Water quality

Information sheet

Aquatic ecosystem condition reports

2017 panel assessment of creeks and rivers in the South Australian Arid Lands and Northern and Yorke NRM regions – Lake Eyre Basin and Flinders Ranges

Issued December 2018

EPA 1108/18: This information sheet describes the outcome of the panel assessment of creeks and rivers from the Lake Eyre Basin and Flinders Ranges in the South Australian Arid Areas and Northern and Yorke Natural Resources Management (NRM) regions, sampled during 2017.

Introduction

The Environment Protection Authority (EPA) coordinates a monitoring, evaluation and reporting (MER) program on the aquatic ecosystem condition of South Australian creeks and rivers. This MER program is designed to meet several objectives:

- Providing a statewide monitoring framework for creeks and rivers that revolves through the NRM regions with sufficient frequency to allow for state of the environment reporting purposes.
- Describing aquatic ecosystem condition for broad general public understanding.
- Identifying the key pressures and management responses to those pressures.
- Providing a useful reporting format that can support environmental decision making within government, community and industry.

This information sheet provides a summary of the scientific work used in assessing monitoring data from creeks and rivers. Aquatic ecosystem science is not always rigid and precise; it is often open to different interpretations in several respects. The EPA has decided that the best way to assess the condition of streams is through an expert panel deliberation that uses a consistent descriptive modelling approach. The panel members comprised an environmental consultant and two biologists from the EPA (the authors of this assessment). All have at least 15 years' experience in monitoring and assessing a range of streams across South Australia.

The panel members were:

- Peter Goonan, EPA
- Tracy Corbin, EPA
- Chris Madden, Freshwater Macroinvertebrates.

This information sheet is a technical document that contains relatively sophisticated concepts and content. It summarises the scientific assessment of data collected from creeks and rivers in the Lake Eyre Basin and Flinders Ranges from the South Australian Arid Areas and Northern and Yorke NRM regions during 2017.

Site selection

A total of 38 sites were sampled during 2017, comprising six sites from the southern Flinders Ranges sites in the Northern and Yorke NRM region, and 32 sites from the mid to Northern Flinders Ranges and Lake Eyre Basin in the South Australian Arid Areas NRM region. The Flinders Ranges sites were sampled in autumn and spring to account for the expected seasonal differences in physical habitat structure and aquatic biology of streams that occur in the area. The Lake Eyre Basin sites were only sampled during autumn due the lack of seasonality effects on the aquatic biota, distance and cost issues for repeated sampling in the region, and expected access problems due to spring rainfall events.

Sites were selected either from a list of previously sampled sites (Flinders Ranges) or to complement fish monitoring sites that are regularly sampled as part of the Lake Eyre Basin Rivers Assessment[1]. The distribution of selected sites throughout each region ensured that the spatial extent of the stream network that was accessible by the existing unsealed road network was sampled.

This sampling design provides targeted information about the fixed sites that are sampled and an indication of the general condition of waters in each region. However, the lack of randomly selected sites using this design limits the ability to provide a statistically valid assessment of all waters in a region with a known degree of error.

The EPA has developed a stream reach database linked to the road network that can be used to select random sites using an unequal probability of selection criterion to ensure a similar number of sites can be generated for each stream order (Catchment Simulations Solution 2011). This approach enables an assessment of the kilometres or percentage of streams with different condition ratings, enriched with nutrients, dominated by fine sediments, or some other indicator of interest recorded during the field studies.

However, in consultation with staff from both NRM regions, Department of Environment and Water (DEW), and South Australian Research and Development Institute (SARDI), the decision was made to continue to build on the limited information base for previously sampled fixed sites and promote a more general understanding of the regional condition of waters at this stage.

It is important to note here that unlike other regions in South Australia, the remote location and generally limited road network throughout the Lake Eyre Basin and parts of the Flinders Ranges have resulted in the collection of only sparse datasets detailing the aquatic biology, water chemistry, sediment and habitat measures of rivers and creeks in these regions. Consequently, extending the limited knowledge base about the few fixed sites that have been sampled in the past remains the logical focus of current work in each region, although future assessments may include a subset of random and fixed sites to provide greater flexibility in the way the overall findings can be reported.

The assessment

Members of the expert panel individually rated each site using a descriptive model for interpreting change in aquatic ecosystems in relation to increasing levels of disturbance (Davies and Jackson 2006). The assumption in this assessment is that biological (ecological) condition deteriorates as the degree of human disturbance in the catchment increases, and conversely, the best condition occurs where there is little to no human disturbance of the environment (Figure 1).

