A Review of Quality Assurance and Quality Control Procedures in the Sustainable Rivers Audit Fish Theme

Adam Richardson

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A report prepared for the Murray–Darling Basin Commission by the Murray–Darling Freshwater Research Centre.

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EXECUTIVE SUMMARY

A review of Quality Assurance/Quality Control (QA/QC) procedures for the 'Fish' component of the Murray–Darling Basin Commission's Sustainable Rivers Audit was undertaken by the Murray-Darling Freshwater Research Centre between May 2006 and May 2007. There were two phases to the review: interviews with program leaders of Sustainable Rivers Audit (SRA) sampling in each state, and field visits to teams actively sampling.

Both phases of the QA/QC procedures review provided a valuable insight into several key areas of SRA fish sampling including adherence to the Australian Code of Electrofishing Practice, sampling site validation, selection of sampling methods, sampling procedure and strategy, fish identification and abnormalities, and data entry. The review was primarily interested in identifying areas of variation among sampling teams and evaluating this variation in terms of sampling effort consistency.

There was a high level of consistency among state agencies with their interpretation and application of the SRA fish sampling protocols. Other positive outcomes included the apparent diligence of sampling teams, their adherence to and understanding of the SRA protocols, and the adoption of these protocols into other projects. There were, however, some differences among state agencies which may affect sampling consistency among teams and with future sampling events.

The following recommendations should further reduce variations among sampling teams and ensure consistency with future sampling events:
1. All states conduct (or attend) some form of SRA training workshop prior to each sampling season. This is relevant to all staff, as new SRA staff can be trained and current staff can be briefed on updated protocols.
2. Sampling continues to be undertaken by SRA-trained staff in each state. All sampling teams led by SRA-dedicated staff.
3. Produce laminated MDB fish guides for use in the field. The guide or key should include pictures of all taxa, a brief description of key diagnostic features, and pictures and descriptions of abnormalities.
4. All states photograph (digital) live specimens of potentially confusing taxa in the field.
5. Develop comprehensive guidelines for bait trap placement.
6. Standardise methods for checking and recording fish abnormalities.
7. Develop guidelines for handling exotic species.
8. Assess the difference between backpack electrofishing with or without mesh on the anode ring.
9. It is recommended that SRA sampling by the SARDI team be formerly assessed.
10. The minutes of TRG meetings should be circulated within two weeks of meetings, and updated protocols should be distributed to sampling teams as early as possible.

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1   INTRODUCTION

The review of Quality Assurance/Quality Control (QA/QC) procedures for the 'Fish' component of the Murray–Darling Basin Commission's Sustainable Rivers Audit was undertaken in two phases.

The first phase involved the retrieval of information regarding the QA/QC procedures each state-based sampling team had in place. This data was then used to identify areas of 'high risk' in terms of the consistency of fish data being collected. Information was retrieved by way of face-to-face interviews, conducted in May–June 2006, with each state agency involved in Sustainable Rivers Audit (SRA) fish sampling — New South Wales Department of Primary Industries (NSWDPI), Queensland Department of Primary Industries (QDPI), South Australian Research and Development Institute (SARDI), and the Victorian Department of Sustainability and Environment (Arthur Rylah Institute — ARI). A summary of QA/QC procedures and major findings of interviews was presented to the SRA Implementation Working Group at the SRA Annual General Meeting (AGM), 27 June 2006. More detailed results were also presented at the AGM, to all state agency staff involved in SRA fish sampling, to facilitate and generate workshop discussions.

The second phase of the QA/QC review was undertaken in March–May 2007 and involved site visits whilst state agencies were actively undertaking SRA fish sampling. NSWDPI, QDPI and ARI teams were the only agencies sampling at this time as SARDI was not required to sample fish during autumn 2007. The main objectives of site visits were to observe actual electrofishing and gather information supplementary to Phase I. Sampling teams were also given the opportunity to provide the Murray–Darling Basin Commission (MDBC) with feedback on the clarity of current SRA protocols.

2   PHASE I

Interview questions were generated in conjunction with the MDBC, and five main areas of interest were identified: 1) adherence to the Australian Code of Electrofishing Practice; 2) sampling site validation; 3) sampling procedure; 4) fish identification; and, 5) data entry. The interviews were also an opportunity for state agencies to provide the MDBC with feedback on the SRA program.

Two questions formed the basis for investigating potentially 'high risk' areas of current SRA fish sampling practices. These questions were applied to the five main areas of interest (detailed above). The questions were:
- Is there variation among state agencies?
- If so, what risks are there to sampling consistency among states?

Below is a summary of the findings from interviews, along with conclusions and recommendations. For a more comprehensive detailing of interviewee responses refer to Appendix I.

2.1   Adherence to the Australian Code of Electrofishing Practice

The Australian Code of Electrofishing Practice (ACEP) addresses a key area of QA/QC; that is, the minimum level of training required for anyone to undertake electrofishing. This has clear implications for the quality of data being collected. The code covers other aspects of electrofishing also relevant to the SRA such as the design and construction of electrofishing apparatus, maintenance and safety guidelines. Interview questions focussed on general adherence to the code, the level of qualifications held by SRA fish samplers, and electrofishing equipment.

Summary of findings
- All states adhered to the ACEP.
- At least one senior operator (ACEP-qualified) involved with SRA electrofishing on every sampling occasion in each state.
- Equipment used for fish sampling (anode configuration, generator size, SRA nets, bait traps, measuring boards, scales, etc.) varied minimally among states and all maintenance was carried out according to the ACEP.

Conclusions
- Minimal variation among states.
- No risk to sampling consistency.

2.2   Sampling site validation

Of particular interest, here, were the measures each state undertook to ensure that sites were validated according to best practices. Interview questions focussed on two main areas: the process of site validation (including site inspection), and equipment used for locating and measuring sample reaches.

Summary of findings
- Most states use a similar site validation procedure. SARDI did not conduct pre-sampling site inspections because the sites they sampled were not dynamic — flow rates were very predictable and, therefore, the types of electrofishing gear required could be determined without a pre-sampling site inspection. For example, the lower Murray River can rarely be sampled with anything other than a large boat, and streams in the Mt. Lofty Ranges can be backpack electrofished only.
- QDPI was the only agency to conduct site inspections by light aircraft. All site inspections undertaken by SRA-dedicated senior operators.
- All states use GPS to locate sample reaches and laser range finders to measure distances (reach width and length) of wider streams. ARI also used hip chains for lengths of some narrow stream reaches.

Conclusions
- Some variation in procedure, due mostly to differences in SA.
- Equipment used for field site measurements are consistent, as are the procedures for site inspections in New South Wales (NSW), Queensland (QLD) and Victoria (VIC).
- Minimal risk to sampling consistency. Sampling in SA has only been undertaken once, and sites there do not change such that the expected sampling method becomes inappropriate.

2.3   Sampling procedure

The manner in which sampling is undertaken, to ensure consistency among states and over time, is probably the most important QA/QC issue. Phase I consisted of face-to-face interviews at state agency offices so actual sampling was not observed — actual sampling was witnessed during Phase II. Phase I interview questions focussed on best practices in place to ensure sampling consistency. Key areas of interest were the selection of sampling methods, ensuring sampling consistency, and the overall rating of sampling performance.

Summary of findings
- Decisions regarding electrofishing methods are based on SRA protocols and made by SRA-dedicated senior operators in all states.
- One notable equipment difference among states — ARI and SARDI use mesh on anode ring of backpack electrofisher, whilst NSWDPI and QDPI do not. Mesh use by ARI is an Occupational Health and Safety requirement.
- Repeatable sampling effort achieved by understanding and following protocols, and the use of SRA-dedicated staff as senior operators.
- Sub-sampling carried out similarly in each state, although NSWDPI measure more individual fish than the protocols stipulate.
- Slightly different strategies for bait trap placement in each state, but each state places them beyond boundaries of electrofished reach, and locates them in proportion to the habitat available. NSWDPI do not pool bait trap samples for processing.

Conclusions
- Minimal variation among states in the selection of methods and procedures for achieving repeatable sampling.
- Some variation among states in regard to mesh on the anode ring of backpack electrofishing unit, methods for sub-sampling, pooling and placement of bait traps.
- Possible risk to sampling consistency with use/non-use of mesh on anode ring of backpack electrofisher — mesh possibly (author's opinion) improves sampling efficiency.
- Non-pooling of bait traps presents no risk to sampling consistency — NSWDPI use a random selection process such that the end result is the equivalent of pooling bait traps.
- Slight variations in methods of bait trap placement pose only a slight risk to consistency — the critical methods are followed by all teams.

