

National River Health Program

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MONITORING RIVER HEALTH INITIATIVE TECHNICAL REPORT
REPORT NUMBER 17

Australia-Wide Assessment of River Health: South Australian AusRivAS Sampling and Processing Manual

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SOUTH AUSTRALIA

AUStralian RIVer Assessment System



SAMPLING AND PROCESSING MANUAL



South Australia

Site Selection

Reference sites

Two groups of sites were sampled during the program: reference and test sites. Reference sites were those 'least-disturbed' sites that were sampled to provide the database used to generate the predictive bioassessment models. These sites represent minimally impacted areas that have not been significantly altered by human activities. They are equivalent to the notion of 'best available condition' discussed in Reynoldson *et al.* (1997) and the process used to select reference sites is detailed in Anon (1994).

In South Australia, 23 drainage basins from five drainage divisions were selected as having sites suitable for inclusion in the study. The basins provide a wide coverage of the geographical and meteorological variation that occurs within the State, and the chemical nature of many surface waters from these basins has already been described (Glatz 1985). Some drainage basins in South Australia have no true riverine systems present within defined channels (e.g. Nullarbor, Gairdner, Mallee) and as such were not included in the program.

The following criteria were used to select reference sites in South Australia:

- (i) National benchmark hydrological monitoring stations (Bureau of Meteorology), which resulted in the inclusion of sites from the following five rivers:
 - Scotts Creek (Onkaparinga Catchment)
 - North Para River at Penrice (Gawler River Catchment)
 - Hill River near Andrews (Broughton River Catchment)
 - Kanyaka Creek (Willochra Creek Catchment)
 - Rocky River (Kangaroo Island)

- (ii) Nationally significant riverine wetlands, which included 19 sites on the following 11 streams:
 - Cooper Creek (Cooper Ck Catchment)
 - Brachina Creek (Lake Torrens Drainage)
 - Parachilna Creek (Lake Torrens Drainage)
 - Oratunga Creek (Lake Torrens Drainage)
 - Wilpena Creek (Lake Torrens Drainage)
 - Cygnet River (Kangaroo Island)
 - Stunsail Boom River (Kangaroo Island)
 - Rocky River (Kangaroo Island)
 - Breakneck River (Kangaroo Island)
 - Tookayerta Creek (Lower Murray Catchment)
 - Bakers Range Drain (Millicent Coast)

(iii) National Parks and Conservation Parks. Where possible, streams traversing parks were sampled at different altitudes to ensure the complete gradient relating to slope and geographic position were adequately covered for each stream. This led to the inclusion of 16 sites from the following eight drainage systems:

- The Deep Creek (Fleurieu Peninsula)
- Sturt River (Torrens Drainage)
- Brownhill Creek (Torrens Drainage)
- Sixth Creek (Torrens Drainage)
- First Creek (Torrens Drainage)
- Mambray Creek (Mambray Coast)
- Arcoona Creek (Lake Frome Drainage)
- Bool Lagoon/Drain M (Millicent Coast)

(iv) Significant stream fauna, including significant sites for native fish, spiny crayfish, mayfly and stonefly species. This included sites on the following five streams:

- Marne River (Lower Murray Catchment)
- Angas River (Lower Murray Catchment)
- Bakers Range Drain (Millicent Coast)
- Deep Creek (Millicent Coast)
- Eight Mile Creek (Millicent Coast)

(v) Significantly different water chemistries, which included a site on Hookina Creek (Lake Torrens Catchment) which has a naturally high sulphate concentration (Glatz 1985);

(vi) Local knowledge of specific sites which were recommended by researchers working on mayflies, stoneflies and caddisflies from the Engineering & Water Supply Department and University of Adelaide. In addition, other sites were selected based on local knowledge of river reaches or catchments by National Parks & Wildlife Service personnel, government hydrologists, property owners and industry personnel.

(vii) Proximity to gauge stations, which generally had some historical flow and water quality data; and

(viii) Finally, some sites were selected to cover gradients in altitude, stream order, river length and stream gradient from different riverine systems.

Test sites

Monitoring or 'test' sites were those which were believed to have been significantly impacted by some sort of human-induced impact or disturbance (Anon 1994). They included sites affected by discharges of effluent, stormwater, industrial or mine leachate, disturbances from heavy grazing, agriculture, forestry, channelisation, vegetation clearance, and disruptions to normal flow regimes by water transfers and water storages.

