Land and Water Resources Research and Development Corporation
National River Health Program

MDR16

QUALITY ASSURANCE AND CONTROL FOR THE MRHI
STATE / TERRITORY BIOASSESSMENT
PROGRAM

Principal Investigators

JOHN HAWKING
Murray-Darling Freshwater Research Centre
PO Box 921, Albury NSW 2640
Phone: 060 582300  Fax: 060 431626

RUTH O’CONNOR
Environmental Research Institute
of the Supervising Scientist - ERISS
Locked Bag 2, Jabiru NT 0886
Phone: 08 89799713  Fax: 08 89792076
Quality assurance and control for the MRHI state/territory bioassessment program

final report to LWRDRC

Reference no: MDR16

Mr J Hawking
Cooperative Research Centre for Freshwater Ecology
Murray-Darling Freshwater Research Centre
PO Box 921 Albury NSW 2640
tel: 060-582340  fax: 060-431626

Ms R O'Connor
Environmental Research Institute of the Supervising Scientist
Locked Bag 2 Jabiru NT 0886
tel: 08-89799713  fax: 08-89792076

Date prepared: September 1997
Abstract

Project number MDR16 was developed as part of the Monitoring River Health Initiative (MRHI) to provide initial training and taxonomic keys for the identification of aquatic macroinvertebrates by State and Territory agencies and to provide external quality assurance to ensure a high standard of taxonomic identification. To this end, the Murray-Darling Freshwater Research Centre (MDFRC) conducted a taxonomic workshop in the early stages of the MRHI and all agencies responsible for invertebrate identification have had 5% of their identifications checked externally by either the MDFRC or the Environmental Research Institute of the Supervising Scientist (ERISS). Feedback from the QA process to agencies has often resulted in the reduction of identification error rates to acceptable levels. Non-conformance to specified taxonomic levels, lack of in-house training by agencies for new staff and overall lack of taxonomic experience were identified as key factors leading to error.
Objectives

1. To provide taxonomic training for biologists from the state/territory (MRHI) agencies.
2. To provide quality control and assurance of the agencies’ specimen identification.
3. To report the quality assurance assessment to the state/territory agencies.
4. To provide an assessment of all agencies and report to NRHP committee.

Methods

Objective 1 - taxonomic training
Training for MRHI participants was given through a two day taxonomy workshop. An MRHI Taxonomic Workshop Handbook (Supporting Document 1) was presented detailing a list of taxa, references for specific taxonomic information as well as keys to the major families to assist in family level identifications. The major speakers were John Lawrence (Coleoptera), Peter Cranston (Diptera), Phil Suter (Plecoptera and Ephemeroptera), John Dean (Ephemeroptera and Trichoptera), Ros St Clair and David Cartwright (Trichoptera) and John Hawking (Odonata, Hemiptera, Megaloptera and other non-insect groups). Identification sessions were held by the taxonomic experts to train participants in the use of taxonomic keys and assist in identification of specimens from difficult groups.

Objective 2 - quality assurance
Details about the methods used for selection of samples for cross-checking were included in the first milestone report for this project. Since the original development of the project the scope for external checking has been reduced to quality assurance (QA) with agencies assuming responsibility for quality control. In summary, 5% of samples identified by each agency within each sampling round were requested for cross-checking of agency identifications. Selection of samples aimed to cover the range of biogeographic regions and habitats sampled (and thus the broadest range of taxa likely to be encountered). Samples were selected randomly from within a given biogeographic region and habitat with secondary selection criteria based on coverage of the range of staff who performed the original identifications. Table 1 gives a breakdown of the progress in cross-checking.

<table>
<thead>
<tr>
<th>Sampling round</th>
<th>No. agencies participating</th>
<th>No. agencies where checking is complete</th>
<th>Agencies with unchecked samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>15</td>
<td>NT Dept Land Planning &amp; Environment</td>
</tr>
<tr>
<td>2</td>
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<td>QLD Dept Primary Industries</td>
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<td></td>
<td>QLD Dept Primary Industries</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>WA Conservation &amp; Land Management</td>
</tr>
</tbody>
</table>

Checking of the above agencies was not completed because they had not finished identifications by a cut-off date in April 1997. The exception to this was Queensland for round 2 where identifications were done but samples were not checked because specimens of different taxonomic groups were not put into separate vials as requested.
Details about procedures for cross-checking were included in the first milestone report. In summary, QA staff identify and enumerate all specimens in a given sample and check them off against results sent by the agency (note: this procedure may change somewhat in the future if enumeration of samples is no longer required). Specimens that the QA staff had difficulty in identifying (because they are poorly described, undescribed, or simply taxonomically difficult) were sent to the national specialist for that particular group for confirmation (for details of this procedure see Supporting Document 2). Discrepancies between results from sample identification and the QA check were recorded on appropriate QA data sheets (see first milestone report), copies of which were forwarded to the agency. Details about how QA data sheets were filled in and how pass and fail criteria were calculated are presented in Supporting Document 3. For this first phase of the program an error rate of greater or equal to 10% for either the new taxa or misidentification criteria, or a Bray Curtis dissimilarity of greater than or equal to 0.1 constituted a fail. These levels were selected on a trial basis and in accordance with comparable programs overseas.

Objective 3 - Reporting to agencies
Feedback to agencies from the QA process has taken several forms:

1. Reporting of results based on the three assessment criteria (Appendix 1). The three assessment criteria used in quality control of macroinvertebrate identifications in the Monitoring River Health Initiative were described in the first milestone report. The criteria reflect the key aspects of community structure that may be affected by errors in enumeration and identification i.e. richness (number of taxa) and relative abundance of taxa as univariate and multivariate measures.

2. Advice on how errors may have occurred and how they may be avoided in future were also included in reports to agencies (Appendix 1).

3. Guidelines have been developed to deal with common problem areas (e.g. how to deal with damaged and immature specimens) and these have been distributed to agencies (Supporting Document 2).

4. Separating and labelling specimens that have been misnamed to allow visual reinforcement of the features of problem taxa. These specimens can then be used by the agency as reference material.

Objective 4 - reporting to NRHP committee
Meetings and Workshops held for the MRHI program have been attended by QA staff to give ongoing progress reports to the NRHP Management Committee. This includes the NRHP meeting in Canberra on the 22-24 May, 1995 and a program review undertaken at the MRHI Workshop on 22-24 October, 1996. A seminar outlining the results of the QA program was also given at the LWRDRC meeting held at the Murray-Darling Freshwater Research Centre (Albury) on 3 December, 1996. Two milestone reports have been submitted to LWRDRC, one in May 1996 and the other in December 1996, detailing quality assurance checking procedures and reporting on agency progress.
Results

Objective 1 - taxonomic training
Initial taxonomic training provided during the Albury workshop in 1995 provided a basis for which agency staff inexperienced in taxonomy could undertake the program. Ongoing training has been via feedback to agencies from QA of identifications.