Recommendations
- Sampling continues to be undertaken by SRA-trained staff in each state.
- Standardise use/non-use of mesh on backpack electrofisher anode ring.
- Comprehensively describe methods for bait trap placement in protocols.

2.4   *Fish identification and abnormalities*

Correct identification of fish is another critically important part of any SRA sampling effort. Interview questions concentrated on the quality control procedures currently in place to ensure correct identifications of fish and fish abnormalities are made.

Summary of findings
- Qualifications of staff employed on SRA projects are similar among states.
- Different levels of taxonomic training among states — for example, NSWDPI run SRA training workshops prior to sampling each season, ARI conduct informal workshops, SARDI has a specialist assist/train staff, and QDPI draws predominantly on existing staff knowledge.
- All states collect voucher specimens as per SRA protocols, and of potentially confusing taxa. Tarmo Raadik (ARI) is the central figure for verifying voucher specimens.
- All states carry identification guides into the field, and most states (not SA) take digital photos of live specimens in the field.
- Procedures for identifying and recording fish abnormalities vary among states. NSWDPI and ARI cover abnormalities in training workshops, QDPI use an abnormality/condition chart, and SARDI relies on staff experience.
- NSWDPI check both sides of each fish and record the number of abnormalities, not just presence or absence. SARDI indicated they only checked one side of each fish.
- All states take the descriptions and codes for abnormalities in the field.

Conclusions
- Some variation in the amount of identification training among states. However, all SRA sampling teams include persons with extensive experience of freshwater fish identification.

- The process for obtaining correct fish identifications is generally consistent — experience, voucher specimens, identification guides and photos.
- Some variation in identification and recording of fish abnormalities.
- Possible risk to consistent identification of taxa and abnormalities among states.

Recommendations
- All states conduct (or attend) some form of SRA training workshop prior to each sampling season.
- All states photograph (digital) live specimens of potentially confusing taxa in the field.
- Standardise methods for checking and recording fish abnormalities.
- Produce laminated MDB fish guides for use in the field should ensure fish identification consistency in all states. This guide should include pictures of all taxa, a brief description of key diagnostic features, and pictures and descriptions of abnormalities.

2.5 Data entry

For the SRA, it is essential that entered and stored data is true and correct. Interview questions, therefore, focussed on the quality control measures in place to ensure that data passed on to the MDBC are correct.

Summary of findings
- All data entered onto datasheets and then onto database undergoes a number of quality control checks in each state — QDPI hasn't entered data as of yet.
- All states use the same codes for fish species.
- Some variation in the amount of time that normally elapses between sampling trip and data entry (1–4 weeks).

Conclusions
- Minimal variation among states.
- Minimal risk to data quality.

2.6 Feedback

To generate feedback, interviewees were asked to identify any aspects of the SRA program that were 'high risk' in terms of QA/QC, and to offer any suggestions for improvements to the program. Summarised below are the most commonly raised issues — for a more comprehensive listing of interviewee feedback see Appendix I.

Communications with MDBC
- Are the MDBC's needs being adequately met?
- What is the data being used for (to explain to landholders)?
- Tardy response times from the MDBC (eg. minutes from TRG meetings, reception of site coordinates, specific questions, distribution of updated protocols).

Sampling protocols
- If anything, the protocols could be more prescriptive (eg. bait trap placement).

- Protocols generally well understood by sampling teams, and SRA protocols are becoming the standard for many other fish sampling projects.
- Issues with buffer zones around weirs.
- Voucher specimen system works as quality control for identifications.

General
- Sampling across state boundaries: who should do it?
- Sometimes the methods in protocols are not the most optimal sampling methods (e.g. SA and the willow-lined lower Murray, QLD and bait traps)
- Intermixing of staff among states could improve sampling consistency among states.

Recommendations
- It is recommended that minutes of TRG meetings are circulated within two weeks, and that updated protocols are distributed to sampling teams as early as possible.

3   PHASE II

The key objective of site visits was to witness field teams sampling according to SRA protocols. This, along with in-field interviews, supplied important information supplementary to that gathered during Phase I. There were also provisions for each sampling team to comment on the clarity of current protocols.

Sampling was not being undertaken in South Australia at the time of site visits, so field teams from SARDI were not involved in Phase II — it is strongly recommended that SRA sampling by the SARDI team be assessed in the future. Also, fieldwork being undertaken by NSWDPI during the site visit was not part of the SRA program, but as they were utilising SRA protocols observations were deemed relevant for QA/QC purposes.

Observations focussed mostly on aspects of actual fish sampling. In consultation with the MDBC, we identified four areas of potential 'high risk' in terms of obtaining consistent and quality data. These four areas of interest were: 1) the selection of sampling methods and equipment; 2) bait trap placement; 3) sampling strategy, and; 4) identifications and abnormalities. For the purposes of ensuring the collection of consistent quality data in the future, we also sought 'evidence of training' in each of the above four areas of interest.

The same two questions from Phase I were applied to each of the four areas of interest:
- Is there variation among state agencies?
- If so, what is the risk to sampling consistency (among states)?

Below are summaries of the findings of site visits, along with conclusions and recommendations. For a more comprehensive detailing of observations and interviewee responses refer to Appendix II.

3.1   *Selection of sampling methods and equipment*
The employment of appropriate sampling methods forms a significant portion of the SRA Fish Theme protocols. In Phase II, we were specifically interested in the decision-making process of each state, the personnel involved, the types of equipment used, and evidence of training.

Summary of findings
- All states have a similar procedure for deciding the appropriate sampling methods. Pre-sampling site visits, close as possible to the actual sampling date, are undertaken in each state to determine sampling methods. Pre-sampling site visits undertaken by SRA-dedicated senior operators.
- On the day of sampling, all decisions made regarding sampling method (or combination) are made by the sampling team (QDPI and ARI) or the senior operator only (NSWDPI). Each state carries protocols.
- States do not sample with inappropriate equipment if habitat has changed substantially between pre-sampling visit and sampling trip (eg. flooding, drawing

down, etc.). Instead, each sampling team returns at a later date with appropriate gear.

- Always at least one SRA-dedicated senior operator sampling in each state.
- On day of site visits, all state teams were using different sampling gear but each was appropriate for the habitat according to the protocols. ARI was the only team to use a combination of methods.
- The only substantial difference in equipment is that ARI use mesh on the anode ring of the backpack electrofisher. During Phase I, SARDI stated that they also used mesh on the anode ring — ARI demonstrated electrofishing methods to SARDI.
- ARI and NSWDPI undertake SRA workshops each year. New staff at NSWDPI are trained and tested on SRA protocols. QDPI do not conduct workshops but training is evident in the field by sharing all tasks.

Conclusions
- Minimal variation among states in the process of selecting sampling methods and qualifications of staff making decisions.
- No risk to sampling consistency.
- Some variation among states in regard to sampling equipment (mesh on anode ring).
- Possible risk to sampling consistency among states.
- Training of staff more formalised in NSW and VIC.

Recommendations
- Assess difference in sampling efficiency with or without mesh on anode ring.
- Involve QDPI team in another state's SRA training workshop.

3.2   *Bait trap placement*

The placement of bait traps during fish sampling was flagged by the MDBC as an area of potential concern, as the procedure is not comprehensively described in the protocols. As well as observing the procedures for bait trap placement, in Phase II we were also interested in the decision-making process and evidence of training.

Summary of findings
- Procedure for bait trap placement was very similar among state teams — outside electrofished area, reach length 50–150 metres, slow-flow areas, fully submerged, proportional to available habitat, etc. All states carry protocols.
- ARI and NSWDPI address bait trap placement in workshops. QDPI team follow protocol and share tasks.

Conclusions
- Minimal variation among states.
- No risk to sampling consistency.

3.3   Sampling strategy

Electrofishing techniques can vary greatly from 'hunting' select species to randomly sampling fish populations. Consequently, the SRA protocols are relatively prescriptive in this regard: describing the location and number of shots as well as boat motion through the sampled area. The purpose of site visits was to observe the application of sampling protocols and assess consistency among state teams.

Summary of findings
- Sampling strategies were very similar among states — upstream motion, virtually all available habitats, mid-stream shots, zigzagging through sampled area, shot duration 5–15 seconds, log piles from different angles, hovering and reversing slowly over snags, etc.
- Samples processed after each shot.
- NSWDPI had a different sub-sampling procedure to protocol, sub-sampling more than required (20 from each shot regardless of whether 50 had been reached).
- NSWDPI returned exotics (eg. carp, goldfish, etc.) live to the sampled reach. QDPI and ARI euthanised exotics, as do SARDI (confirmed by Qifeng Ye to MDBC).