Final site selection

All sites were initially located on 1:50 000 topographic maps. Final site selection was based on a field assessment to ensure that each site appeared to be representative of the general appearance of the stream in the region, was accessible and had suitable

habitats present to sample. Consequently, a number of sites were re-located to more appropriate “least-disturbed” locations, usually where both edge and riffle habitats could be sampled.

A total of 141 sites on 61 different stream systems were included in the study in 1994-95, comprising 111 reference and 30 test sites. They were distributed from Eight Mile Creek in the South-East to Cooper Creek in the north of the State. Most sites were located in the Mt Lofty Ranges where the greatest congregation of industry and people were found, and probably where the greatest impact on aquatic environments occurs. Other sites were located in the Flinders Ranges, Eyre Peninsula, River Murray catchment and Kangaroo Island.

Habitats sampled

Areas with riffle and edge habitats that are representative of the conditions found within the reach of interest along a creek or river should be chosen for sampling. The site is defined as a 100m section of the stream as stipulated in the bioassessment manual (Anon 1994). In South Australia, models have been created for both **Riffle** and **Edge** habitats.

The **riffle** habitat is defined as an area of shallow turbulent water flowing over a substrate, which is usually cobble, pebble and/or gravel, but may include sand, detritus, roots, etc.



The **edge** habitat is defined as an area of little to no current, or aquatic vegetation, often in quite deep water. It may have overhanging or emergent vegetation, undercut banks, root mats or other suitable habitat providing cover and refuge for macroinvertebrates.



Habitat Assessment

An explanation of all habitat measurements required for sites sampled in South Australia and how to obtain them is given in the following section. The field datasheets and habitat assessment form used for South Australia can be found in Appendix A.

Habitat measurements

Numerous habitat characteristics and field measurements were taken at each site to assist in the assessment process. These included:

- conductivity using an ICI 303 ATC conductivity meter (uS/cm). Conductivity is measured in the field to assist in calibrating the dissolved oxygen meter and understanding the conditions at the site during sampling. The actual conductivity measurements used in the AUSRIVAS models are based on laboratory readings using standard methods.

- water temperature (degrees C) and dissolved oxygen (mg/L and % saturation) using a YSI model 55 dissolved oxygen meter with automatic temperature and manual salinity compensation,
- pH using a Hanna HI 9025 pH meter,
- secchi depth using a secchi disc,
- shading (the estimated % of stream shaded during daylight hours)
- stream width (mean width of site in metres),
- habitat area (% area over the linear area of the site)
- current speed (max. and min. in m/s determined from the habitats present throughout the whole site, not necessarily from where the samples were collected),
- depth (measured in metres using a measuring staff and assigned to an average ranked depth class),
- composition of the substrate based on the specific area of habitat sampled for macroinvertebrates (% bedrock, cobble, pebble, gravel, sand, silt, clay, algae and detritus for each habitat).

Chemical samples

Surface water samples were collected and stored in air-free, airtight bottles on ice before laboratory analyses for nutrients, turbidity, colour and major ions. A separate water sample was also pre-processed in the field by filtering about 50 mL water through a 0.45 µm Gelman Acrodisc for the analysis of dissolved reactive phosphorus in the laboratory. In the case of very turbid samples a 0.8 or 1.0 µm pre-filter was used.

Analyses followed standard procedures (Anon 1989, Anon 1990). They included:

cations (sodium, magnesium, potassium and calcium) and sulphate were analysed using a Spectroflame ICP emission spectrophotometer fitted with a polychromator, chloride was determined by the automated ferricyanide method on a Skalar Sanplus system,

bicarbonate, carbonate and alkalinity were calculated after titration with 0.02N HCl to the phenolphthalein end point at pH 8.3 and the total alkalinity end point at pH 4.5 with a Radiometer Autotitrator,

dissolved reactive phosphorus, oxidised nitrogen and ammonia were analysed using a Skalar Sanplus automated flow analyser with a two channel matrix spectrophotometer for each parameter,

Total Kjeldahl nitrogen and total phosphorus analyses were made with a Technicon autoanalyser and spectrophotometer,

Colour was calculated using a Pye SP8-100 ultraviolet spectrophotometer by comparing the absorbance of the sample at 456 nm with a calibration curve of Pt-Co standard solutions at the same wavelength,

Turbidity was determined by the nephelometric method using a Hach radio Turbidimeter,

Electrical conductivity was measured in the laboratory using a Radiometer model CDM83 auto-ranging conductivity meter with automatic temperature compensation.