Objective 2 - quality control and assurance

Victoria

The Victorian Environmental Protection Agency and Water Ecocience were the two agencies undertaking macroinvertebrate identifications for the MRHI in Victoria. A high percentage of the errors detected in Victorian EPA samples (Fig. 1) were due to Physidae/Planorbidae (Mollusca) not being enumerated separately on data sheets. This is probably because accurate separation of these two taxa can require an extra processing stage (boiling of radulas). Fails (>10% error) were given in two criteria in round 2 because trichopteran specimens were not sent for checking (Appendix 2). Round 3 achieved total passes, while miscounts and grouping of molluscs accounted for two fails in a sample from round 4 (Fig. 1, Appendix 2).

\[\text{Figure 1 Average error rates for Victorian agencies based on three QA/QC criteria (number of new taxa, number of misidentifications and Bray Curtis dissimilarity) with number of samples checked and one standard deviation shown.}\]

Physid and planorbid molluscs were also grouped by Water Ecocience. This and the misidentification of lymnaeid molluscs accounted for fails across three criteria in all rounds (except round 1 - Appendix 2). Additional miscounts and missing specimens increased the error margins. Two sites in the fourth round failed all categories due to the lack of experience of the staff member undertaking identifications.

Overall, error rates for Victorian agencies were below 10% and these levels could be reduced by agencies conforming to standard taxonomic levels. The EPA generally had significantly lower error rates than Water Ecocience which may reflect a difference in the experience of staff between the two agencies.

New South Wales

Five agencies undertook invertebrate identifications for the MRHI in NSW (Fig.2). The Environmental Protection Agency had a number of samples fail the three QA criteria in the first
round (Appendix 2) due to incorrect identifications and chironomids not being keyed to subfamily. In the following three sampling rounds only a few misidentifications occurred and passes were given in all criteria. Therefore, overall performance improved over time (Fig. 2).

Results from the Department of Land and Water Conservation were generally very good in all rounds (Fig. 2) although, in comparing these results with other agencies, low average richness in DLWC samples needs to be considered (Appendix 2). Only one fail was given, in round 2 (Appendix 2), for the new taxa criterion due to the misidentification of one taxon (Tabanidae). The only other criticism of the agency was failure to include identifier/date labels with samples in rounds 1 and 2.

Australian Water Technologies was only involved in the first two sampling rounds. Errors in the first round were due to a number of missing specimens. In the second round the agency made no errors (Fig. 2).

Samples identified by the University of New England in the first round failed in two of the assessment criteria due to absence of taxa recorded on data sheets in samples, unidentified and miscounted specimens (Appendix 2). These errors were minimized in subsequent rounds (Fig. 2) and no fails were given (Appendix 2).

Charles Sturt University disposed of samples collected in the first three rounds so these could not be checked. Fourth round errors included miscounts, misidentifications and failure to record specimens on data sheets. These errors resulted in fails in all criteria at one site while another site had no errors (Appendix 2). It would appear there were two identifiers involved, however, no names were provided by the agency.

Overall, error rates decreased for all NSW agencies after the first round (Fig. 2). This may be a function of feedback from QA and increasing experience of agency staff. Charles Sturt University (CSU) is the main exception to this, being the only agency that didn’t have samples from the first rounds checked. If the trends for other agencies are a guide, the high error rate for CSU in round 4 (Fig. 2) may be representative of the quality of results from the previous unchecked rounds. These results highlight the need for checking to take place from the outset to ensure that problems are rectified at an early stage.
Western Australia

Four agencies were involved in identification of invertebrate samples for the MRHI in Western Australia. Edith Cowan University and the University of Western Australia passed all QA criteria in all samples checked (Appendix 2) and so are not included in Figure 3 (below). Both Murdoch University and the Department of Conservation and Land Management (CALM) had highest error rates in the first round and showed improvement thereafter (Fig. 3). Misidentifications, miscounts, missing specimens, and unrecorded families accounted for fails being given to Murdoch in the first round. The fourth round was within limits eventhough the molluscs were misidentified. Errors in round 1 samples from CALM were in the form of miscounts, misidentifications (mainly hemipterans and odonates) and omission of taxa from data sheets. Fails were generally given for samples identified by a new staff member not familiar with the northern fauna. Subsequent new staff members performed better. Round 4 was not assessed for CALM.

Overall, results from WA showed an improvement after the first round when error rates dropped to below an average of 5% (Fig. 3). Low overall error rates in WA may be related to low diversity in this state (except for the northern regions sampled by CALM).

![Average error rates for Western Australian agencies based on three QA/QC criteria (number of new taxa, number of misidentifications and Bray Curtis dissimilarity) with number of samples checked and one standard deviation shown.](image)

South Australia - Environment Protection Agency

Passes were given in all sampling rounds except for round 3, which had a low number of taxa, and one misidentification led to a fail in the new taxa category (Appendix 2). Errors were minimal in rounds 1 and 2 and no errors were made in round 4 (Fig. 4).

Australian Capital Territory - University of Canberra

Errors repeated throughout the four rounds meant a high fail rate for this agency across the three identification criteria (Fig. 4). Amphipods were not keyed to family level in any round and accounted for many fails. Many misidentifications occurred across both non-insect and insect groups. Specimens of Oligochaeta and Acarina were often not recorded on data sheets which led to fails in the new taxa criterion, particularly in round 1 where fails were given at all sites (Appendix 2). The consistently poor performance of this agency may be attributed to staff inexperienced in identification, non-conformance to specified taxonomic levels and a degree of carelessness.

Tasmania - Department of Primary Industry and Fisheries

Samples from round 2 were identified first by DPIF. A high fail rate in round 2 was due to chironomids not being keyed to subfamily. In subsequent rounds chironomids were identified to the appropriate level and rounds 1 and 3 passed all the identification criteria with minimal
errors (Fig 4). One site in round 4 attracted fails in all three criteria (Appendix 2) due to misidentifications of a significant proportion of taxa. The errors cannot be attributed to a new identifier but possibly to carelessness, either in identifications or in the recording of specimens on data sheets.

**Figure 4** Average error rates for South Australia, Australian Capital Territory and Tasmania based on three QA/QC criteria (number of new taxa, number of misidentifications and Bray Curtis dissimilarity) with number of samples checked and one standard deviation shown.

**Queensland and the Northern Territory**

Only one round from both Queensland and the Northern Territory could be checked. Checking for the NT is incomplete, consisting of two habitats with one of these incomplete. Overall, both agencies achieved passes in the round checked (Table 2). Queensland samples were checked in two stages and an improvement in error rate was noticed, probably due to increasing experience of staff.
Table 2. Summary of results for Queensland and Northern Territory showing the number of samples checked, average % error (based on the 3 QA/QC criteria) and the standard error associated with the average.

<table>
<thead>
<tr>
<th></th>
<th>Queensland</th>
<th>Northern Territory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of samples checked</td>
<td>27</td>
<td>9</td>
</tr>
<tr>
<td>Average error (%)</td>
<td>3.6</td>
<td>3.7</td>
</tr>
<tr>
<td>Standard error</td>
<td>3.5</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Objective 3 - Reporting to agencies
A QA summary report was produced and sent to agencies for each round that was checked. Reports included a summary of results, commentary about errors (Appendix 1) and copies of QA/QC data sheets which detail all errors and calculation of the three assessment criteria.

Objective 4 - Reporting to NRHP committee
Collation of data from cross-checking of macroinvertebrate identifications for four rounds of the MRHI has highlighted several key points:

1. Error rates were often contributed to by non-conformance to specified taxonomic levels (particularly molluscs, chironomids and amphipods). Non-conformance did not always result from lack of communication, so responses to deliberate non-conformance may need to be assessed.

2. In-house training of new staff in identification and induction with relation to MRHI protocols is necessary to maintain low levels of error (this is part of quality assurance).

3. Feedback from external cross-checking is essential for all agencies involved in the program, preferably after the first round of sampling, to avoid compounding of errors over time.