Conclusions
- Minimal variation in overall sampling strategy.
- Only risk to consistency is the returning of exotics in one state only.

Recommendation
- Develop guidelines for handling exotic species. Possibly determined by conditions of research permits in each state.

3.4   Identifications and abnormalities

Correct identifications of fish are critical to the SRA, as is accurate reporting of abnormalities. Site visits provided an opportunity to observe the procedures employed to ensure correct identifications of species are made and abnormalities are correctly recorded. We were also interested in evidence of training.

Summary of findings
- Procedures for identifying fish are very similar among states — netter identifies fish, confirmations made with senior operator, vouchers are taken as requested in protocols, etc.
- ARI and NSWDPI carry in-house 'cheat sheets' – modified keys for quick identifications. QDPI uses ID guide.
- All states check each fish for abnormalities, with NSWDPI checking both sides and counting number of abnormalities (see Section 2.4).
- All states rely on staff training (workshops) or staff experience to correctly identify abnormalities.
- Training evident in each state by constant interaction between senior operators and staff. NSWDPI and ARI also run workshops where fish identifications and abnormalities are covered.

Conclusions
- Minimal variation among states in procedure.
- Some variation among states in regard to levels of training and resources.
- Possible risk to consistency among states.

Recommendations
- All states conduct (or attend) some form of SRA training workshop prior to each sampling season. This is relevant to all staff, as new SRA staff can be trained and current staff can be briefed on updated protocols.
- Produce laminated MDB fish guides for use in the field should ensure fish identification consistency in all states. This guide or key should include pictures of all taxa, a brief description of key diagnostic features, and pictures and descriptions of abnormalities.

4   DISCUSSION — REFLECTION

Ensuring that quality fish data is collected consistently is paramount to the overall success of the SRA, and the need for a rigorous QA/QC program can be justified for this reason alone. But the SRA is an extremely ambitious project and, as such, proffers several unique challenges for the collection of consistent data. Fish sampling is conducted by four state-based agencies across the MDB — New South Wales Department of Primary Industries, Queensland Department of Primary Industries, South Australian Research and Development Institute, and the Arthur Rylah Institute in Victoria — and, among these agencies, there are substantial differences in the levels of electrofishing experience in inland waters. Secondly, because the SRA is basin-wide, many different types of waterways are sampled, from small fast-flowing upland streams to large slow-flow lowland rivers, requiring the employment of a range of electrofishing apparatus and methods. Finally, the SRA is a long-term program (>6 years) aiming to detect temporal trends in river health; therefore, sampling-effort consistency over time within each state agency must also be achieved.

This review of QA/QC procedures provided valuable insight into the fish sampling efforts of all state agencies. Despite the many conceivable problems inherent in the SRA (see above), there appeared to be a high level of consistency among state agencies, or, rather, the interpretation and application of the current SRA fish sampling protocols was very similar. There were, however, some observed differences among states, most of which can be ascribed to the varying levels of experience electrofishing in inland waters. The three main differences related to levels of SRA-specific training, the use of mesh on the anode ring of the backpack electrofisher unit in Victoria and South Australia, and the live return of exotics to sampled reaches in New South Wales. The more established states, in terms of electrofishing inland waters (Victoria and New South Wales), had structures in place to train SRA-dedicated staff and procedures for field work. Interestingly, these more 'established' state agencies were more likely to have developed cultural practices contributing to the differences among states — on the contrary, 'new' state agencies (QLD and SA) had not developed cultural practices and sampled strictly according to the SRA protocols. The observed differences in sampling effort are, overall, relatively minor and pose no more than 'possible' risks to sampling consistency among states. However, to achieve greater consistency and to further reduce risks to data quality, several recommendations are made in the following section.

The most positive outcome of the QA/QC review, particularly evident during the field visits, was the diligence of sampling teams and their adherence to the SRA sampling protocols. This clearly demonstrated commitment to the project and a thorough understanding of the protocols. One of the major vagaries of freshwater systems is flow, which in turn — with specific regard to electrofishing — will determine the most appropriate sampling method. For logistical reasons, (all) sampling teams predict which types of equipment will be most appropriate at each site before venturing into the field. But unpredictable flow events can occur, in both regulated and unregulated systems, rendering the equipment with which a team may have arrived at a site with completely inappropriate — in a regulated system an example would be a flood, and in a regulated system it might be a particularly high (or low)

flow event due to changes in irrigation demand. It was impressive to note that, if the prediction of stream flow proved incorrect such that the sample reach was substantially different, that none of the teams would sample it at that time. Each state team had contingency plans such as re-visiting sites at a later date or having the correct gear type brought to the site. It is also noteworthy that SRA sampling protocols have been adopted as the protocols for other projects in several states (NSW, VIC and SA), and this can only act to improve knowledge and familiarity of SRA protocols.

Although it is a considerable achievement to obtain a consistent sampling effort from four different state agencies, it is essential for the SRA that the current sampling effort is repeated at future sampling events. This can be achieved with prescriptive protocols and experienced, adequately-trained personnel undertaking fish sampling. This QA/QC review indicated that the current protocols, in the main, are an improvement on previous versions and are well understood. Adequate training in SRA protocols, and electrofishing in general, and the use of SRA-dedicated staff, should ensure that the current high standard of sampling consistency is repeated in the future.

5   RECOMMENDATIONS

We make the following recommendations to improve the QA/QC procedures of the SRA fish theme:

1. All states conduct (or attend) some form of SRA training workshop prior to each sampling season. This is relevant to all staff, as new SRA staff can be trained and current staff can be briefed on updated protocols.
2. Sampling continues to be undertaken by SRA-trained staff in each state. All sampling teams led by SRA-dedicated staff.
3. Produce laminated MDB fish guides for use in the field. The guide or key should include pictures of all taxa, a brief description of key diagnostic features, and pictures and descriptions of abnormalities.
4. All states photograph (digital) live specimens of potentially confusing taxa in the field.
5. Develop comprehensive guidelines for bait trap placement.
6. Standardise methods for checking and recording fish abnormalities.
7. Develop guidelines for handling exotic species.
8. Assess the difference between backpack electrofishing with or without mesh on the anode ring.
9. It is recommended that SRA sampling by the SARDI team be formerly assessed.
10. The minutes of TRG meetings should be circulated within two weeks of meetings, and updated protocols should be distributed to sampling teams as early as possible.

ACKNOWLEDGEMENTS

APPENDIX I

Phase 1 — Summary of interviews

1. AUSTRALIAN CODE OF ELECTROFISHING PRACTICE (ACEP)
Q: How do you ensure that SRA electrofishing adheres to the ACEP?

NEW SOUTH WALES	
General	• All rules and regulations of the ACEP come before SRA protocols.
Operator qualifications	• Senior Operators — qualified as per ACEP (minimum set-ups, hours, first aid, ECG, manual) plus exam. • Never more than one uncertified operator on SRA field trips — training purposes.
Log books	• Log books taken into field. • Staff instructed to complete log details with each set-up, or daily as a minimum. • Recorded details include operator's electrofishing hours, boat electrofishing log, backpack electrofishing log, electrofishing maintenance log, instructor's comments, water conductibility and electrofishing settings.
Equipment	• All equipment complies with the ACEP for construction and safety. • Electrofishing maintenance logged. • Comprehensive safety checks of electrofishing equipment undertaken every 1–2 years at Marine Navaid in Sydney.
VICTORIA	
General	• ACEP has priority over SRA protocols. • All staff members have a copy of the ACEP.
Operator qualifications	• Senior Operators — as per ACEP plus extra hours supervised by certified senior operators. This certification process stipulated in ARI/DSE OH&S rules. • All SRA team leaders are senior operators and a core staff of five involved with all SRA field work. • Uncertified staff is at a minimum due to staff freeze, but not involved with SRA sampling anyway.
Log books	• As per ACEP — elapsed time and fishing time. • Staff in training log their hours and are signed off by senior operator/supervisor daily or at end of trip.
Equipment	• All equipment complies with the ACEP for construction and safety. • Machine hours derived from field data sheets.
SOUTH AUSTRALIA	

General	• SARDI have only been using electrofishing for sampling in the last 4-5 years and have trained/gained experience from ARI (especially) and Narrandera Fisheries Centre. • Operate within the ACEP.
Operator qualifications	• Senior operators are qualified according to the ACEP (First Aid, ECG, training hours) plus exam. • At least one senior operator on electrofishing boat (driver) and senior operator with backpack electrofisher. • Limited number of senior operators at SARDI (2), but capacity is increasing with training and recruitment.
Log books	• Machine (boat and backpack) hours are logged and so are individual electrofishing hours.
Equipment	• Use the standard anodes that came with the equipment. • Electrofishing units based on those used by ARI and Narrandera Fisheries Centre from previous Fishways project. • Nets are of a standard mesh and head size for SRA, were initially supplied by ARI and are used on other projects.
QUEENSLAND	
General	• ACEP guidelines are adhered to for all long term monitoring programs.
Operator qualifications	• Senior operators are qualified according to the ACEP (set-ups, hours, first aid and ECG). • Two senior operators and one operator in training on all SRA sampling trips.
Log books	• Electronic log books are kept for person and electrofishing equipment hours. • A hard copy log is kept of boat hours. • Log books are filled out every trip, not just SRA sampling trips.
Equipment	• All electrofishing equipment is tested annually. Outsourced organization measures power outputs and calibrates equipment. • Maintenance issues are dealt with as they arise. • Regular routine maintenance checks are carried out prior to each field trip (gloves, nets, vessel, etc.).