[1] http://www.lakeeyrebasin.gov.au/programs/leb-rivers-assessment

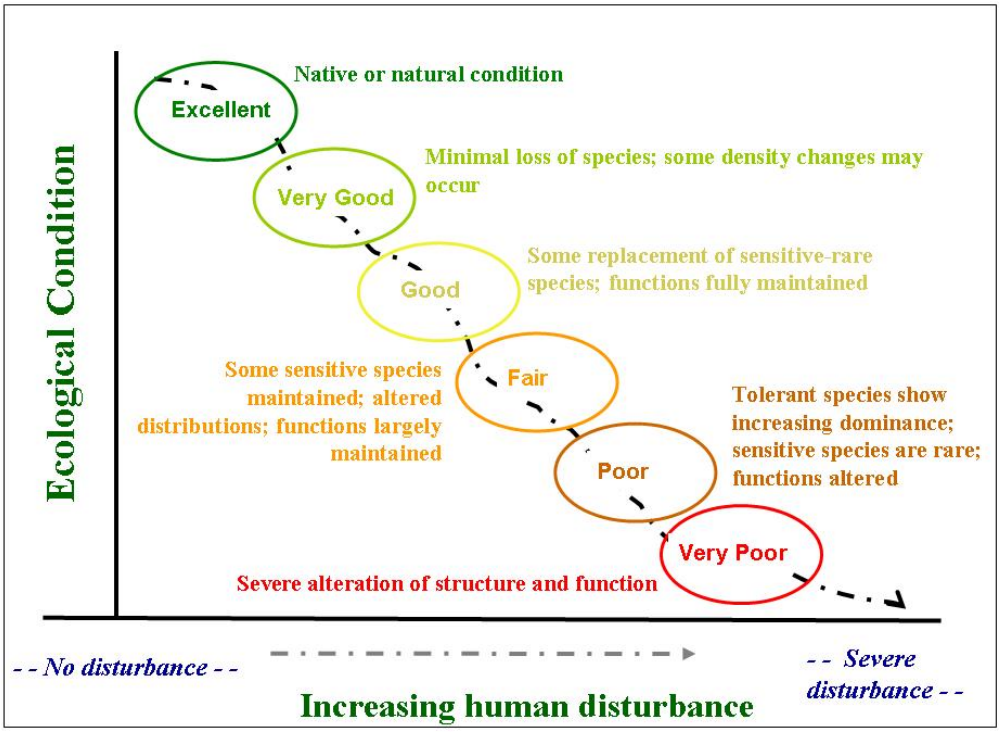

Figure 1 **Human disturbance gradient showing the six different ecological condition grades or ratings ranging from excellent (best) to very poor (worst) with a brief definition of each condition**

The process used to grade or rate sites involved the following steps.

Firstly, conceptual models describing the ecological responses to general disturbance gradients were developed, reviewed and updated by the panel; separate models were developed for the Flinders Ranges and the Lake Eyre Basin to represent the different stream types that occur in the Far North of South Australia (Tables 1–2).

Secondly, species lists were compiled for each model from the data collected in 2017 that described the expected biotic assemblage for each of the possible condition ratings; separate species lists were developed for the Flinders Ranges and the Eastern and Western Lake Eyre Basin to describe the obvious biotic differences that occur across each region (Tables 3–5).

Thirdly, each site was given a rating based on the macroinvertebrate communities and vegetation assemblages that were recorded during the sampling periods; the sediment, water quality and habitat data provided information about pressures at the site scale to confirm if the biology was consistent with the conceptual models for each region. Note that for sites that were consistently dry, only the vegetation data was used to provide a rating; during wetter periods, many of these sites would probably rate differently but the assessment was based on the conditions that occurred during each site visit in 2017.

Lastly, the individual ratings derived by the panel members were combined to produce an overall, or final, rating for each site (Table 6).

The final reported ratings were derived by determining the mode rating (most common rating from the panel ratings for each site).

The ratings in the model range from Excellent to Very Poor. However, given the extent of stock and feral animal grazing in the Flinders and Lake Eyre Basin, the panel considered that Excellent probably no longer occurs and was not evident from the sites sampled in 2017. Similarly, the Very Poor rating was also unlikely to occur because it typically applies to severely altered streams in urban areas or downstream from industry discharges or mines leaking metals, acid or salt into local waterways. Neither situation was expected to occur in the Far North given the limited extent of urban centres and the location and type of mines in relation to creeks and rivers in arid South Australia.