Implications of results
Acceptable error levels need to be reassessed in the light of data collected to date. Such an assessment may look at whether the continued use of an acceptance sampling approach (i.e. management decides on an acceptable level of error) is appropriate and review of the acceptance level, possibly from the current 10% to 5%. Factors that may be taken into consideration in making this decision include:

1. Results of the modelling process: acceptable error rates may be linked to those that will start to cause a breakdown in the predictive model, this may also involve assessing the contribution of identification errors to other sources of error such as bias resulting from live-sorting.

2. Protocols developed elsewhere such as the US which advocate a 10% error rate for a lower level of taxonomic resolution (generally genus - Cuffney et al. 1993). Results from the current QA work suggest a 5% target for family-level is now attainable.

3. It is envisaged that future sample identification for testing and use of the AUSRIVAS model will be on a presence/absence basis. Miscounts will cease to be a criteria and error rates are likely to be reduced (see Appendix 2 for recalculation of results using presence/absence data). This represents another argument for reduction of the acceptable error rate from 10% to 5%.

Alternately a true quality control approach may be adopted whereby an acceptable level of variability is determined empirically, as per the British approach (Van Dijk 1994). In the
current approach, inherent variability may be partially masked by the buffer zone of accepting
miscalculation of <5% or 1.

Recommender
A QA/QC manual should be produced that is available to all people interested in applying the
AUSRIVAS model. This would include all aspects of QA/QC such as sample collection,
sorting etc with QA/QC of identifications being only one component. An area highlighted in
this document that is also worthy of inclusion is provision of in-house training for new staff.
The manual should also suggest protocols for action when a sample fails one of the three
criteria i.e. quality control procedures. This may consist of an appropriate block of samples
being reidentified by the agency and QA/QC repeated. External QA/QC should continue at the
current rate to ensure ongoing quality of data with regard to identifications.

Communication of results/ adoption activities
- presentation of guide/workshop
- constant feedback to agencies via reports for each round

List of publications, sources of further information
assurance of benthic invertebrate samples collected as part of the national water-quality

Rivers Authority R&D Note 331, Bristol, 37pp.

Supporting documents
2. Guidelines for identification and quantification for agencies participating in the MRHI based
3. Calculation and documentation of QA/QC error rates.

Acknowledgments
Thanks go to Chris Humphrey for his help in establishing this project, Di Crowther and Jo
Thompson for their technical and professional support, and finally Peter Davies and Nick
Schofield for providing advice throughout the project.
APPENDIX 1: EXAMPLE OF PROGRESS REPORT


PROGRESS REPORT ON QUALITY CONTROL CHECKING OF MACROINVERTEBRATE IDENTIFICATIONS.

CONTACT: Garry Bennison

STATE/TERRITORY: Victoria

AGENCY: Water Ecoscience Pty Ltd

SAMPLING OCCASSION: Mar/Apr 1995

Samples cross-checked and summary of results:

<table>
<thead>
<tr>
<th>Biogeographic region</th>
<th>Site</th>
<th>Habitat</th>
<th>Assessment criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NT</td>
<td>IE</td>
</tr>
<tr>
<td>Region 1, Moorabool River Basin</td>
<td>Moorabool River at Sheoaks</td>
<td>Pool</td>
<td>P</td>
</tr>
<tr>
<td>Region 2, Tambo River Basin</td>
<td>Tambo River downstream Peters Creek</td>
<td>Pool</td>
<td>P</td>
</tr>
<tr>
<td>Region 3, Werribee River Basin</td>
<td>Kororoit Creek, Beatty's Road Crossing</td>
<td>Pool</td>
<td>P</td>
</tr>
<tr>
<td>Region 4, Maribyrnong River Basin</td>
<td>Deep Creek, Daraweit Guim</td>
<td>Pool</td>
<td>F</td>
</tr>
<tr>
<td>Region 5, Broken River Basin</td>
<td>Broken Creek downstream of Nathalia</td>
<td>Pool</td>
<td>P</td>
</tr>
</tbody>
</table>

NT=percent new taxa  IE=percent incorrect identifications or counts  BC=Bray Curtis

Assessment criteria: P=Pass, F=Fail.

Comments

Region 1, Moorabool River at Sheoaks

- 6 chironomids only identified to family level. These specimens should have been taken to subfamily.
- Molluscs only identified to Physidae/Planorbidae. The snails were all Physids and should have been identified. (ref. Smith and Kershaw, 1979, Field Guide to the Non-Marine Molluscs of South Eastern Australia, page 75)
- The two Oligochaeta specimens were missing.
- The Mecaploptera specimen was missing
  - The Proteurididae and Zygoptera damaged specimens both keyed to Isostictidae (Hawking 1995 - MRHI workshop key.) Confusion may be due to Isostictidae originally being a sub-family of Proteurididae (see Hawking 1986).
Region 2. Tambo River downstream of Peters Creek

- The three Mollusca specimens should not have been lumped into Planorbidae/Physidae. They have been identified by Brian Smith and are all Lymnaeidae Austropeplea tomentosa.
- There were 6 Ecnomidae not 5.
- Unknown coleoptera (possibly terrestrial) has been sent to J. Lawrence for determination.
- A Blephariceridae (pupae) was not listed on the data sheet.

Region 3. Kororoit creek, Beatty’s Road

- Once again the Mollusca were only identified to Planorbidae/Physidae. The specimen was Physa acuta (Physidae).
- Incorrect counts for Corixidae and Dytiscidae were taken as errors.

Region 4. Deep Creek, Darraweit Guim

- The Mollusca were not identified to family level (MRHI- protocol)
  - The group contained both the families suggested. Identification is simple and can be achieved by boiling the radula out from an example of each different looking specimen.
  - The method is found in Smith & Kershaw, 1979.(as above)

Region 5. Broken Creek downstream of Nathalia

- One Palaemonidae (prawn) was recorded incorrectly as an Atyidae (shrimp)
- The Simuliidae specimen was missing
- Notonectidae count was 14 specimens, not 15.

Cheers,

John Hawking
APPENDIX 2

Assessment of the MRHI Agencies performance for “Rank abundance” and “Presence/absence”

data for Rounds 1 to 4
### ASSESSMENT OF VICTORIAN AGENCIES PERFORMANCE (RANK ABUNDANCE) FOR ROUNDS 1-4

<table>
<thead>
<tr>
<th>ROUND/AGENCY</th>
<th>1 EPA</th>
<th>1 WES</th>
<th>2 EPA</th>
<th>2 WES</th>
<th>3 EPA</th>
<th>3 WES</th>
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</thead>
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<tr>
<td>#Sites</td>
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<td>#Sites Cross-checked</td>
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<td>5</td>
<td>5</td>
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<td>7</td>
</tr>
<tr>
<td>New Taxa (Pass)</td>
<td>7</td>
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<td>8</td>
<td>3</td>
<td>5</td>
<td>6</td>
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<td>5</td>
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<tr>
<td>Incorrect (Pass)</td>
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<td>5</td>
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<tr>
<td>Bray-Curtis (Pass)</td>
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<tr>
<td>Pass/Fail</td>
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<td>21</td>
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<tr>
<td>Average Richness</td>
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<td>1301</td>
<td>1537</td>
<td>1969</td>
<td>873</td>
<td>1751</td>
<td>516</td>
<td>1339</td>
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<tr>
<td>Total Abundance</td>
<td>159</td>
<td>434</td>
<td>192</td>
<td>394</td>
<td>175</td>
<td>292</td>
<td>129</td>
<td>191</td>
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<tr>
<td>Average Abundance</td>
<td>LP</td>
<td>LP</td>
<td>LP</td>
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</tbody>
</table>

