abundance of taxa depending on sampling effort and mesh size.

2 Definitions
2.1 benthic: Dwelling at the bottom of an aquatic environment.
2.2 biotope: An area in which the main environmental conditions are uniform.
2.3 macro-invertebrates: Invertebrates that are easily visible without magnification (>0.5 mm).
2.4 taxa: Taxonomic units, for example families.

3 Principle
Sampling of benthic macro-invertebrates in shallow, standing or running water by manual collection using a lightweight handnet.

4 Sampling equipment
Handnet, consisting of a handle and a frame holding a net in which the organisms are collected.

Handles are usually made of metal, wood or reinforced plastics. Frames, usually constructed in metal, have been made in various shapes, for example round, triangular, rectangular. Of these alternatives the rectangular shape (see figure 1) is preferred since the flat edge can be placed in close contact with the bed during use and the vertical sides permit a better cross-sectional area of water to enter the net than does a triangular shape. The frame should be large enough to allow a reasonable sample to be taken but not so large that the complete handnet offers too much resistance to the flow of water, which could make sampling difficult in fast flows. Suitable rectangular handnets currently in use have evolved in the light of experience and have frame dimensions in the following ranges (see figure 1):

width, w 200 to 400 mm
height, h 200 to 300 mm
shoulder, s 100 to 200 mm (for example)

In choosing an appropriate net two interrelated factors have to be considered:

a) the dimensions and shape of the net;

b) the mesh size of the net material.

Finer mesh sizes increase the risk of clogging with organisms and debris which reduces net efficiency by increasing the tendency of water and organisms to flow around rather than into the net. This effect can be minimized by increasing the depth, d, of the net (see figure 1) or frequent emptying. On the other hand, an unnecessarily deep net can be inconvenient in use. For guidance, the table gives examples of the most suitable depths of nets as a function of their size of openings.

The shape of the net is not particularly important from a sampling point of view but may be determined by practical considerations in manufacture, for example figure 2a) shows how two conical nets can be cut from material 1 m wide, whilst figure 2 b) is the pattern for one of the more usual bag-shaped nets. The net material is normally sewn to strong canvas which is attached to an inner frame thereby reducing abrasion.

Methods of joining the inner and main frames, which facilitate replacement in the field, are clearly advantageous. Net material may be of a monofilament weave or knitted but the latter, being stronger, may be preferred for this reason. Synthetic fibre is
Table – Recommended handnet mesh sizes

<table>
<thead>
<tr>
<th>Survey objective</th>
<th>Maximum size of openings</th>
<th>Recommended minimum depth, d</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>General/routine biological monitoring; data for surveys using biotic scores/indices</td>
<td>0.5 to 0.75</td>
<td>400</td>
<td>May not capture small stages of most benthos</td>
</tr>
<tr>
<td>For surveillance with more complete records of taxa present</td>
<td>0.5</td>
<td>450</td>
<td>May not capture early instar stages of many insects</td>
</tr>
<tr>
<td>For special surveys requiring complete taxa lists</td>
<td>0.25</td>
<td>560</td>
<td>Ensures capture of first instar stages and very small organisms which may prove of value in water quality determination</td>
</tr>
</tbody>
</table>

preferable since it is stronger and less liable to decompose, but shall be selected to ensure sufficient flexibility. The mesh size should be appropriate for the objectives of the study; the maximum recommended sizes of openings are given in the table.

5 Sampling procedures

The factors which influence the selection of a sampling procedure are:

a) the sampling objective — which may be a comprehensive species list for the site and/or the relative abundance of taxa within a selected biotope;

b) the characteristics of the site — including depth, current velocity, type of bed and amount of vegetation;

c) safe working conditions — water depth, current velocity and bed stability. Lone working is not recommended.

No sampling is appropriate to all types of water and it is necessary to describe a number of sampling procedures to meet different requirements. Sampling effort should be appropriate to the objectives and the site, and hence be based on a suitable distance, area or time. When it is intended to collect as many species as possible, take a sample by a combination of the methods specified in 5.1 to 5.3. It is customary to explore thoroughly all the types of substratum by this method including sweeps through weed patches and between the roots of overhanging trees.

Except in deep or static water or when sweeping the net through weeds or in the surface of mud or silt deposits, place the handnet on the bed and carry out the sampling in such a way that the animals drift into it, i.e. with the opening of the net facing upstream. Carry out sampling in an upstream direction to avoid disturbance to the area not yet sampled.

5.1 Sampling in flowing shallow water by hand

Hold the straight lower edge of the handnet against the stream bed whilst turning over the stones immediately upstream by hand in the flowing water. Dislodged animals are carried into the net by the current. Examine the stones, remove any attached or clinging species and add them to the sample. Disturb the finer lower deposits to dislodge any further organisms. Repeat this process at several places across the river to include different microhabitats within the riffles. It may be appropriate to sample these habitats proportionately.