2017 results

The results provided in Table 6 may be summarised by condition rating and NRM region as follows:

Condition rating	NY Flinders sites	SAAL Flinders sites	SAAL Lower Eyre Basin sites	Total sites
Excellent	0	0	0	0
Very Good	0	0	0	0
Good	2	11	9	22
Fair	2	6	3	11
Poor	2	2	1	5
Very Poor	0	0	0	0

The majority of sites were assigned Good (63%) or Fair (29%) rating due to the dominance of comparable generalist aquatic communities and presence of natural overstorey vegetation associated with each stream. The better sites had a richer range of macroinvertebrates and usually supported at least a few rare, sensitive or habitat specialist species. They included sites from the mid to upper reaches of streams in the Flinders Ranges and most of the larger streams from the Lake Eyre Basin.

The Fair sites were dominated by a more generalist and tolerant range of macroinvertebrates and showed increasing evidence of moderate nutrient enrichment. Sites assigned to this rating were located from among gorge and lowland stream settings in the Flinders Ranges and from the Lindsay and Neales Creeks from the Western Lake Eyre Basin and Warburton Creek at Cowarie Crossing Waterhole from the Eastern Lake Eyre Basin.

The Poor sites comprised 13% of stream sites assessed and were notable by their more limited range of tolerant and generalist macroinvertebrates. Each community was dominated by dipterans, beetles and bugs, and some provided habitat for odonates and other taxa in low numbers. These sites appeared to be significantly affected by high salinity (particularly two sites from Willochra Creek in the lower Flinders Ranges and Peake Creek from the Western Lake Eyre Basin) and/or gross nutrient enrichment (eg Baratta Creek and Hookina Creek in the lower and mid Flinders Ranges).

Interestingly, no sites were in Very Good condition in 2017 despite previous work in 2012 assigning this rating to four dry sites (Willow Creek, Oraparinna Creek, First Spring in Oratunga Creek catchment and Balcanoona Creek) and two wet sites (Snob's Hut Spring and Yardaparinna Creek).

The dry sites were rated highly due to the good habitat structure provided by the surrounding native riparian vegetation and lack of evidence of significant pressure from large numbers of stock or feral animals visiting each waterway. The wet sites supported a wide range of regionally rare, sensitive and generalist species and comprised examples of the 'best' condition assemblages that are expected for streams in the Far North. In 2017, Willow Creek and Balcanoona Creek remained dry and were rated Good due to increased pressure caused by feral animal grazing, and Yardaparinna Creek was wet and also assigned a Good rating in response to recent cattle grazing effects noted for the site sampled.

It should be noted that a central assumption of the conceptual models for the Far North was that the high levels of nutrients such as nitrogen and phosphorus originated from human activities rather than from some sort of natural source or process (NLWRA 2001 and SAAL NRM 2010).

This is consistent with the general poor nutrient status of ancient Australian soils and the need for arid-zone plants to conserve and recycle nutrients, rather than allow the regular export of nutrients from the root zone into a stream, where the nutrients may be deposited tens to hundreds of kilometres away.

However, according to Phelps *et al* (2007), floodplain soils in the channel country in Queensland are moderately fertile with a relatively high available phosphorus (13–48 mg/kg) and total nitrogen (0.02–0.07%) by Australian standards, so it is possible that some soils in the region have a higher than expected nutrient status. The constant stocking of between 500,000–1 million cattle that graze on the same floodplain in Queensland and the subsequent role that this has on the nutrient load entering streams in the Eastern Lake Eyre Basin was not mentioned by Phelps *et al* (2007). It appears likely that this is a major contributor to nutrient levels recorded in floodplain soils and streams draining such areas.

Consequently, the conceptual models were developed under the assumption that both historical and present stock, and feral animal grazing land uses and cropping activities in some upper catchment streams have contributed towards the high concentrations of nutrients and/or obvious enrichment effects (eg large growths of phytoplankton, filamentous algae or aquatic plants) consistently recorded from many streams sampled from the Far North of South Australia.