LP=Live Pick  Assessment=Bray-Curtis index on possible passes vs. attained passes for 3 criteria (pass<0.1)

### ASSESSMENT OF VICTORIAN AGENCIES PERFORMANCE (PRESENCE/ABSENCE) FOR ROUNDS 1-4

<table>
<thead>
<tr>
<th>ROUND/AGENCY</th>
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<td>3</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>5</td>
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<tr>
<td>New Taxa: 5% (Pass)</td>
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<tr>
<td>Index (Pass)</td>
<td>7</td>
<td>3</td>
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<td>6</td>
<td>4</td>
<td>5</td>
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</table>

Index=Bray-Curtis assessment on agency taxa list vs. cross-check taxa list
### ASSESSMENT OF NEW SOUTH WALES AGENCIES PERFORMANCE (RANK ABUNDANCE) FOR ROUNDS 1-4

<table>
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<td>F</td>
<td>F</td>
<td>F</td>
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<td>P</td>
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<td>P</td>
<td>P</td>
<td>P</td>
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</tr>
<tr>
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<td>6</td>
<td>18</td>
<td>21</td>
<td>14</td>
<td>8</td>
<td>16</td>
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<td>8</td>
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<td>11</td>
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<tr>
<td>Total Abund.</td>
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<td>175</td>
<td>169</td>
<td>*</td>
<td>249</td>
<td>1150</td>
<td>305</td>
<td>164</td>
<td>*</td>
<td>177</td>
<td>1101</td>
<td>94</td>
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<td>125</td>
<td>115</td>
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</tr>
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</table>

C/C=Cross-check  
P=Pass  
B-C=Bray-Curtis  
Av=Average  
Abund=Abundance  
LP=Live Pick  
* - samples discarded by agency; no assessment possible

### ASSESSMENT OF NEW SOUTH WALES AGENCIES PERFORMANCE (PRESENCE/ABSENCE) FOR ROUNDS 1-4

<table>
<thead>
<tr>
<th>ROUND/AGENCY</th>
<th>EPA</th>
<th>L&amp;W</th>
<th>AWT</th>
<th>CSU</th>
<th>UNE</th>
<th>EPA</th>
<th>L&amp;W</th>
<th>AWT</th>
<th>CSU</th>
<th>UNE</th>
<th>EPA</th>
<th>L&amp;W</th>
<th>CSU</th>
<th>UNE</th>
<th>EPA</th>
<th>L&amp;W</th>
<th>CSU</th>
<th>UNE</th>
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<tr>
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<td>3</td>
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<td>2</td>
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<tr>
<td>#Sites C/C</td>
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<td>3</td>
<td>2</td>
<td>*</td>
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<td>10</td>
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<td>8</td>
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<tr>
<td>NT: 10% (P)</td>
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<td>*</td>
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<td>8</td>
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<td>1</td>
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</tr>
<tr>
<td>NT: 5% (P)</td>
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<td>*</td>
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<td>9</td>
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<td>7</td>
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<td>*</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Index (P)</td>
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<td></td>
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</tbody>
</table>

C/C=Cross-check  
NT=New Taxa  
P=Pass  
Index=Bray-Curtis assessment on agency taxa list vs. cross-check taxa list  
* - samples discarded by agency; no assessment possible
# ASSESSMENT OF SOUTH AUSTRALIAN AGENCY PERFORMANCE (RANK ABUNDANCE) FOR ROUNDS 1-4

<table>
<thead>
<tr>
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<th>4 EPA SA</th>
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</thead>
<tbody>
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<td>141</td>
<td>132</td>
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<tr>
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<td>7</td>
<td>6</td>
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<tr>
<td>New Taxa (Pass)</td>
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<td>6</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Incorrect (Pass)</td>
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<td>6</td>
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<td>p</td>
</tr>
<tr>
<td>Pass/Fail</td>
<td>p</td>
<td>p</td>
<td>p</td>
<td>p</td>
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<tr>
<td>Average Richness</td>
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<td>22</td>
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</table>

FP=Field Preservation  
Assessment=Bray-Curtis index on possible passes vs. attained passes for 3 criteria (pass<0.1)  
*represents total abundance being entered on QA/QC sheet (generally a 10% subsample would be cross-checked in this case)

---

# ASSESSMENT OF SOUTH AUSTRALIAN AGENCY PERFORMANCE (PRESENCE/ABSENCE) FOR ROUNDS 1-4

<table>
<thead>
<tr>
<th>ROUND/AGENCY</th>
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<th>4 EPA SA</th>
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<td>New Taxa: 5% (P)</td>
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<td>6</td>
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<td>Index (P)</td>
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P=Pass  
Index=Bray-Curtis assessment on agency taxa list vs. cross-check taxa list
### ASSESSMENT OF TASMANIAN AGENCY PERFORMANCE (RANK ABUNDANCE) FOR ROUNDS 1-4

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<tr>
<td>New Taxa (Pass)</td>
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<td>2</td>
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<tr>
<td>Incorrect (Pass)</td>
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<td>F</td>
<td>P</td>
<td>P</td>
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<tr>
<td>Pass/Fail</td>
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<td>16</td>
<td>15</td>
<td>17</td>
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<tr>
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FP=Field Preservation  
Assessment=Bray-Curtis index on possible passes vs. attained passes for 3 criteria (pass<0.1)

### ASSESSMENT OF TASMANIAN AGENCY PERFORMANCE (PRESENCE/ABSENCE) FOR ROUNDS 1-4

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<tr>
<td>New Taxa 10% (Pass)</td>
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<tr>
<td>New Taxa 5% (Pass)</td>
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<td>Index (Pass)</td>
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Index=Bray-Curtis assessment on agency taxa list vs. cross-check taxa list
### ASSESSMENT OF WESTERN AUSTRALIAN AGENCIES PERFORMANCE (RANK ABUNDANCE) FOR ROUNDS 1-4

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<th>MURD</th>
<th>ECU</th>
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<td>New Taxa (P)</td>
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<tr>
<td>Incorrect (P)</td>
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<td>5</td>
<td>5</td>
<td>3</td>
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<tr>
<td>B-C (P)</td>
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**Calculation:** Pass/Fail, Bray-Curtis (B-C), Bray-Curtis (Av), Abundance (Abund), Live Pick (LP), Cross-check (C/C), Bray-Curtis (Assessment)

### ASSESSMENT OF WESTERN AUSTRALIAN AGENCIES PERFORMANCE (PRESENCE/ABSENCE) FOR ROUNDS 1-4

<table>
<thead>
<tr>
<th>ROUND/AGENCY</th>
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<th>MURD</th>
<th>ECU</th>
</tr>
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<tbody>
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<tr>
<td>NT: 10% (P)</td>
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<td>3</td>
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<tr>
<td>NT: 5% (P)</td>
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<tr>
<td>Index (P)</td>
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<td>5</td>
<td>5</td>
<td>3</td>
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</table>

**Calculation:** Pass/Fail, Bray-Curtis (B-C), Bray-Curtis (Av), Abundance (Abund), Live Pick (LP), Cross-check (C/C), Bray-Curtis (Assessment)
### ASSESSMENT OF A.C.T. AGENCY PERFORMANCE (RANK ABUNDANCE) FOR ROUNDS 1-4

<table>
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<tr>
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<tr>
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<td>Pass/Fail</td>
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<td>F</td>
<td>F</td>
<td>F</td>
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<tr>
<td>Average Richness</td>
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<td>17</td>
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</tr>
</tbody>
</table>