2. FISH IDENTIFICATION
Q: What quality control measures are adopted to ensure that fish are identified correctly?

NEW SOUTH WALES

Staff qualifications	• All recruited staff (for SRA or other projects) have demonstrated experience in fish biology and/or are university graduates with studies in fish biology/identification
Training	• NSW DPI have held two-day <u>SRA training workshops</u> for all staff involved with the SRA prior to the 2005 and 2006 sampling seasons. ❖ There have been two recommendations made for Tarmo Raadik to conduct specific SRA fish identification workshops.
Voucher specimens	• Collected as per SRA protocols (species). • Any difficult to identify individuals are preserved and returned to the lab for later identification.

Other	• Technicians provided with a list of potentially confusing species.
	• Senior operators with extensive experience in identification of inland fish present with all sampling.
	• Procedure for identification of difficult fish:
	  • Digital photos taken in field of large and small fish (if possible).
	  • Preserve small fish and return to lab for later identification.
	  • Checked by Dean Gilligan then verified by Tarmo Raadik and lodged with the Australian Museum.
	❖ Currently preparing document (one page per species) — diagnostic features, distribution, habitat, etc. — for use in field and laboratory.

VICTORIA	
Staff qualifications	• All scientific/technical positions at ARI (freshwater ecology) require a degree and the equivalent of three years experience. • Identification of native fish usually included during employment interview.
Training	• Informal fish taxonomy workshops or exercises for ARI (Freshwater Ecology) and for SRA as a subset. • On-going training of staff as voucher specimens and other fish are brought in for identification.
Voucher specimens	• Collected as per SRA protocols (species) and as part of other projects. • Any confusing/unknown or unknown individuals are kept as part of standard ARI procedure (see <u>SRA Fish Theme Project Procedures</u> document)
Other	• Staff create species list — based on distribution and habitat — for projects and identify problem taxa. • Simplified keys for problem taxa are used in the field.

	• Senior operators have fished extensively in SRA sampling areas. • Digital photos of problem taxa.
SOUTH AUSTRALIA	
Staff qualifications	• Technicians at SARDI working on the SRA program hold a relevant degree. • All staff experienced in SRA rivers and native fish of region
Training	• Mike Hammer (SA Museum) has assisted/trained staff in the field/lab to identify inland fish species.
Voucher specimens	• Collecting for own taxonomic purposes, particularly the more difficult species (carp gudgeons, flat head gudgeon, dwarf flathead gudgeon and hardyheads). • Also collecting by demand for Mike Hammer at the SA Museum. ❖ NOTE: SARDI was previously caught out during the SRA program by not collecting voucher specimens (Murray hardyhead) but have revised procedures so that preserving gear is carried at all times.
Other	• Aquaria at SARDI housing live native species. • Identification books.
QUEENSLAND	
Staff qualifications	• All staff involved with SRA (3) have tertiary qualifications in relevant field involving studies in fish biology and taxonomy — degree (1) plus honors (1), associate diploma (1). • Darren Smallwood has over 17 years of experience identifying Queensland inland species.
Training	• Most training is on the job. • Everyone is briefed on the SRA protocols.
Voucher specimens	• Collected as per SRA protocols. • Vouchers collected are identified at the Queensland Museum or Tarmo Raadik (ARI) and housed at Southern Fisheries Centre.
Other	• All staff are briefed on species outside zones that may be translocated into QLD inland rivers. Contact with outside organizations. • Photographs in the laboratory. • Keys with major diagnostic features.

	• There are a restricted number of species in the QLD SRA sampled rivers (appox. 25) and they mostly have easily distinguishable features. • Use Midgley's freshwater fish guide. ❖ NOTE: Using Tarmo Raadik to verify species (rainbowfish) in next few weeks.

3.   SAMPLING SITE SELECTION
Q: How do you ensure that sites are validated according to best practices?

NEW SOUTH WALES	
Procedure	• MDBC site coordinates are overlayed on a GIS map. • Site coordinates and stream names (also from MDBC) are tabled. • Sites are 'validated' prior to sampling field trips as part of Site Inspection (see below). • 14 sites per zone from MDBC sites are validated: 7 priority and 7 extras.
Site Inspection	• Undertaken prior to sampling teams being sent out. • Conducted by senior operators. • Information collected includes owners' names, access, boat launching location, risk assessment, types of sampling equipment required (boat, backpack, boat-mounted) and water conductivity, and photos are taken. • Information placed onto database.
Measurements	• All positions are recorded using a GPS unit with a GDA 1994 datum. • River width and reach length measured with a laser range finder.
VICTORIA	
Procedure	• MDBC coordinates are placed on a GIS overlay. • Coordinates are 'snapped' to a stream process. • Dialogue is maintained with MDBC — to make sure everyone is working with the same datum — until site is snapped. • From GIS overlay sites are plotted onto field maps. • 10 sites per zone are validated. • Sites are accepted or rejected prior to sampling field trips as part of Site Ground Truthing (see below).

	❖ Access is the most common reason for site rejection.
Site ground truthing — Site Inspection	• Conducted prior to the sampling season. • Conducted by SRA field team leaders, all experienced senior operators. • Information collected includes owners, access, boat launching location, risk assessment, types of sampling equipment required (boat, backpack, boat-mounted) and water conductivity, and photos are taken. • All details in SRA Fish Theme Project Procedures.
Measurements	• GPS for reach start, finish and midpoint. • Laser range finder or hip chain for reach length. • Laser range finder for river width. • Sinuous streams paced out. • Subjective assessments of water depth (expected).
SOUTH AUSTRALIA	
Procedure	• Mapped onto Aussie Explorer and onto topographical maps. • Would use GIS Arc Maps for Mt Lofty Ranges but there was no time available once coordinates were known. • No need to validate sites in lower Murray. No confusion as to which stream is to be sampled and sites are generally accessible. • Launch boat and find site coordinate using GPS. ❖ Access to the Mt. Lofty Ranges was more good luck than good management. Mike Hammer knew landholders from previous work in the region. Due to the lateness of obtaining the site coordinates it was impossible to validate sites pre sampling trip.
Site ground truthing — Site inspection	❖ NOTE: The situation in SA is different than other states and pre-sampling site inspection is not as critical to determine sampling gear types, access, boat ramps, etc. Several factors dictate this: • Most SRA sites are located on the main stem of the lower Murray. • Staff are familiar with most sites along the main stem of the lower Murray. • Sites on the main stem of the lower Murray are not dynamic. • Sites on the main stem of the lower Murray are most effectively electrofished by boat because of water depth and bank steepness.

	• Sites in the Mt. Lofty Ranges can only be electrofished with a backpack unit.
	❖ NOTE: Procedures are different because they have only sampled once as part of the SRA program. On that occasion, the MDBC provided site location coordinates too late for site inspections or the implementation of other procedures.
Measurements	• Measure reach 500 m up and down stream of midpoint using GPS odometer.
	• Boat river width using laser range finder
	• Backpack river width using tape measure and estimation.
QUEENSLAND	
Procedure	• Site coordinates received from MDBC.
	• GIS overlay put onto a palm pilot ArcPad, backed up by hand held GPS.
	• Sites are validated prior to sampling trips.
	• Every single available site is validated.
Site ground truthing — Site inspection	• Aerial survey conducted to determine presence/absence of water at site coordinates.
	• Specific trip undertaken prior to sampling to groundtruth sites.
	• Sites are eliminated if the waterbody is too small or the waterbody is too far from the MDBC coordinates.
	• Information given (Site Validation Data Sheet) include habitat types, electrofishing gear types required, position for bait traps, location of boat ramp, etc).
	❖ NOTE: The major reasons for site rejection are lack of water or lack of suitable access (boat). Waterbodies that are filled by bore water are also rejected (if this information is known prior to sampling).
Measurements	• GPS and palm pilot (ArcPad) used to locate sites based on MDBC coordinates.
	• Reach length and width measured with range finding binoculars.
	• Small distances (reaches, backpack fishing length) estimated or paced out.