Under such conditions, a more generalist assemblage of aquatic macroinvertebrates, capable of exploiting the resulting high plant productivity and tolerating occasional low oxygen levels when plants die and decay, would be expected to dominate in-stream aquatic habitats. In contrast, few sensitive or rare habitat specialists would be expected to occur and would certainly not dominate aquatic communities. These nutrient enrichment responses were subsequently incorporated into the conceptual models to represent the commonly described patterns that have regularly been described in the scientific literature for well over 100 years.

Similarly, the models assumed that high salinity has been exacerbated by historical disturbances to vegetation changes associated with human cropping and grazing practices in the Willochra catchment and some parts of the Western Lake Eyre Basin. High salinity has also been recognised as a major driver for limiting aquatic communities to only the most salt-tolerant species, particularly when salinities exceed 5,000 mg/L (eg McEvoy and Goonan 2003, Nielsen *et al* 2008, Kefford *et al* 2011).

It is possible that some streams in the Far North, particularly the lower reaches of the Willochra Creek, may have approached or exceeded this general threshold prior to European settlement. It was assumed as part of this assessment that the extensive land-use changes brought about by farming practices in the past has mobilised more salt into each affected stream than would have occurred if the landscape had remained unchanged.

Further work is needed to confirm if these assumptions are appropriate or whether the conceptual models developed as part of this assessment should be amended. Targeted studies of historical diatom assemblages in sediment cores taken from selected in-stream waterholes in the Flinders Ranges and Lake Eyre Basin may provide the only means of confirming whether there has been an increase in the frequency and dominance of nutrient-favouring species and/or saline tolerant species since European settlement, or whether diatom communities have remained largely unchanged over the past several hundred years in response to little change in the nutrient and salinity status of streams in arid South Australia.

If nutrient and salinity levels have obviously increased, then further work can be directed towards reviewing and possibly reducing the thresholds used in the conceptual models (eg enrichment confirmed if the 100-m area of site has >10% macrophytes and/or >35% filamentous algae when nutrient concentrations are >1 mg/L nitrogen and >0.1 mg/L phosphorus). Alternatively, if salinity and nutrient changes have not occurred then further work is needed to clarify the source and movement of these chemicals into waters because they still have the potential to degrade aquatic habitats whenever they occur in particularly high concentrations.

A statistical summary of the nutrient and phytoplankton algal indicator data from sites sampled in 2017 is provided in Table 7, which shows that streams from the Flinders Ranges and Lake Eyre Basin had large amounts of chlorophyll, enriched with nitrogen (>>1.5 mg/L) and phosphorus (>>0.1 mg/L), moderately saline (conductivity >5,000 µS/cm), and were well oxygenated (>>8 mg/L) and alkaline (pH>8). The comparison of sites sampled from each region in autumn indicate that Lake Eyre Basin streams were more enriched with nutrients and had more chlorophyll than streams from the Flinders Ranges (Tables 7a and b). Only the Flinders Ranges sites were resampled in spring 2017, and the results are comparable to autumn 2017 but with a tendency for a slightly lower concentrations of total phosphorus and higher amounts of chlorophyll and dissolved oxygen (Table 7c)

Finally, it should be noted that the ratings for the dry sites, in particular, would probably vary when they hold water and support aquatic communities. However, this should be considered within the broader context of the expected variability that will occur in any arid-zone stream in response to the differences in the frequency and timing of floods and droughts, differences in the distribution and abundance of stock and feral animals, and other biological, chemical and physical habitat changes that can occur from one year to the next. Despite this, the ratings assigned in this report provide a considered and accurate condition assessment of sites sampled in 2017 using the data and conceptual models specifically developed for both the Flinders Ranges and Lake Eyre Basin areas.

Variability in panel member ratings

The results in Table 6 show that the three panel members assigned the same condition rating to 50% of the sites and differed by only one rating class of each other for the remaining 50% sites, indicating that there was considerable consistency for rating each of the sampled sites.

In the previous assessment of the Far North in 2012, 6 of 65 sites sampled were, however, assigned by the panel to three possible ratings, indicating that the conceptual models were either not clear enough to remove ambiguity between some of the response measures or the panel members inconsistently applied some of the criteria in assigning ratings for some sites.

It was noted that given the variability of stream types across each region (eg differences in the presence of water and flowing habitats, seasonal differences in hydrology, variable salinity patterns and climatic influences), it would be unrealistic to expect to see complete agreement in rating sites using an expert panel approach or indeed any other means of integrating and reporting on measures of stream condition (eg indices or models using the reference-based concept, gradients, comparisons against guidelines, etc), largely because of the boundary or edge effects that invariably occur whenever environmental data is grouped.