Assessment=Bray-Curtis index on possible passes vs. attained passes for 3 criteria (pass<0.1)  
FP=Field Preservation

### ASSESSMENT OF A.C.T. AGENCY PERFORMANCE (PRESENCE/ABSENCE) FOR ROUNDS 1-4

<table>
<thead>
<tr>
<th>ROUND/AGENCY</th>
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<th>3 UC</th>
<th>4 UC</th>
</tr>
</thead>
<tbody>
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<tr>
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</tr>
<tr>
<td>Index (P)</td>
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</tbody>
</table>

P=Pass  
Index=Bray-Curtis assessment on agency taxa list vs. cross-check taxa list
### Assessment of Queensland Agency Performance (Rank Abundance) for Rounds 1-4

<table>
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<tr>
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<th>4 DPI</th>
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<td>--</td>
<td>--</td>
</tr>
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<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Incorrect (Pass)</td>
<td>24</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Bray-Curtis (Pass)</td>
<td>26</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Assessment</td>
<td>0.03</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Pass/Fail</td>
<td>P</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Average Richness</td>
<td>15</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Total Abundance</td>
<td>2267</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Average Abundance</td>
<td>84</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Sample</td>
<td>LP</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Assessment = Bray-Curtis index on possible passes vs. attained passes for 3 criteria (pass<0.1)  
LP = Live Pick  
-- samples not received; results pending

### Assessment of Queensland Agency Performance (Presence/Absence) for Rounds 1-4

<table>
<thead>
<tr>
<th>ROUND/AGENCY</th>
<th>1 DPI</th>
<th>2 DPI</th>
<th>3 DPI</th>
<th>4 DPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>#Sites Cross-checked</td>
<td>27</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>New Taxa: 10% (P)</td>
<td>25</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>New Taxa: 5% (P)</td>
<td>18</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Index (P)</td>
<td>26</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

P = Pass  
Index = Bray-Curtis assessment on agency taxa list vs. cross-check taxa list  
-- samples not received; results pending
### ASSESSMENT OF NORTHERN TERRITORY AGENCY PERFORMANCE (RANK ABUNDANCE) FOR ROUNDS 1-4

<table>
<thead>
<tr>
<th>ROUND/AGENCY</th>
<th>1 P&amp;W</th>
<th>2 P&amp;W</th>
<th>3 P&amp;W</th>
<th>4 P&amp;W</th>
</tr>
</thead>
<tbody>
<tr>
<td>#Sites</td>
<td>--</td>
<td>--</td>
<td>63</td>
<td>--</td>
</tr>
<tr>
<td>#Sites Cross-checked</td>
<td>--</td>
<td>--</td>
<td>6</td>
<td>--</td>
</tr>
<tr>
<td>New Taxa (Pass)</td>
<td>--</td>
<td>--</td>
<td>6</td>
<td>--</td>
</tr>
<tr>
<td>Incorrect (Pass)</td>
<td>--</td>
<td>--</td>
<td>4</td>
<td>--</td>
</tr>
<tr>
<td>Bray-Curtis (Pass)</td>
<td>--</td>
<td>--</td>
<td>6</td>
<td>--</td>
</tr>
<tr>
<td>Assessment</td>
<td>--</td>
<td>--</td>
<td>0.05</td>
<td>--</td>
</tr>
<tr>
<td>Pass/Fail</td>
<td>--</td>
<td>--</td>
<td>P</td>
<td>--</td>
</tr>
<tr>
<td>Average Richness</td>
<td>--</td>
<td>--</td>
<td>14</td>
<td>--</td>
</tr>
<tr>
<td>Total Abundance</td>
<td>--</td>
<td>--</td>
<td>1297</td>
<td>--</td>
</tr>
<tr>
<td>Average Abundance</td>
<td>--</td>
<td>--</td>
<td>216</td>
<td>--</td>
</tr>
<tr>
<td>Sample</td>
<td>--</td>
<td>--</td>
<td>LP</td>
<td>--</td>
</tr>
</tbody>
</table>

Assessment = Bray-Curtis index on possible passes vs. attained passes for 3 criteria (pass<0.1) --samples not received; results pending

### ASSESSMENT OF NORTHERN TERRITORY AGENCY PERFORMANCE (PRESENCE/ABSENCE) FOR ROUNDS 1-4

<table>
<thead>
<tr>
<th>ROUND/AGENCY</th>
<th>1 P&amp;W</th>
<th>2 P&amp;W</th>
<th>3 P&amp;W</th>
<th>4 P&amp;W</th>
</tr>
</thead>
<tbody>
<tr>
<td>#Sites Cross-checked</td>
<td>--</td>
<td>--</td>
<td>6</td>
<td>--</td>
</tr>
<tr>
<td>New Taxa: 10% (Pass)</td>
<td>--</td>
<td>--</td>
<td>6</td>
<td>--</td>
</tr>
<tr>
<td>New Taxa: 5% (Pass)</td>
<td>--</td>
<td>--</td>
<td>4</td>
<td>--</td>
</tr>
<tr>
<td>Index (Pass)</td>
<td>--</td>
<td>--</td>
<td>6</td>
<td>--</td>
</tr>
</tbody>
</table>

Index = Bray-Curtis assessment on agency taxa list vs. cross-check taxa list --samples not received; results pending
SUPPORT DOCUMENT No 3

CALCULATION AND DOCUMENTATION

OF QA/QC ERROR RATES

LWRRDC PROJECT MDR16
SUPPORT DOCUMENT 3
CALCULATION AND DOCUMENTATION OF QA/QC ERROR RATES

Breakdown of discrepancy types

*e.g. 1* *miscount within accepted limits*

<table>
<thead>
<tr>
<th>agency result</th>
<th>QA/QC result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caenidae 50</td>
<td>Caenidae 48</td>
</tr>
</tbody>
</table>

This discrepancy would not be recorded on the list of revisions sheet because the QA/QC result was less than the agency result by less than 5%. The acceptable level for miscounts is if the QA/QC count is less than agency count by 1 or 5% of the count (in this instance 47-50 acceptable). **In the calculation of Bray Curtis dissimilarity the QA/QC result would be altered to coincide with the agency result.**

*Note:* The only exception to this rule is where the agency count =1, QA/QC result = 0 which constitutes an error.

*e.g. 2* *miscount beyond accepted limits*

<table>
<thead>
<tr>
<th>agency result</th>
<th>QA/QC result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caenidae 50</td>
<td>Caenidae 43</td>
</tr>
</tbody>
</table>

This discrepancy would be recorded as follows:

<table>
<thead>
<tr>
<th>List of revisions to identifications and enumerations:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Taxon</strong></td>
</tr>
<tr>
<td>Original identification</td>
</tr>
<tr>
<td>Caenidae</td>
</tr>
</tbody>
</table>

This error would be assimilated into the data analysis by having 7 'incorrect identifications or counts' and by a discrepancy in Bray Curtis. **Note:** this form of error becomes redundant when only presence/absence data is used.
e.g. 3 misidentification leading to change in original taxa list

| agency result: | Caeinidae | 5 | \n| | Leptophlebiidae | 0 | 
| QA/QC result: | Caeinidae | 0 | 
| | Leptophlebiidae | 5 | 

i.e. 5 leptophlebiids misidentified as caenids

This discrepancy would be recorded as follows:

<p>| List of revisions to identifications and enumerations: |</p>
<table>
<thead>
<tr>
<th>Taxon</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Original identification</strong></td>
<td><strong>Corrected identification</strong></td>
</tr>
<tr>
<td>Caeinidae</td>
<td></td>
</tr>
<tr>
<td>Leptophlebiidae</td>
<td>5</td>
</tr>
<tr>
<td>Caeinidae</td>
<td>Leptophlebiidae</td>
</tr>
</tbody>
</table>

This error would appear in all 3 criteria: in percent new taxa there would be 1 new taxon, in incorrect Ids/counts there would be 5 and the discrepancy between the 2 data sets would also be manifest in Bray Curtis.


e.g. 4 misidentification that does not lead to an addition to the taxa list:

| agency result: | Caeinidae | 5 |
| | Leptophlebiidae | 5 |
| QA/QC result: | Caeinidae | 6 |
| | Leptophlebiidae | 4 |

i.e. 1 caenid misidentified as a leptophlebiid

This discrepancy would be recorded as follows:

<p>| List of revisions to identifications and enumerations: |</p>
<table>
<thead>
<tr>
<th>Taxon</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Original identification</strong></td>
<td><strong>Corrected identification</strong></td>
</tr>
<tr>
<td>Caeinidae</td>
<td></td>
</tr>
<tr>
<td>Leptophlebiidae</td>
<td>5</td>
</tr>
</tbody>
</table>

This error would appear in: incorrect Ids/counts as 1 and as a discrepancy in Bray Curtis. Note: eventhough the QA/QC count for Leptophlebiidae is within the miscount acceptance range, it is still included as an error because in this instance a misidentification rather than a miscount occurred.
e.g. 5  incorrect (higher) taxonomic level used

agency result: Chironomidae 10
QA/QC result: Orthocladiinae 6
Tanypodinae 4

This is an example of the agency not identifying specimens to the required taxonomic level (in this case family rather than sub-family level).

This discrepancy would be recorded as follows:

<table>
<thead>
<tr>
<th>Original identification</th>
<th>Corrected identification</th>
<th>Original</th>
<th>Re-count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chironomidae</td>
<td>Orthocladiinae</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Chironomidae</td>
<td>Tanypodinae</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>

What generally occurred in the development of identification protocols for the MRHI was that errors such as that shown above were not counted in the first round but were mentioned in the accompanying report. If such errors were repeated, calculations were as follows: in e.g. 5 new taxa would be 2, 10 miscounts/identifications and Bray Curtis dissimilarities would be calculated as they appear in the above table. Note: when the wrong taxonomic level was specified and the correct level had only one taxon, this was not counted as an error but was noted in the accompanying report to the agency. e.g. 'Tricladida' instead of 'Dugesiidae'.

e.g. 6  inclusion of terrestrial taxa

agency result: Hebridae 1
QA/QC result: terrestrial hemiptera 1

This discrepancy would be recorded as follows:

<table>
<thead>
<tr>
<th>Original identification</th>
<th>Corrected identification</th>
<th>Original</th>
<th>Re-count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hebridae</td>
<td>terrestrial hemiptera</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

This error would not be included in new taxa calculations (as the new taxa is not included in the final database) but would appear as 1 miscount/misidentification. Calculations of Bray Curtis would not include the terrestrial taxon but a discrepancy between the original data set and the QA/QC data set would be manifest by the presence of 1 hebrid in the original and none in the QA/QC. Note: In the opposite situation i.e. an aquatic taxon not included in the original because it was classified as terrestrial, there would be: 1 new taxon, 1 misidentification/miscount and the discrepancy in Bray Curtis would consist of 1 hebrid being present in the QA/QC but not the original.
Fully worked example

Below is an example of a potential outcome of QA/QC with data from the agency and QA/QC results from the corresponding sample.

<table>
<thead>
<tr>
<th>Agency data</th>
<th>QA/QC data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Taxon</strong></td>
<td><strong>Count</strong></td>
</tr>
<tr>
<td>Chironominae</td>
<td>133</td>
</tr>
<tr>
<td>Orthocladinae</td>
<td>6</td>
</tr>
<tr>
<td>Caenidae</td>
<td>3</td>
</tr>
<tr>
<td>Corixidae</td>
<td>1</td>
</tr>
<tr>
<td>Gomphidae</td>
<td>1</td>
</tr>
<tr>
<td>Isostictidae</td>
<td>7</td>
</tr>
<tr>
<td>Ecnomidae</td>
<td>4</td>
</tr>
<tr>
<td>Hydroptilidae</td>
<td>10</td>
</tr>
<tr>
<td>Thiaridae</td>
<td>1</td>
</tr>
</tbody>
</table>

no. taxa=9  \[ \Sigma x 166 \]

no. taxa=10 \[ \Sigma x 157 \]

The corresponding QA/QC list of revisions and enumerations would be as follows:

<table>
<thead>
<tr>
<th>List of revisions to identifications and enumerations:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Taxon</strong></td>
</tr>
<tr>
<td>Original identification</td>
</tr>
<tr>
<td>Chironominae</td>
</tr>
<tr>
<td>Ecnomidae</td>
</tr>
<tr>
<td>Ecnomidae</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percent new taxa</th>
<th>Incorrect identifications or counts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of taxa (a)</td>
<td>10</td>
</tr>
<tr>
<td>Number of new taxa (b)</td>
<td>1</td>
</tr>
<tr>
<td>Percent ((\frac{b}{a}) x 100)</td>
<td>10</td>
</tr>
<tr>
<td>Pass or fail? (Pass if &lt; 10%)</td>
<td>F</td>
</tr>
</tbody>
</table>

Bray Curtis dissimilarity index: 0.03  Pass or fail? (Pass if index <0.1)  P

Total number of taxa - taken from the QA/QC result.

Number of new taxa - taxa present in QA/QC result that are not present in agency result (in this instance Polycentropodidae only taxon therefore no. new taxa=1).

Total number of organisms - taken from the QA/QC result.

Number of organisms incorrectly identified - difference between QA/QC result and agency ie Chironominae accounted for 8 miscounts and 1 misidentified polycentropodid = 9.

Bray Curtis: \[ \frac{\Sigma | Dij - Dik |}{\Sigma (Dij + Dik)} = \frac{8+0+0+0+0+0+1+1+0+0}{258+12+6+2+2+14+7+1+20+2} = 0.03 \]

Note: Hydroptilidae not included as a miscount or in Bray Curtis because it was within the accepted <5% or 1 range.
GUIDELINES FOR

IDENTIFICATION AND QUANTIFICATION

FOR AGENCIES PARTICIPATING IN THE

MRHI BASED ON QUALITY CONTROL

PROCEDURES
GUIDELINES FOR IDENTIFICATION AND QUANTIFICATION FOR
AGENCIES PARTICIPATING IN THE MRHI BASED ON
QUALITY CONTROL PROCEDURES

John Hawking (CRCFE/MDFRC) and Ruth O’Connor (ERISS)

Draft 6 June 1997

1. BACKGROUND

The quality control / quality assurance (QA/QC) procedures are designed to establish an acceptable taxonomic standard of macroinvertebrate identifications for the state/territory agencies involved in the MRHI bioassessment. The quality control component is to determine the variation in the level of identifications and monitor this to detect changes in quality, and quality assurance provides potential users with the assurance that the accuracy of the results is within controlled limits.

Approximately 5% of the samples identified by each agency, as collected within each sampling round, were requested for cross-checking. The samples were selected with the aim to cover a range of biogeographical regions and habitats sampled (and thus the broadest range of taxa likely to be encountered). The samples were selected on a stratified / random basis, by (a) catchment (b) habitat (c) sampler. Samples were selected randomly from within a given biogeographical region and habitat. Duplicate samples from within biogeographical region and habitat were also selected to allow for breakages and to increase the scope of checking a broad range of staff who performed the original identifications.