4.   SAMPLING PROCEDURES

Q.   How do you ensure that the appropriate combination of electrofishing methods are used at each site?

NEW SOUTH WALES	
General	• Senior operators follow SRA protocols and estimate methods by availability of suitable habitat (e.g. if half the site can be boat electrofished then half is). • Decision made by field team at the time of sampling. • SRA protocols are discussed at annual two-day <u>SRA training workshop</u>. • There are 15 individuals involved with SRA sampling and the combination of senior operators, the SRA protocols and the annual workshop ensure best practices are applied in decision making.

Equipment	• Standard approaches and equipment types:
	  • For rivers > 15 m wide: large boat with 7.5 kVA generator and Wisconsin ring anodes (18 droppers per anode).
	  • For rivers < 15 m wide: small boat with 2.5 kVA generator and Wisconsin ring anodes (8 droppers per anode).
	  • Non boatable: backpack if suitable (depth) and conductivity < 1500 μScm^{-1}.
	  • Non-boatable: bank-mounted if conductivity > 1500 μScm^{-1}.
	  • No mesh used on anode ring of backpack electrofisher.
	  • Mesh size as per SRA protocol on dip nets.
	❖ Currently no formal strategy for replacing netting on dip nets. Spares are carried on board and changed when netting is damaged.

VICTORIA	
General	• Proportions of habitat are estimated based on visual inspection on sampling day. • Estimations of habitat type made by SRA field team leaders trained in SRA protocols at annual ARI <u>SRA QA/QC workshop.</u> • Operators take SRA protocols into the field. • Mobile phone call to ARI (Tarmo/Jason) if any doubts or issues.
Equipment	• Electrodes for SRA sampling determined by the SRA sampling protocols; backpack (anode ring) and boat (Wisconsin ring). • Nets used are to SRA specifications and replaced when damaged.

	• All staff briefed at annual <u>SRA workshop</u>. ❖ Use mesh on backpack anode ring — to have netter moving quickly around electrofisher is considered an unsafe practice under ARI/DSE OH&S.
SOUTH AUSTRALIA	
General	• Not an issue in SA SRA sampling sites. Lower Murray River can only be boat electrofished and the Mt. Lofty Ranges can only be backpack electrofished (see earlier).
Equipment	• Only use the standard configuration provided with the electrofishing equipment. • Based on the gear types used by ARI and Narrandera Fisheries Centre — Wisconsin rings for boat and anode ring for backpack. • Initially used backpack anode ring without mesh as per SRA protocol, but upon hearing that each state has been given the option of their preferred method will use net in future.
QUEENSLAND	
General	• This is done at site validation stage and then redone at time of sampling. • Laminated (abbreviated) copy of protocols carried into the field. • Estimations of habitat and suitable electrofishing method are made by eye once the whole reach has been studied — in most cases the site can only electrofished by boat (steep-sided channels), but the reach is surveyed for shallow backwater areas. • The procedure is consistent because the same team of two does all SRA sampling third person does not necessarily do all SRA.

Equipment	• Standard gear type on all electrofishing equipment:
	  • Small boat — one Wisconsin Ring.
	  • Large boat — two Wisconsin Rings.
	  • Backpack — anode ring (no mesh).
	❖ Dip nets — the mesh size on dip nets originally provided was too big (small fish escaping) so we use a standard 6 mm mesh size now. Use the original frames provided, on small boat and backpack , larger net heads on large boat sites

Q.   How do you maintain best practice that ensures consistent sampling?

	NEW SOUTH WALES

Repeatable sampling effort	• Follow SRA protocols.
	• Staff are familiar with SRA protocols because of:
	  • Annual internal <u>SRA training workshop.</u>
	  • SRA protocols are used in projects in NSW.

Measurements	• Real time measured by stopwatch by boat operator or backpack electrofishing assistant. • Fishing time measured by timer on boat and backpack units. • Both time measurements on boat are recorded by driver. • Dip-netter checks timer on backpack unit. • If more than 90 seconds fishing elapses it is recorded (not rounded). • Distance travelled measured with laser range finder. • Fish length measured (mm) in PVC pipes with metal ruler. • Weight measured with scales: small fish (0.1 g) and large fish (1 g) • Procedure for small fish: tare container with water; pat dry fish and place in water. ❖ Estimating fish total/fork length when individual is damaged. A bit of subjective guess work so an individual whose length is estimated is flagged on the data sheet in the comments column and not included in data set if other individuals are available. • The <u>SRA training workshop</u> informs staff about SRA protocols. • List of measurements required for SRA taken into the field.
Electrode configuration	• Electrodes (anodes) are not changed for any purpose.

Sub-sampling	• Annual internal <u>SRA training workshop </u>to inform and discuss protocols with staff.
	• Procedure:
	  • Follow SRA protocol — measure/weigh first 50 of a species plus the rest of that species in the sample that the 50th occurred in.
	  • Measure/weigh up to 20 individuals (random) from each subsequent 'shot' — to remove any chance of

	size/stage bias. • Only the taxa required (as per SRA protocols) are weighed.
Bait traps	• Placement according to SRA protocols. • Placement of bait traps addressed <u>SRA training workshop.</u> ❖ Bait traps are <u>not</u> pooled but are recorded individually (and the same as electrofishing samples). For SRA purposes, length/weight data from bait traps collected using the NSW procedure can be randomised (random number generator) and the data from only the first 50 of a taxa used for SRA analyses.
Fish abnormalities	• Staff informed of requirements at <u>SRA training workshop.</u> • Use of experienced senior operators. • Follow SRA protocols. ❖ In NSW, look at both sides of fish and count the total number of abnormalities on each individual, not just presence/absence. ❖ Preparing one page laminated sheet with each type of fish abnormality for use in field and lab.
VICTORIA	
Repeatable sampling effort	• Follow SRA protocols. • Use dedicated SRA staff briefed annually at internal <u>SRA training workshop.</u> • Familiarity with SRA protocols increased by using protocols for other projects.
Measurements	• Power-on (fishing) time and elapsed time measured. • Fishing time measured on electro-units and real time recorded by stopwatch. • Distance travelled measured with laser range finder or hip chain. • Total length or fork length (mm) in standard fish measurer. • Weight measured with scales: small fish (0.1 g) and large fish (1 g). ❖ Estimating length of damaged fish a concern but undertaken nonetheless. • The <u>SRA training workshop</u> informs staff as to the measurements required and for which species. • The <u>SRA Fish Theme Project Procedures</u> are taken into the field and includes a list of measurements required.
Electrode	• As per SRA protocols.

configuration	
Sub-sampling	- No different to SRA protocols. - Procedures discussed at <u>SRA training workshop</u> and in <u>SRA Fish Theme Project Procedures.</u> - Procedure: - All individuals of a species in which the 50th of that species occurred are counted/weighed/measured.
Bait traps	- Follow SRA protocols. - Placement discussed in <u>SRA training workshop.</u> - Bait traps are pooled as per SRA protocols<u>.</u>
Fish abnormalities	- Discussed at <u>SRA training workshop.</u> - Included in <u>SRA Fish Theme Project Procedures.</u> - Also part of normal staff training. - Use qualified and experienced staff. - Additional references: books by NSWDPI on abnormalities. - Data sheets have condition codes on them. - Only look on one side of the fish — as per SRA protocol — for presence/absence.
SOUTH AUSTRALIA	
Repeatable sampling effort	- Stick to the protocols. - Take protocols into field. - Limited number of senior operators (2) and small team (5) working on SRA program – same people doing all the sampling. - Small teams is key to consistency. - Similar techniques used in SRA to previous fishways works. - Attendance to MDBC SRA Protocols Workshop. - Datasheets are derived directly from the protocols and ensure all required fields are measured. - Understand the protocols – not difficult to understand and carry out.
Measurements	Timers on backpack and boat electrofisher record fishing time (seconds). Actual time recorded.