Catchment measurements

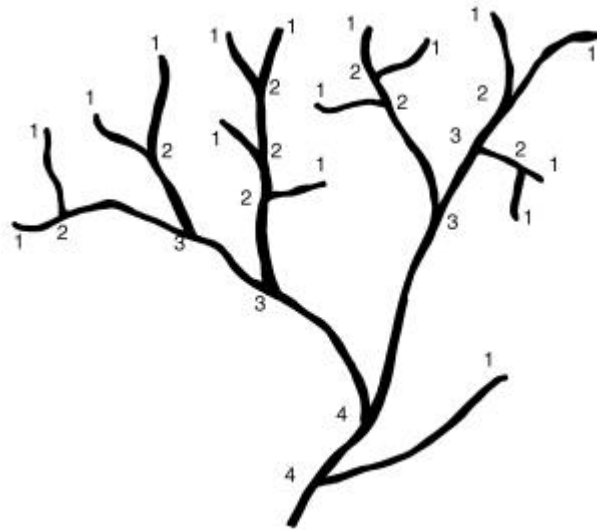
A number of variables were calculated for each site using a geographic information system based on 1:50 000 (for sites from the middle of the Flinders Ranges south),

and 1:250 000 (for sites north of Flinders Ranges) topographic maps. Variables include latitude, longitude, easting, northing, altitude, slope in m/km, catchment area upstream of site in sqkm, stream order and distance from source (DFS) in km.

Slope (m/km): Change in elevation between the site and a point 1 km upstream.

Catchment Area (km²): The area of land above the site being assessed from which the water drains towards the stream.

Stream Order: Hierarchical ordering system based upon the degree of branching (Strahler 1957). A second-order stream is formed by the joining of two first order-streams; the junction of two second-order streams forms a third order stream etc.



Distance from Source (km): Distance from the site to longest thread of stream source.

Discharge data from gauge stations was reviewed to assign an annual median daily discharge for gauged streams and extrapolated to include categories for ungauged streams as well.

Macroinvertebrate Sampling

Riffle Sampling

Macroinvertebrate samples were taken using a triangular framed 250 μm mesh pond net (35 x 30 x 30cm) to capture those animals present in a 10 m area of riffle present at a site. The sampled area was not necessarily contiguous, and attempted to encompass all the microhabitats available. The substrate was disturbed by vigorous kicking and rocks were rubbed by hand to dislodge organisms into the net that was held immediately downstream. The site was defined as a 100 m section of the stream, and samples could be collected from anywhere within the site. Note that sampling proceeded upstream or was conducted in a manner that prevented the contamination of samples due to drift and disturbance while working the site.

Edge Sampling

Macroinvertebrate samples were taken using a triangular framed 250 μm mesh pond net (35 x 30 x 30cm) to capture those animals present in a 10 m area of edge present at a site. The sampled area was not necessarily contiguous, and attempted to encompass all the microhabitats available. The net was moved in sweeping actions through the water column as the sampler moved along the bank, and the sediment was kicked to ensure benthic organisms were collected in the sample. Three rocks were also rubbed by hand (when present) and the dislodged macroinvertebrates included in the sample. The site was defined as a 100 m section of the stream, and samples could be collected from anywhere within the site. Note that sampling proceeded upstream or was conducted in a manner that prevented the contamination of samples due to drift and disturbance while working the site.

Macroinvertebrate sample processing

Samples were preserved in 5% formalin and taken back to the laboratory where macroinvertebrates were sorted, identified and counted using dissecting and compound microscopes. A minimum of 10% of each sample was sorted using the sub-sampling technique described by Marchant (1988). The remainder was always scanned for the presence of rare taxa. Whenever the total number of organisms in the sub-sample was less than 20 individuals another 10% of the sample was processed. If the number of organisms was still less than 20 then the whole sample was sorted. This processing procedure was followed for the samples collected during the 1994 and autumn 1995 surveys.