Each laboratory is requested to forward the samples to be cross-checked, with the organisms sorted to order level (single order per vial) or if possible to family level, especially when the family is abundant. The order level separation eliminates any high level discrepancies. This also is needed for future curatorial preservation and storage. Sample vials should be individually wrapped or placed in polystyrene containers and packaged securely to avoid breakage during shipping.

The MRHI Technical Working Group has determined a taxonomic level for a selected list of macroinvertebrate taxa (Appendix 1). All taxa are to be identified to family level, except in the following cases: (a) Nemertea, Nematoda, Oligochaete, Polychaete, Conchostraca, Ostracoda (WA only, optional for other states/territories), Acarina and Collembola, which are to a higher level and (b) chironomids which are to the lower level of subfamily. Excluded from the list are some of the primitive groups, Porifera (sponges), Polypoza (bryozoans) and the microinvertebrates (Rotifera, Cladocera, Copepoda, Branchiura, Tardigrada and Gastrotricha). The majority of the taxa listed in Appendix 1 are identifiable by the keys listed in the “MRHI Workshop Handbook” (Hawking 1995) and for lower level identifications use the keys suggested in the “Guide to keys” (Hawking 1994).

In the process of undertaking external QA/QC of invertebrate identifications for the Monitoring River Health Initiative, several common taxonomic problem areas have
been highlighted. Problems have arisen where there was confusion as to the required taxonomic level, or where the required level did not conform to that which the agency traditionally used, or where a subjective judgement was required as to whether a specimen was identifiable or not. This document aims to clarify required taxonomic levels, and give guidance on how to deal with problematic taxonomic groups. The outcome will hopefully be for a more consistent approach to macroinvertebrate identification across agencies and fewer identification errors.

2. TAXONOMIC PROCEDURES FOR IDENTIFIERS

2.1 Identification Tree

Specific instructions will be given for particular taxa which have commonly been misidentified, but it was recognised that it would be impossible to cover every potential identification problem in this way. Therefore to provide a generic procedure to be applied for the identification process a decision tree (Appendix II) has been formulated. The decision tree should be used if any uncertainty arises as to whether or not a specimen can be identified.

2.2 Voucher collection

Representatives (late instar/stage specimens) of all taxa must be kept aside and curated to form a reference voucher collection. The collection should be arranged systematically, in phylogenetic order, with accompanying voucher sheets and a list of the references used [The operation and maintenance of the voucher collection will be detailed in the QA/QC Procedures Manual, in preparation]. These reference specimens should be validated (have their identifications confirmed by a specialist) and then can be used for comparison with new specimens.

2.3 Specialist Taxonomists

The MRHI has provided funds (presently till December 1997) to support the taxonomic studies of a few specialists: John Dean, David Cartwright, Ros St Clair and Jean Jackson (taxonomic studies of Trichoptera families) and John Dean and Phil Suter (families of Ephemeroptera). The other specialist taxonomists have not been provided with funding and have to charge an identification fee (approximately $75.00 per hour). This is a very small cost in the projects funding, especially considering its importance, to the validity of the results for the model. Davies (1994) provided a list of the specialist taxonomists, which has been updated and included as Appendix III. It is important to contact the specialist and discuss your requirements before sending specimens.

3. COMMON TAXONOMIC PROBLEMS

Listed below are procedures to follow when unknown, immature, pupae, damaged, exuviae and terrestrial specimens are encountered.
3.1 Unknown specimens

Agency staff are expected to identify all specimens and this should be possible to the expected level, except in the cases discussed below. In the case of new or unknown taxa the identifier should attempt the identification and then (1) give the taxa a temporary code with its associated details on a temporary taxa sheet [This will be detailed in the QA/QC Procedures Manual] and (2) have the identification confirmed by a specialist (Appendix III). No taxon should be recorded as unidentified. It is the responsibility of the agency to make an effort to identify the specimen.

3.2 Immature specimens

Early instars/stages of many groups are difficult to identify as they lack the distinguishing features needed to identify them in a key. In this case, as long as the specimens are immatures and only someone with specialist skills could identify the specimen, the identifier will not be penalised in QA/QC (see decision tree - Appendix II). When it is impossible to identify these specimens, as they lack distinguishing features, it is appropriate to list the specimens as immatures (eg. immature Trichoptera). In many cases there are late instar specimens of a particular taxa that can be used for comparison to immature specimens. The other possibility is to mount the diagnostic features on a microscope slide and identify it under a compound microscope.

Some examples of immature specimens that can be misidentified are:

1. Discriminating between the very early instars of corduliid and libellulid odonate larvae can be difficult, as the libellulid larvae that have palpal dentations, a major feature of the corduliids. This problem will be encountered mostly in northern Australia.

2. Confusion can occur with the early instar ecomids, first instar hydropsychids and hydroptilids which have come out of their cases.

3. Immature specimens of Corbiculidae can be confused with mature Sphaeriidae specimens.

3.3 Pupae

Many insect pupae can’t be identified due to the lack of keys and it is acceptable for staff to record them to order (eg. Diptera pupae, Trichoptera pupae, etc). Many can be identified to family and this is encouraged. In the assessment pupae will not be counted as a new taxa because they are only another stage of a taxon (eg. larva, pupa and adult of a single taxon). If they can be identified they should be added to the numbers for larvae of that particular family.

3.4 Damaged specimens

Many specimens are damaged during collection and a few simple rules can be applied to determine if a specimen should be included and how to estimate the number of specimens that are present.
(1) Heads and bums of damaged specimens should be counted and the highest number recorded. If a specimen cannot be identified due to damaged/missing features then it should be listed as damaged on data sheets e.g. Ephemeroptera (damaged).

(2) Oligochaetes are damaged easily and break-up into segments. Therefore their numbers must be estimated by counting the number of head and bum ends in the sample.

(3) Gills are an important feature in the identification of Ephemeroptera and zygopteran odonates. If Zygoptera are missing all caudal gills they may be identified by using other features e.g. premental setae, along with distribution information (see decision tree - Appendix II). For example, if a taxonomic feature is common only to Families A and B, but Family A has never been recorded in the area, then it is reasonable to record the specimen as Family B based on its distribution in the area. The same principle can be applied to mayflies missing gills.

3.5 Exuviae and empty mollusc shells

Exuvial skins and empty shells should be disregarded as they are not indicative of the fauna at the particular site at that present time.

3.6 Terrestrial

Terrestrial animals are not to be counted but can be kept as examples for later reference. To be certain that the specimen is terrestrial, its identification should be confirmed by a specialist. If an aquatic organism is identified and recorded as terrestrial, then it is a misidentification and is counted as an error.

3.7 Difficult groups and commonly confused taxa

From the first phase of the monitoring program the following problem areas were recognised:

- The larvae of *Archichauliodes* (Megaloptera: Corydalidae) are commonly confused with gyrinid larvae (Coleoptera: Gyrinidae). The Corydalidae larvae have 8 pairs of lateral gills and the apical segment of abdomen with a pair of prolegs, whereas the gyrinid larvae have feathery gills on the first 8 abdominal segments, 2 pairs of gills on the 9th segment, and 2 pairs of hooks at the end of the 10th segment.