	• Elapsed time recorded by clock – shot start and finish times.
	• Fish weights have not been recorded.
	• Small and large measuring boards measure fish length (mm).
	• Data sheets indicate which length measurements (FL or TL) are required.
Electrode configuration	• Only use the standard configuration provided with the electrofishing equipment.
	• Based on the gear types used by ARI and Narrandera Fisheries Centre.
Sub-sampling	• Stick to the SRA protocols and carry into the field.
	• Measure first 50 and then the rest of that species from the shot in which the 50th occurred.
	• Have adopted same procedure for other sampling programs.
	• No fish being weighed.
Bait traps	• Key to consistent placement is the use of small teams.
	• Once reach to be sampled is surveyed, 5 traps are placed just outside each end of the to-be-sampled reach.
	• Traps are placed in mixture of habitats representative of the sampled reach.
Fish abnormalities	• Types of fish abnormalities, descriptions and codes are printed on field data sheets, based on table in SRA protocols.
	• Small group ensures consistency.
	• One side (left side) of fish is checked for abnormalities.
	• Staff experienced in recognizing abnormalities.
QUEENSLAND	
Repeatable sampling effort	• Follow SRA protocols which are taken into the field.
	• Designed methods are based on long-term monitoring programs, and there are set procedures for positioning of boat, and zapping time for boat and backpack.
	• Same sampling team carries out all SRA sampling.
Measurements	• Shot duration is measured with timers (on backpack unit and by boat operator).
	• Fishing time and elapsed time recorded.
	• Actual time is recorded (e.g. if not 90 seconds).
	• Standard SRA measuring boards for measuring fork length and total length.

	• Hanging scales for weighing big fish (25 g). • Small scales for small fish (1 g). • Protocols are carried into field so team knows which species to weigh.
Electrode configuration	• Same configurations are used for all DPI sampling so gear is not changed over for any reason.
Sub-sampling	• Carried out as per SRA protocols. • Protocols carried into the field. • Same small group conducting all sampling. ❖ Sub-sampling is rarely required as they don't catch enough small fish (yet) in Western rivers.
Bait traps	• Small team on SRA ensures consistent placement of bait traps. • Try to target *Hypseleotris* habitat but most sites don't contain much suitable habitat (e.g. reeds), if any. • Target other available structure such as snags. • No pooling of sampling prior to measuring/counting.
Fish abnormalities	• Laminated fish abnormality/condition chart taken into field. • Protocols with abnormality codes taken into field. • Crew check abnormalities with Darren Smallwood. • Same crews carry out all SRA sampling.

Q.   What procedures ensure a consistent rating of the overall sampling performance?

NEW SOUTH WALES	
General	• Discussed at <u>SRA training workshops</u> but has not been officially implemented. ❖ All data sent to MDBC are effectively GREEN. If data was AMBER (e.g. anode broke) the site would be re-sampled at a later date. RED rating would not occur because site would not be sampled under those conditions.
VICTORIA	
General	• Sampling performance rated according to SRA protocols.

	• Covered in annual <u>SRA training workshop</u>.
	• Only GREEN and AMBER ratings are valid:
	   • GREEN — site sampled well, everything worked.
	   • AMBER — examples: high turbidity and numerous fish missed, flows higher than normal, depth issues, etc.
	   • RED — sampling suspended due to a *force majeure* such as high flows or equipment breakdown in the middle of sampling. Under these conditions the site would be re-sampled later.
	❖ Question the biological relevance of such a rating as it may not be consistent across the MDB. For example, in Victoria water would be considered turbid at 30 NTU and fewer than normal fish would be spotted and netted. In western QLD though, at 30 NTU water is probably not considered turbid.

SOUTH AUSTRALIA	
General	• Red amber and green rating system was not introduced until after SARDI SRA sampling had been completed. Though it would be a good system to adopt and would highlight situations such as the willow lined banks which were not able to be sampled as efficiently as other sites.
QUEENSLAND	
General	• This process is carried out and is worthwhile. • Same sampling crews provide all the ratings. • Green — sampling was perfect with protocols. • Amber — something minor that shouldn't necessarily effect the outcome of sampling (e.g. landholder said local rainfall filled waterhole). • Red — Something major that would effect sampling outcome (e.g. bore filled waterhole) ❖ If a site was rated as red it would not be sampled (rejected), but if the sampling performance was red it would be re-sampled.

5. DATA ENTRY
Q. What quality control measures are taken to ensure that all data entered are correct?

NEW SOUTH WALES	
Data checks	- There are effectively 3 levels at which data are checked. Data are entered by the following procedure: - Data entered into MS Access database. - Range checks for every each individual entry occur automatically — checks species against size, river, catchment, etc - Questionable data checked with senior operator. - All data ran by Dean Gilligan prior to being sent off to MDBC.
Fish codes	6 character codes for each species: 3 genus and 3 specific epithet (e.g. RETSEM for Australian smelt). - Dropdown menus and autofill.
Elapsed time	- Data is entered at Port Stephens. - Between 1–4 weeks following sampling trip.
VICTORIA	
Data checks	- Data is checked at three stages. The following procedure is applied to all SRA data and included in the <u>SRA Fish Theme Project Procedures</u>: - Data sheets fully completed by field team leader. - Sheets handed to 'data entry leader' and checks for conformity made. - Data entry assigned to SRA group member. - Data checked/validated after all data for a site are entered (by enterer). - Data entry leader checks or assigns someone to check all data for a catchment. - Before full IP data is sent to MDBC, a final check of all field against data sheets is made.
Fish codes	6 character codes for each species: 3 genus and 3 specific epithet (e.g. RETSEM for Australian smelt). - XL spreadsheet autofill.
Elapsed time	- Data entered immediately after field trip. - Data entry and check completed 1–4 weeks after field trip.
SOUTH AUSTRALIA	
Data checks	Data on data sheets checked daily or at the end of the field trip by senior operator.

	• Same person usually enters the data for the season. • Data entered into Excel and transferred to Access database. • Once data is entered, it is manually checked against the original data sheets. • Once in Access, query checks are run in a number of fields such as fish lengths (minimums and maximums are known) and species lists (incorrect codes), and abundances are cross-checked. ❖ NOTE: Was previously caught out with some previously 'false' data so the following procedure is now applied to SRA and other programs.
Fish codes	• 6 number code – 3 genus 3 specific epithet (e.g. RETSEM for smelt). • Excel autofill and then query checked.
Elapsed time	• 1-2 weeks after sampling trip.
QUEENSLAND	
Data checks	❖ NOTE: No data has been entered at this stage. MDBC were going to provide an Access database but, to this stage, haven't. DPI are in the process of building their own database, so what is listed is the planned procedure. • Raw data sheets verified after sampling — all field completed and legible. • Enter data (one person enters all data). • Two people check entered data against sheets. • Range checks to check size data of sampled fish. No range check for species because all species are ubiquitous in sampled valleys.
Fish codes	• Six letter fish codes; 3 genus, 3 specific epithet. • Pull down menus for species.
Elapsed time	• Four week maximum.

6. FEEDBACK
Q. Can you identify any areas that are 'high risk' in terms of the QA/QC of the SRA program?
Q. Can you offer any suggested improvements to the SRA program?

NEW SOUTH WALES

Issues	• Delays in getting site coordinates from the MDBC in earlier sampling rounds meant delays in site validation and logistics for sampling program.
	• Issues with the 'buffer zones' around weirs:
	   • Sampling 500 m up and downstream of weirs, but not being able to sample within a certain distance of a weir.
	   • Sometimes the only sampleable water at a site is around the weirs.
	   • Sometimes the access point (for boat) and site are separated by weirs.
	   • Need to refine in protocols as per decisions made by ISRAG in 2006 season.
	• Catchments that straddle borders are sampled by individual states, such that other states sample within NSW — cannot be sure that other states are correctly following protocols.

Improvements	• Water quality measurements:
	   • SRA protocols — one measurement at a specified depth.
	   • We suggest (and take) two types of measurements — one at depth and a depth profile.
	• GPS readings for the first and last shots document sampled reach information.
	• Sub-sampling — SRA protocols may exclude 'true' population information.
	• Don't estimate length of damaged fish.
	• Allow states to sample all sites within their own state.