The issue about how to best assign condition or 'health' assessments to environmental resources remains an area of ongoing scrutiny and refinement. Models are currently under development to enable site conditions in the future to be estimated using just map-based data for a coarse 'expected' condition rating and using map-based and field collected data in a particular year to provide an 'observed' condition rating for each sampled site. All results would then be reviewed by an expert panel to provide a reality check and confirm if the taxa responses and conceptual models remain valid or need further revision.

References

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Further information

Legislation

Online legislation is freely available. Copies of legislation are available for purchase from:

Service SA Government Legislation Outlet
Adelaide Service SA Centre
108 North Terrace
Adelaide SA 5000

Telephone: 13 23 24
Facsimile: (08) 8204 1909
Website: shop.service.sa.gov.au
Email: ServiceSAcustomerservice@sa.gov.au

General information

Environment Protection Authority
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Freecall: 1800 623 445 (country)
Website: www.epa.sa.gov.au
Email: epainfo@sa.gov.au

Table 1 Conceptual model describing the general biological responses to the human disturbance gradient in the Flinders Ranges

Rating	Excellent	Very good	Good	Fair	Poor	Very poor
Stressor description	As naturally occurs with native vegetation and no pest or introduced species present. Given the historical sheep and cattle stocking practices in region from the 1800s–mid 1900s, ongoing damage caused by pest species (eg goats, donkeys rabbits, and mosquitofish in some catchments), occasional grazing of refuge springs and waterholes by stock and feral animals, and presence of weeds across much of the Flinders Ranges, this rating may no longer exist in the region.	Least disturbed assemblages. Vegetation largely native trees over predominantly native understorey but typically includes some introduced species. Aquatic macroinvertebrate assemblages typically with high richness; intolerants and specialist taxa often dominate abundances but more ephemeral habitats include rich insect fauna; may include some introduced species present in low abundances.	Slightly modified and likely to be showing initial signs of enrichment and some modification of natural habitat features. Likely to occur in springs and streams with large areas of natural vegetation remaining. Generally only applies for well-vegetated, permanent or near permanent freshwater habitats but may also include more ephemeral waters with only minor habitat changes and evidence of slight addition of nutrient and fine sediment from the surrounding land uses.	Moderate changes to native vegetation and habitats but retains major natural features present in watercourses from the region. Some localised nutrient enrichment and fine sediment additions likely to occur due to the extent of stock and feral animals accessing the site.	Substantially modified and likely to retain only limited areas of native vegetation and show evidence of clearly altered habitats. Damage from stock and feral animal grazing of riparian habitats likely to be widespread and evidence of large amounts of nutrients and possibly fine sediment being added to sites from local sources. May occur near urban centres, mines or major roads, areas where historical damage to springs and creeks may have occurred in the past and contributed to the poor condition of individual reaches or springs. May also occur at springs and waterholes damaged by leaking septics from nearby rural homesteads or where stock concentrate near waters due to local farming practices.	Severely altered and likely to only occur in the region in urban stream reaches. Sites assigned to this rating will typically be affected by a toxicant or other disturbance that significantly limits the diversity and abundance of aquatic life present in a stream. Past work focused on current and disused mines in the region, failed to show any evidence of significant sediment or contaminant damage of streams but it is possible that localised reaches or future tailings dam failures could result in major environmental damage. However, given the existing land uses in the Flinders Ranges, this rating is unlikely to occur in the region.