- Ecnomid, hydropsychid, philopotamid and polycentropod larvae are commonly confused. Ecnomid and hydropsychid larvae have sclerotization on the first three thoracic segments, whereas the philopotamid and polycentropod larvae have sclerotization only on the first thoracic segment (pronotum). Hydropsychids have abdominal gills (except in the first instar) whereas they are absent on ecnomids.

- Physids/planorbids have been grouped in the past (a decision made by some agencies). The separation of the two families is possible and the agencies that have keyed them out have attained good results. The radula should be boiled out
in dilute potassium hydroxide to positively confirm the identification and from this the major differences between the families will become apparent. There are other features that are diagnostic, as in the case of Physidae, the mottling, digitate processes on the mantle edge and the light coloured shell are easily recognisable, especially in larger specimens, which can be readily identified under the microscope. The methods and notes on the distinguishing features of the families are adequately covered in Smith (1996).

- The late stages, as with the immatures, of some species of the odonate family Libellulidae (those with palpal dentations) will key out to the family Corduliidae. All of the libellulids with palpal dentations can be distinguished by their short cerci (approximately half the length of epiproct), except species of Agrionoptera, Pantala, Trapezostigma and Urothemis. and these should be sent off for confirmation.

- Empidids and dolichopodids (Diptera) can be difficult to separate and may need to be grouped together when the identifier cannot reasonably separate them.

- Some of the families of Hemiptera (Salididae, Hebridae, Mesoveliidae) are mistaken as terrestrial bugs.

- The baetid, Playbaetis (from the NT) could be confused with the leptophlebiids, because of its prognathous head, but differs in that it has a very short median terminal filament (Dean & Suter 1996, Suter 1997).

- Confusion has arisen in the instances where the family name or status has changed.
  (a) Odonata: Family Chlorolestidae changed to Synlestidae; subfamily Isostictinae raised to family status, Isostictidae; family Macrodiplactidae reduced to subfamily status in the family Libellulidae; family Synthemidae reduced to subfamily status in the family Corduliidae.
  (b) Coleoptera: Family Hydrochidae reduced to subfamily status in the family Hydrophilidae; family Scirtidae formerly known as Helodidae; family Elmidae formerly known as Helminthidae.

REFERENCES


**CONTACTS**

John Hawking, Cooperative Research Centre for Freshwater Ecology / Murray Darling Freshwater Research Centre, P.O. Box 921, Albury, NSW, 2640. Ph 060-582340, Fax 060-431626, Email hawkingj@mdfrc.canberra.edu.au

Ruth O’Connor, Environmental Research Institute of the Supervising Scientist, Locked Bag 2, Jabiru, NT, 0886. Ph (08) 89799713, Fax (08) 89792149, Email rutho@eriss.erin.gov.au

**ACKNOWLEDGEMENTS**

Diane Crowther is thanked for her help in formulating these guidelines.
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**APPENDIX I: LIST OF THE MAJOR GROUPS AND THEIR FAMILIES**

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*only to be included by W.A. agencies
(optional for other states/territories)
IS THE ORDER IN THE 'LIST OF TAXA TO BE IDENTIFIED'?

GO TO APPROPRIATE FAMILY KEY OR COUNT

SPECIMEN HAS ALL FEATURES NECESSARY FOR IDENTIFICATION (MATURE & UNDAMAGED)

PROCEED WITH IDENTIFICATION

UNSURE OF OUTCOME FROM IDENTIFICATION PROCESS

SEND SPECIMEN TO NATIONAL EXPERT (record tentative identification on data sheet noting confirmation pending)

IDENTIFY & COUNT

IDENTIFY SPECIMEN (same as complete specimen)

DO NOT ATTEMPT IDENTIFICATION (count recorded for lowest practical level eg 'Zygoptera damaged')

SPECIMEN NOT COUNTED OR IDENTIFIED

COUPLER USING MISSING/ UNDEVELOPED FEATURE SEPARATES 2 GROUPS OF TAXA - 1 NOT FOUND IN THE STATE/TERRITORY OF COLLECTION

COMPLETE IDENTIFICATION

TAXON POSSESSES ANOTHER UNIQUE FEATURE THAT IDENTIFIES IT

COMPLETE IDENTIFICATION

AT LEAST 1 OTHER COMPLETE SPECIMEN PRESENT IN THE SAMPLE THAT LOOKS THE SAME AS THE DAMAGED SPECIMEN

COMPLETE IDENTIFICATION

YES

NO
APPENDIX III

TAXONOMIC SPECIALISTS

This list provides contact numbers for specialist invertebrate taxonomists who can be consulted over the identification of specimens in their particular field.

GASTROPODA

Brian Smith Ph: (03) 6331-6777, Fax: (03) 6334-5230, E-mail: brian@qvmag.tased.edu.au
Winston Ponder Ph: (02) 9320-6120, Fax: (02) 9320-6073

OLIGOCHAETA

ACARINA

Jane Growns Ph: (060) 582-324, Fax: (060) 431-626, E-mail: grownsj@mdfrc.canberra.edu.au

AMPHIPODA

John Bradbury Ph: (08) 3035847

DECAPODA

Pierre Horwitz Ph: (09) 4005558, E-mail: p.horwitz@cowan.edu.au

EPHEMEROPTERA

Phil Suter Ph: (060) 58-3889, Fax: (060) 58-3888, E-mail: p.suter@aw.latrobe.edu.au Baetidae/Caenidae
John Dean Ph: (03) 9628-5921, Fax: (03) 9614-3575 Leptophlebiidae

ODONATA

John Hawking Ph: (060) 582-340, Fax: (060) 431-626, E-mail: hawkingj@mdfrc.canberra.edu.au

PLECOPTERA

Gunther Theischinger Ph: (02) 9540-1795
Cathy Yule Ph: 0011 609 312-1069, Fax: 0011 609 312-1069

HEMIPTERA

Tom Weir Ph: (06) 246-4267, Fax: (06) 246-4000

MEGALOPTERA

Gunther Theischinger Ph: (02) 9540-1795

COLEOPTERA

Chris Watts Ph: (08) 8207-7500, Fax: (08) 8207-7430 Dytiscidae & Hydrophilidae
Alena Glaister Ph: (03) 9905-5648, E-mail: alena.glaister@sci.monash.edu.au Elmidae larvae
COLEOPTERA (continued)

Andrew Calder Ph: (06) 246-4269 Elmidae adults

Jenny Davis Ph: (09) 360-2939, Fax: (09) 310-4997 Psephenidae

John Lawrence Ph: (06) 246-4268, Fax: (06) 246-4000 Coleoptera

Tom Weir Ph: (06) 246-4267, Fax: (06) 246-4000 Coleoptera adults

DIPTERA

Peter Cranston Ph: (06) 246-4282, Fax: (06) 246-4000

TRICHOPTERA

David Cartwright Ph: (03) 9742-9245, Fax: (03) 9642-9288 Philopotamidae/Ecnomidae/Tasimiidae

John Dean Ph: (03) 9628-5921, Fax: (03) 9614-3575 Hydrobiosidae/Hydropsychidae & general families

Jean Jackson Ph: (03) 6226-2522 or (03) 6223-7133, E-mail: Jean.Jackson@zoo.utas.edu.au Calocidae/Helicidae/Conoecidae

Ros St Clair Ph: (03) 9628-5921, Fax: (03) 9614-3575 Helicopsychidae/Philorheithridae/Leptoceridae/Calamoceratidae

Alice Wells Ph: (06) 250 9450, Fax: (06) 250-9448 Hydroptilidae

N.B. A number of groups have not been covered in this list and further information can be obtained from the contact personnel.