Comments	• SRA protocols have been adopted for other projects in NSW; reducing any potential confusion as to the specific requirements of protocols, and allowing standardisation of data sets.
VICTORIA	

Issues	• Too much emphasis on some aspects of QA/QC and not others.
	• Fish sampling protocols are a bit confusing:
	   • Sometimes some changes have appeared independent of the Fish TRG meetings.
	   • Difficult to keep up with all the changes.
	   • Not sure who made changes (or why) if not via the Fish TRG.
	   • Very difficult to know if latest version of protocols has been distributed.
	   • The QA/QC protocols for modifying and disseminating the updated Fish Sampling Protocol to state

	members is poor.
	• SRA Fish TRG draft minutes are distributed too long following meetings (up to 4 months).
	• Comments on minutes are made but no final draft minutes incorporating comments are distributed for final check off.
	• Final minutes not distributed.
	• What are the QA/QC protocols for any of the decisions made, regarding sampling protocols, within and outside TRG meetings?
	• Continuity of the SRA project — from pilot to implementation — was poor. As a result, knowledge of some of the finer details from the pilot project had to be re-explained and some of the issues thrashed out earl;ier on are now unknown or forgotten.
Improvements	• Intermixing of staff (from other states) for field sampling could improve CA/QC and sampling consistency among states.
	• MDBC provide site coordinates earlier in the process.
	• Get more reserve sites in the initial list of sites for each zone in each catchment.
Comments	• Voucher specimens collected by other states and sent to ARI:
	• Very good process.
	• Acts as QA/QC for fish identification in all states.
	• The SRA AGM is a worthwhile experience.
	• Some parts of the SRA protocols are permeating into other projects (depends on the nature of project — research v. monitoring). ARI using SRA protocols in six catchments outside the MDB for Victorian state projects and, as a result, staff are becoming very well versed in SRA protocols.
SOUTH AUSTRALIA	
Issues	• Received site coordinates very late from MDBC: unable to prepare properly.
	• Would have liked much more prescriptive protocols and instructions from MDBC. For example, this is what we want you to do, this is how we want you to do it.
	• At some lower Murray sites the banks were choked with willows such that sampling along the banks was impossible. Don't think electrofishing was the most effective method, but was only option under protocols.

Improvements	• More feedback from MDBC in regard to whether SARDI are adequately meeting the needs of the SRA. For example when SARDI submitted the data Greg Long mentioned that there were some improvements that could be made to the format of the database but did not elaborate on what they were.
Comments	• Happier with program now that one season has been completed. • Quite happy from the SA end as to how the program is going. • Some of the SRA protocols being adopted in other projects.
QUEENSLAND	
Issues	• Bait traps — difficulty finding appropriate habitat for *Hypseleotris* in sampled reaches in the western valley. It is OK in the border rivers but it may not be a consistent approach across the state. • Would like to know what the data is going to be used for. Currently they have no proper answer for inquiring property owners. • The number of sites to be sampled in NSW (by QLD team) has increased since pilot putting financial pressure on DPI. Similarly, the number of QLD sites have decreased. • Not receiving site coordinates early enough for adequate planning of SRA sampling trip around other sampling programs. Makes it more difficult to dedicate a team. ❖ Acknowledges that the states may be to blame because of the tardy supply of stream layers to the MDBC.
Improvements	• Send out the site coordinates earlier, even several years in advance. • Quality assurance person working with teams on sampling trips.
Comments	• Only need to mix up teams for consistency if cross-valley comparisons are to be made. • Quite happy to sample in whatever way the MDBC wants (MDBC could be more prescriptive). • No major problems with protocols as they had input in their development. • The program and protocols have improved since the Pilot Study. • QLD DPI very happy to be specific to the SRA protocols as they are not trying to incorporate or compare with other monitoring programs.

APPENDIX II

Phase II — Summary of interviews

SRA Fish — QAQC Field Visit

Organisation:
New South Wales Department of Primary Industries (Narrandera Fisheries Centre)

Team Leader:
Vanessa Carracher

Field staff:
Jarrod McPherson
John Doyle

Date & Location:
10/05/2007 at Pomona Rd, Darling River.

1. Compliance to Australian Code of Electrofishing Practice

- **Staff qualifications**

VC – senior operator according to NSWDPI: supervised fishing hours and internally trained, but no official test or course completed (as per ACEP). Smith-Root training courses for all staff apparently being arranged.
JM & JD – operators under supervision.

- **Safety (eg. gloves, waders, life jackets)**

Adhere to all safety regulations in ACEP and carrying all appropriate equipment.

- **Copy of code? Y/N**

Yes

2. Sampling Procedures

- **Protocols**

Protocols taken into the field. NSWDPI have also developed an SRA-specific field manual that includes all associated field information (contacts, site validation, etc.)

- **How are sampling methods decided? (eg. protocols, individual/team)**

An SRA-experienced senior operator undertakes site selection before sampling. Appropriate methods are decided at this time. Protocols Are taken into the field, photos are taken, aspects such as access are also noted.

What if habitat changes between site validation and sampling?
There is always an SRA-dedicated senior operator in the field to make this call. However, the chances of the habitat changing are reduced by undertaking sampling soon after site selection/validation. A backpack electrofisher is taken into the field if it is suspected that the habitat has

changed and it may be required. They have also phoned for a small boat on occasion and had it bought up the next day.

- **What equipment is used? (eg. boat size, generator size, nets, electrode config, scales, measuring boards, etc.)**

On this site visit:
  - Medium boat – app. 14 foot
  - 7.5 KVa generator.
  - Two anodes – 6 dropper Wisconsin rings.
  - Nets – SRA standard mesh.
  - Fish with one bin on board
  - Small and large scales and measuring boards.
  - GPS, digital camera, fish finder (water depth), Horiba, range finder, sat phone, voucher specimen kit, etc.

- **How are bait traps distributed? (eg. placement, who decides, not in protocols)**

Bait traps distributed prior to electrofishing, spread over an area of 50-100 metres amongst habitats proportional to what is available. Traps are deployed outside the electrofishing area. Bait trap deployment addressed in SRA sampling workshops. All new staff are briefed about bait trap placement. Usually two staff distributes bait traps.

Bait traps are processed separately not pooled as in protocols.

- **General comments on sampling procedure. (eg. sampling all habitats, hunting out habitats, zapping period, capture/miss, etc. general stuff).**
- Sampling in river > 15 m.
- Sample along alternate banks concentrating on habitats and structure. Sample 2 mid-channel shots if less than 4 m in depth (as in protocols).
- Working upstream.
- Process one sample at a time
- Generally zapping for 5-15 seconds . — either still or gently reversing — then waiting before moving on.
- Attacking log piles from a number of angles.
- Clearly sampling and not hunting.
- Water quality taken at surface and at one metre.
- Exotics (carp, goldfish and redfin) are returned to the water and not euthanased.
- Subsamples – measure twenty out of each shot even if a total of fifty has been reached (more than protocol).
- Missed a couple of fish

3. Fish identifications

- **Who identifies? (eg. same person, qualifications/experience)**

Netters do most of identifications. Both the netters are not senior operators but they hold relevant degrees and have been trained in identifications.

- **Are there confirmations on small species?**

Yes — observed — confirmations made with senior operator.

- **Are there cheat sheets? Y/N   SRA(?) or generic?**

They have a generic cheat sheet – created in-house. McDowall is also carried on board.

- **How is data recorded in the field?**

Directly onto field sheets — hard copy — by boat operator.

- **Were any voucher specimens collected?**

Yes – hardyheads.

- **How were fish abnormalities identified? (eg. cheat sheets)**

No cheat sheets available – only the relevant codes. However, abnormalities and their recognition are covered at in-house SRA-sampling workshop in conjunction with Port Stephens team. Abnormalities are checked on both sides. Parasites (eg. Lernea) are counted on measured side only. Confirmations made between operators.

- **General — how is staff training in the above evident?**

New staff are given protocols to study and then tested. There are always two experienced (including one senior operator) with any new inexperienced staff. The NSWDPI annual SRA workshops ensure training is on-going.

4. Comments on current protocols

- **Which areas have been improved?**

The protocols are very clear.
The quality (location) of site coordinates provided to sampling teams have improved.
Protocols used on a range of other non-SRA projects.

- **Which areas are still unclear?**

Killing of pest species during sampling. There should be a standard procedure for all states.

5. General concerns in regard to QAQC

None stated

SRA Fish — QAQC Field Visit

Organisation:
Arthur Rylah Institute (Victoria)

Team Leader:
Jason Lieschke

Field staff:
Paul Tinkler

Date & Location:
19/3/2006 at Frosts Crossing, Ovens River

6. *Compliance to Australian Code of Electrofishing Practice*

- **Staff qualifications**

JL — senior operator (boat and back-pack) accredited (ACEP & ARI — more stringent)
PT — operator (boat, backpack and bank-mounted) (ACEP & ARI)

- **Safety (eg. gloves, waders, life jackets)**

Adhere to all safety regulations in ACEP and carrying all appropriate equipment.
Regular phone-ins to ARI.

- **Copy of code? Y/N**

Yes

7. *Sampling Procedures*

- **Protocols**

ARI project procedures carried in the field — this document contains the most recent protocols and all associated field information (contacts, site validation, etc.)