The removal of the catch can be facilitated by washing it into a corner of the net using the flowing water and gently shaking the net whilst removing it from the water. Then turn the net inside out to aid the transfer of the sample to a container of water and remove by hand any animals clinging to the net and add them to the sample. It is recommended that the net be thoroughly washed between taking samples. Further sample treatment, such as decanting surplus water (for example to minimize predation by carnivores), reducing sample bulk by removing sticks, stones, leaves and other debris and the addition of preservatives, depends upon operator preference and the objective of the sampling programme. A small sieve of the same mesh as the net, can be used to reduce sample bulk.

5.2 Foot sampling usually in deeper water

Where the fauna is suspected, perhaps superficially, of being sparse or where the water is too deep for hand sampling, foot sampling may be used and is generally satisfactory. Foot sampling can also be used in shallow water between sites of different depths or where depth variation may not, at times, allow hand sampling.

Hold the net vertically on the river bed downstream of the foot. Disturb the substratum forcefully with the toe or heel of the boot and catch the released material in the net.

By working across the river different habitats are sampled. This method is somewhat selective in that fewer of the attached animals may be taken. Where practicable therefore, lift some of the stones and examine them for these. Transfer the animals to a container as described in 5.1.

5.3 Sampling in slow-flowing and static water

In static water the handnet may not be the most appropriate method for sampling. Consideration should be given to the use of sieves, grabs, dredges, cores, colorization or air-lift samplers.

Some habitats, such as stony shores of lakes, may be sampled by the hand-picking method (5.1) but collecting efficiency may be lower. The best procedure is to remove stones carefully and agitate them vigorously in the net, after which any animals remaining may be picked off by hand.

When sampling other slow-flowing or static habitats, the absence or reduction of water movement necessitates a different
procedure from that used in flowing water where the current is used to advantage in order to sweep dislodged animals into the net. In static water the relative motion of the fauna and net must be supplied by the operator. Disturb the substratum with the feet and catch the dislodged fauna by repeated sweeps of the net through the water immediately above the disturbed area.

In deeper static water where the substratum consists of mud or silt, draw or push the handnet or a sieve through the surface layer, preferably over a predetermined area or distance.

6 Assessment of relative abundance

A consistent indication of relative abundance of taxa within a sample from a clearly defined substrate can be obtained by any of the qualitative methods described in 5.1 to 5.3, but results should always be interpreted with caution. By sampling over a fixed distance or area or for a defined period of time (area probably being optimal) relative abundance within samples may be compared at different sites for water quality monitoring purposes provided that the sites have similar substrates. For hand sampling (5.1), up to 10 min may be required and with foot sampling (5.2) a shorter period, up to 2 min, is usually sufficient with additional time for picking off attached and clinging organisms. The operator should endeavour to apply similar techniques of hand or foot disturbance and a similar frequency of net emptying at the different sites.

For this reason only one operator for any single survey is best involved. Even then different conditions such as current velocity, depth, temperature (with hand sampling) and nature of the substratum may affect the sampling efficiency. Long periods of foot sampling (5.2) in a river with a rich benthic fauna can result in excessive catches to process and when carried out frequently at the same station can adversely affect the aquatic community.

7 Validation of method

The handnet method is widely used for qualitative sampling of benthic macro-invertebrates and gives consistent results when used repeatedly at a given site. Such observations are not, however, sufficient in themselves as evidence that the method is valid.

Quadrat samplers have received widespread acceptance for quantitative estimates of benthic macro-invertebrate abundance. The method furnishes a useful technique for the validation of the handnet since it is possible to compare the qualitative aspects of results from quadrat sampling with those from handnet sampling.

Data from quadrat samples and net samples from two major British rivers and their tributaries were compared. Plots were made of the numbers of species obtained at several sites by means of the quadrat sampler and the number of species obtained by the use of a handnet at the same site. The same operators were involved in taking both kinds of samples.

This analysis showed highly significant correlations (p < 0.001) between the number of species recovered by means of net samples and those obtained by the use of the quantitative quadrat sampler (see figure 3).
Figure 1 — Basic handnet
a) For two conical nets from material 1 m wide

b) For bag-shaped nets from material 1 m wide

Figure 2 — Suggested patterns for nets
Figure 3 — Comparison of numbers of taxa collected by net and quadrat sampler at a selection of sites on different rivers

\[ y = 0.78x + 7.8 \]

\[ r = 0.98 \]

(where \( r \) is the correlation coefficient)