In response to the review of sub-sampling and sorting procedures by Humphrey & Thurtell (1997) the operational rules concerning the target minimum number of organisms to be sorted was increased to 200 in a 10% sub-sample. Thereafter, if the number of organisms was still less than 200 in the first sub-sample then either another 10% of the sample or the whole sample was sorted. This procedure was initiated for the spring 1995 samples and has been used in all of the later surveys.

Macroinvertebrates were identified to the lowest taxonomic level possible using the keys described in Hawking (1994). This meant that some taxa were identified to species level, others generic or family level. The oligochaetes, nematodes, turbellarians, mites, sponges and nemertians were each grouped into a separate taxon.

Macroinvertebrate Quality Control/Quality Assurance procedures

Field sampling

The South Australian program has involved a small group of biologists from the same laboratory collecting all samples from 1994 to 2000. This has ensured that an experienced operator has been involved with sampling each site, and over time all members in the group have gained considerable experience sampling a wide variety of river types throughout the State. This has ensured a consistent approach to identifying habitats and field sampling effort during the course of the program. It is recommended that any future use of this protocol should involve the participation of at least one of the team members involved with this work at the Australian Water Quality Centre or EPA to minimise the chance of introducing significant sampling errors.

Laboratory

The sub-sampler is subject to an internal check of an additional 5% of samples to ensure random sub-samples are being produced with the laboratory sorting method used in S.A.

In addition, ERISS carried out external checks of residues from the 1995 surveys to test the performance of the sub-samplers used by each State and Territory (where laboratory sorting methods are used). That work confirmed the sub-sampler operated effectively to randomly sort the sample and allow the retrieval of a representative 10% sub-sample. A 5% randomised selection of residues from each survey has been kept in storage for any possible future QA of the sorting protocol used in S.A.

As part of a national QA/QC program involving the identification of macroinvertebrates, the Murray-Darling Freshwater Research Centre independently checked samples that had been sorted and identified by the team in S.A. Samples were assessed for the 1994, 1995 and 1997 surveys. The results from these showed the high performance of the approach used in S.A. and indicated that no further work was needed to improve the identification of specimens from this State.

All new staff are trained in the use of the sub-sampler and identification keys used in S.A. The experienced team members have also assisted new staff to identify organisms that they are not familiar with and check difficult taxa.

The addition of new staff during the program led to the development of a more rigorous internal training protocol in 1998. This included:

1. Random checks of sorting trays of new members to ensure all specimens were being collected and more importantly that novel taxa were not being overlooked.
2. All staff involved with the project process and identify a contrived sorted sample to provide a check on counting and identification skills.
3. Random checks of identifications carried out by all operators.

Further Information

Enquiries on sampling in South Australia may be directed to Peter Goonan on (08) 8204 2044 or by emailing pgoonan@dehaa.sa.gov.au.

Stream Transects

1	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	Width
Depth (cm)															
	15m	16m	17m	18m	19m	20m	21m	22m	23m	24m	25m	26m	27m	28m	
Depth (cm)															
2	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	
Depth (cm)															
	15m	16m	17m	18m	19m	20m	21m	22m	23m	24m	25m	26m	27m	28m	
Depth (cm)															
3	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	
Depth (cm)															
	15m	16m	17m	18m	19m	20m	21m	22m	23m	24m	25m	26m	27m	28m	
Depth (cm)															

Habitat Descriptions

Riffle							
Current Speed (m/s)	Max	_____			Min	_____	Area of Site %
Mean Depth (cm)	1<25	2<50	3<100	4<200	5>200		animals added or released ?
Substrate Description							
Bedrock	_____ %		Gravel (4-16mm)	_____ %			
Boulder (>256mm)	_____ %		Sand (1-4mm)	_____ %			
Cobble (64-256mm)	_____ %		Silt (<1mm)	_____ %			
Pebble (16-64mm)	_____ %		Clay	_____ %			
Algal Cover	_____ %		Detritus Cover	_____ %			