- **How are sampling methods decided? (eg. protocols, individual/team)**

There is <u>always </u>an SRA-dedicated person sampling — it is their responsibility to make the call. On the day, habitat is assessed by the team and decision is made regarding the appropriate combination of methods, as per protocols.

What if habitat changes between site validation and sampling?
There is <u>always </u>an SRA-dedicated person sampling — it is their responsibility to make the call. The types of methods used are decided during site validation (experience); however, river heights may change and a decision regarding methods has to be made in the field. At this point it is a team decision and may involve:

- Returning at later date with appropriate gear (eg. bigger/smaller boat)

- Taking photo.

- **What equipment is used? (eg. boat size, generator size, nets, electrode config, scales, measuring boards, etc.)**

On this site visit:
- Medium boat — app. 14 ft.
- 5 kVA generator with a half switch on control box— brings it back to 2.5–3 kVA.
- Two anodes — 6 dropper Wisconsin rings.
- Nets — SRA standard (6mm?) mesh.
- Fish with two bins on board.
- Other gear — range finder, large and small measuring boards and scales, secchi discs, GPS, digital camera, fish finder (water depth)

- **How are bait traps distributed? (eg. placement, who decides, not in protocols)**

Bait traps distributed prior to fishing, and are spread out over an area of 50–150 metres. Bait traps are not set within the electrofished reach: instead either up- or downstream of reach — minimise disturbance. Bait traps are fully submerged, in proportion to the availability of habitat (structure, macrophytes, undercut banks, roots, open water, etc. Normally, one person sets traps and the other collects water chemistry data.

- **General comments on sampling procedure. (eg. sampling all habitats, hunting out habitats, zapping period, capture/miss, etc. general stuff).**
- Sampling virtually all habitat within reach including open water and sandy beaches — trying to capture a range of species.
- Working upstream — even though no flow in reach.
- Mostly narrow reach so not much zigzagging. In the wider sections, some zigzagging but more working upstream along habitat, then boating back downstream to work on other side or along structure (if there) in channel.
- Predominantly 5–10 second shots.
- Attacking log piles from a couple of angles.
- Generally zapping for 5–10 seconds — either still or gently reversing — then waiting before moving on.
- Driver alerting netter of fish to the sides of the boat.
- Missed only a couple of small fish

8. Fish identifications

- **Who identifies? (eg. same person, qualifications/experience)**
Netter usually identifies and measures fish.
- **Are there confirmations on small species?**
Yes — observed — confirmations made with senior operator.
- **Are there cheat sheets? Y/N   SRA(?) or generic?**
Yes there are cheat sheets — created by ARI for each basin, based on PERCH lists. These sheets also contain information on species to be weighed, preserved, and also potentially difficult species to differentiate.

- **How is data recorded in the field?**

Directly onto field sheets — hard copy — by boat operator.

- **Were any voucher specimens collected?**

No — not necessary.

- **How were fish abnormalities identified? (eg. cheat sheets)**

No cheat sheets available — only the codes are listed on the data sheets. Observed the noting of an undernourished trout cod and lernea on other fish. Confirmations of these observations made between operators.

- **General — how is staff training in the above evident?**

PT moving toward senior operator license simply by accruing time. General experience gathered by informal interaction with senior operator (boat operation, fish ID, habitats, etc.)

9. Comments on current protocols

- **Which areas have been improved?**

The protocols are very clear.

- **Which areas are still unclear?**

Position of GPS reading — Why was it changed? What difference does it make? — prefer taking it at middle of site as opposed to downstream end.

Bait traps — there could be a couple of lines on bait trap positioning, but only need minimal information on this (eg. representative habitats, < 1m water, etc.)

10.   General concerns in regard to QAQC

- Generic lists and cheat sheets, abnormalities with photos — where are they?
- Weighing issues — each time a new protocol is developed the species to be weighed alters?

SRA Fish — QAQC Field Visit

Organisation:
Department of Primary Industries (QLD)

Team Leader:
Darren Smallwood

Field staff:
Richard Marsh

Date & Location:
11/04/2007 at Kings Creek, Aides Crossing near Clifton

11. Compliance to Australian Code of Electrofishing Practice

- **Staff qualifications**

DS and RM are both senior electrofishing operators (boat and backpack) in accordance with the ACEP. A DPI senior operator has the same level of training as NSWDPI.

- **Safety (eg. gloves, waders, life jackets)**

Adhere to all safety regulations in ACEP and carrying all appropriate equipment.

- **Copy of code? Y/N**

Yes

12. Sampling Procedures

- **Protocols**

SRA protocols are taken into the field as reference.

- **How are sampling methods decided? (eg. protocols, individual/team)**

DS and RM are both SRA-dedicated staff and they carry out all SRA sampling. The most appropriate sampling methods for each site are flagged during site validation (fly over) by one of these staff members. However, on the day of sampling it is a joint decision in regard to the best methods.

- **What if habitat changes between site validation and sampling?**

There is very little time between site validation and sampling — because the site coordinates are always received very late — so there is usually no change in habitat due to dramatic flow changes. However, if dramatic habitat changes do occur there are contingencies. For example, if a site that was intended to be boat-electrofished is no longer so (dried up), then it is backpack electrofished (carried all the time anyway). If, however, a site that was planned to be small boat or backpack electrofished has risen

considerably (rainfall, regulation), then it will be fished by big boat on the next trip. Once again, it is a team decision.

- **What equipment is used? (eg. boat size, generator size, nets, electrode config, scales, measuring boards, etc.)**

On this site visit (creek less than 10 m wide):
  - Small boat — 3.5 m tinny.
  - 2.5 kVA generator and electrofishing unit.
  - Single anode — 6 dropper Wisconsin ring
  - Nets — SRA standard (6mm?) mesh
  - One large fish bin
  - Other gear — large and small measuring boards and scales, secchi discs, GPS, digital camera, fish finder (water depth), multi-probe water quality meter

- **How are bait traps distributed? (eg. placement, who decides, not in protocols)**

Bait traps distributed prior to electrofishing in an area not disturbed by electrofishing operations — the creek was a series of long, disconnected pools so the bait traps were placed in a separate pool. Traps spread along reach about 100 m, fully submerged in a range of habitats representative of the reach (e.g. open water, macrophytes, roots, overhanging veg, etc.). DS and RM usually put in 5 traps each, so it is a joint decision as to where they are placed.

- **General comments on sampling procedure. (eg. sampling all habitats, hunting out habitats, zapping period, capture/miss, etc. general stuff).**
- Water quality parameters measured prior to sampling.
- Drive boat downstream from launching side (top of pool) so they can sample in an upstream direction (even though non-flowing), noting habitats along the way.
- Work alternate banks in a zigzag motion.
- Occasional mid stream sampling runs through open water.
- Predominantly 5–10 second shots — either moving very slowly forward, or zapping whist still and reversing slowly.
- Sampling structures from several different angles.
- Hardly missing any fish.
- Processing fish after each shot.
- Driver and netter swap jobs after six shots.

13.   Fish identifications

- **Who identifies? (eg. same person, qualifications/experience)**

Netter usually identifies and measures fish whilst the driver scribes.

- **Are there confirmations on small species?**

Yes — observed — confirmations frequently made between operators.

- **Are there cheat sheets? Y/N   SRA(?) or generic?**

No cheat sheets, but carrying an ID guide.

- **How is data recorded in the field?**

Hard copy data sheets

- **Were any voucher specimens collected?**

Yes — hardyheads and carp gudgeons. Photos taken of live species (hardyhead and rainbowfish).

- **How were fish abnormalities identified? (eg. cheat sheets)**

Predominantly from experience — confirmations made among crew if an abnormality found. Each fish checked.

- **General — how is staff training in the above evident? Comments on current protocols**

Staff training evident throughout the sampling event. All tasks are shared and there is communications and confirmations on virtually everything that is recorded.

14.   *Comments on current protocols*

- **Which areas have been improved?**
- Locating sites from coordinates — less ambiguous.
- Fishing in proportion to whatever habitat is available — as opposed to targeting instream structure only — is much clearer and sensible.

- **Which areas are still unclear?**
- Some of the measurements (eg. weighing gambusia) seem odd, and getting feedback from the MDBC to clarify such details is difficult (if not forthcoming at all)
- If a waterway is dry at the given coordinates, the samplers should seek to find water within 500m. But is this river kilometres or radius? These are quite distinct parameters and it would make more sense if it was 500 m radius.

15.   *General concerns in regard to QAQC*

- No real concerns. Still getting coordinates late, but that probably isn't MDBC's fault.