Edge							
Current Speed (m/s)	Max	_____			Min	_____	Area of Site %
Mean Depth (cm)	1<25	2<50	3<100	4<200	5>200		animals added or released ?
Substrate Description							
Bedrock	_____ %		Gravel (4-16mm)	_____ %			
Boulder (>256mm)	_____ %		Sand (1-4mm)	_____ %			
Cobble (64-256mm)	_____ %		Silt (<1mm)	_____ %			
Pebble (16-64mm)	_____ %		Clay	_____ %			
Algal Cover	_____ %		Detritus Cover	_____ %			
Degree of bank overhang:		Nil	Slight	Moderate		Extensive	
Trailing bank vegetation:		Nil	Slight	Moderate		Extensive	

Biological Description

Dominant Terrestrial Vegetation _____

Macrophytes

SUBMERGED/ FLOATING

Azolla

Chara (Stonewort).....

Myriophyllum (Water Milfoil)

Nitella (Stonewort)

Potamogeton (Pondweed)

Ruppia (Sea Tassel)

Triglochin (Water Ribbon)

Vallisneria (Ribbonweed)

Zanichellia

Other

EMERGENT (ctd.)

Carex (Tussock Sedge)

Crassula (Crassula)

Cyperus (Sedge).....

Eleocharis (Spikerush).....

Rorripa (Watercress)

Polygonum (Smartweed)

Ranunculus (Buttercup)

Isolepis (Clubrush).....

Mimulus

Bolboschoenus (Clubrush).....

Schoenoplectus (Clubrush).....

Cotula (Waterbutton).....

EMERGENT

Typha (Cumbungi).....

Phragmites (Common Reed).....

Juncus (Rush).....

Callitriche (Starwort).....

Other

Epiphyte Cover Nil Slight Moderate Extensive

 % Native vegetation _____ % Exotic vegetation _____ (total 100%)

Algae (Attached/ Floating) *Cladophora* *Spirogyra* *Enteromorpha*

sample collected? algae macrophyte none

Percent of 100 m reach covered by:

Periphyton	1 <10%	2 10-35%	3 35-65%	4 65-90%	5 >90%
Moss	1 <10%	2 10-35%	3 35-65%	4 65-90%	5 >90%
Filamentous algae	1 <10%	2 10-35%	3 35-65%	4 65-90%	5 >90%
Macrophytes	1 <10%	2 10-35%	3 35-65%	4 65-90%	5 >90%

Fauna Observed _____

General Stream Description and Use

WATER ODOURS:	normal	sewage	petroleum	chemical	none	
WATER OILS:	slick	sheen	globbs	flecks	none	
TURBIDITY:	clear	slight	turbid	opaque		
PLUME (amount of fine sediment generated when sediment is disturbed):	little	some	lots			
SEDIMENT ODOURS	normal	sewage	petroleum	chemical	anaerobic	none
FLOW LEVEL:	(relative to normal inundation level, shown by terrestrial grasses, eroded area or boundary in bank sediment)					
	No flow	Low	Normal		High	
Are the undersides of stones which are not deeply embedded black?				yes	no	
SEDIMENT DEPOSITS:	none	fine organic	manure	sand	relict shells	
EXISTENCE OF EROSION:	none	some	moderate	heavy	causes: _____	
NPS POLLUTION:	no evidence	potential	_____	obvious	type _____	
RESTRICTIONS TO FLOW	present	upstream / downstream			absent	
	types	_____				
LANDUSE:	Native forest	Forestry	Native pasture	Grazing	Cropped	
	Residential Commercial	Industrial	Recreational	other	_____	
BARS: (bed surface protruding from normal water level & forming a bar)					_____ %	

Samples Collected

1.25L water	_____	No. Net Samples	_____
50mL Filtered sample	_____	Description of Net Samples	
Diatom	_____	1	_____
Protozoa [$>5000 \mu\text{S}$]	_____	2	_____
		3	_____
Photographs	_____		
Comments	_____		

Any Other Observations	_____		

Field Data Sheet - Supplement

Catchment Variables

River _____ Location Code _____

Stream Order _____ (1:50,000 scale map)

Distance From Source (DFS) _____ km

Catchment Area Upstream _____ km²

Slope _____ m/last km (1:50,000 scale map)

Chemical Description

Alkalinity _____ (mg/L)

Carbonates _____ CO_3^{-2} mg/L