Rating	Excellent	Very good	Good	Fair	Poor	Very poor
Biological assemblages	Native assemblages of plants and animals, as naturally occurs for the landscape. Typically native gum tree overstorey with range of native understorey plants, including different age classes but no introduced species. More saline landscapes may lack gum trees and often comprise paperbarks or acacia overstorey species. Aquatic macroinvertebrate assemblages usually comprise some flow dependent species and non-insect groups, and a wide range of insect species. No obvious symptoms of stress or presence of any introduced aquatic species. Include a range of short- and long-lived life-history strategies, and wide range of traits which confer local ecosystem resilience to disturbance. More permanent habitats likely	Least disturbed with high proportion of natural features. Water likely to be naturally fresh (salinity <3,000 mg/L) apart from the Willochra catchment and some low-lying streams along the eastern side of Lake Eyre that are possibly naturally saline. Streams are also typically well oxygenated and show no evidence of significant eutrophication effects (eg large algal or plant growths, blackened sediments due to organic enrichment).	Good richness; generalist assemblage that includes at least some non-insect species for the permanent springs and creeks but more ephemeral habitats may only support aerially dispersed insects such as beetles, waterbugs and dipterans; emerging symptoms of stress in relation to nutrient enrichment evident due to the dominance by organic feeders; vegetation is slightly altered from the natural assemblage expected for the landscape, comprising predominantly native trees with a few weeds and introduced species present; extent of the well-vegetated bank cover typically >50%.	Impaired assemblages; generalists and tolerant taxa dominate numbers which usually includes some very abundant taxa; more sensitive and rare taxa, if present, only occur in very low numbers; absence of some taxa expected for the available habitats present; vegetation showing obvious change from natural assemblages in the landscape, comprising at least some trees present in or near the riparian zone that is dominated by introduced plants; extent of the moderately well-vegetated bank cover typically <50%.	Degraded assemblages; tolerant and generalist insect taxa dominate but numbers usually reduced, although 1–2 generalist taxa may be present in high abundances; only 1–2 rare or non-insect species present in low abundances or absent; often few or only 1–2 scattered trees occur as small patches over an understorey dominated by introduced plants; extent of the poorly bank vegetative cover typically <25% cover.	Severely degraded assemblages with few taxa and generally low abundances; may have large numbers of 1–2 tolerant taxa such as oligochaetes, mosquito larvae or midges (eg *Chironomus, Procladius* and *Tanytarsus*); vegetation typically expected to comprise introduced species with little to no remnant native vegetation.

Rating	Excellent	Very good	Good	Fair	Poor	Very poor
	to provide a significant refuge but more ephemeral and naturally saline waters will typically be dominated by a range of generalist insects. Abundances of all aquatic species generally low.					
Water chemistry conditions	As naturally occurs; no human contaminants present, and stock or pest species elsewhere in the catchment not impacting on the local water quality (eg nutrients, hormones).	Near natural habitat and flow regimes; mostly well- vegetated catchments with few dams present; range of sediment types present and not always anaerobic.	Largely unremarkable water quality but with at least some nutrients present at higher than expected concentrations, coupled with at least one plant indicator showing emerging signs of enrichment effects (eg either chlorophyll a >10 ug/L, macrophyte extent >35% cover and/or filamentous algae >10% cover) but site not overwhelmed.	Fair water quality with generally saturated dissolved oxygen (when sampled during the day); nutrients present at high concentrations and corresponding high levels of algal and plant growths (eg chlorophyll a >10 ug/L, macrophyte extent >35% cover and/or filamentous algae >10% cover) evident on occasions.	Poor water quality with generally saturated dissolved oxygen (when sampled during the day), nutrients present at very high concentrations and high plant productivity evident throughout the site (eg chlorophyll a >>10 ug/L, macrophyte extent >35% cover and filamentous algae >10% cover most of the time).	Very poor water quality with at least one parameter at a toxicant concentration that limits aquatic diversity; often very low dissolved oxygen and may be saline and enriched in nutrients but algal and plant growth limited.
Physical habitat and flow patterns	Natural habitat and flow patterns; no dams or abstractions present; range of sediment types typically present and not always anaerobic.		Good habitat structure and flow patterns; extent of dam development has not caused an obvious loss of riffle habitats; range of sediment types present and not always anaerobic.	Fair habitat structure and flow patterns; many small dams may be present in catchment; anaerobic fine sediments usually present, except for coarse sandy sediments or when large algal growths oxygenate sediments.	Poor habitat structure and flow patterns; may have many dams present in the catchment; anaerobic fine sediments usually present except when large algal growths are present and aerate the sediments.	Severe modifications to physical habitat and flow patterns; may have many dams present in the catchment; generally cleared agricultural or urban sites; anaerobic fine sediments often dominate.

Table 2 Conceptual model describing the general biological responses to the human disturbance gradient in the Lake Eyre Basin

Rating	Excellent	Very good	Good	Fair	Poor	Very poor
Stressor description	As naturally occurs with native vegetation and no pest or introduced species present. Given the historical cattle stocking practices in region from the 1800s–mid-1900s, ongoing damage caused by pest species (eg camels, pigs, rabbits, mosquitofish and goldfish in some catchments), occasional grazing of waterholes by cattle and presence of weeds across much of the arid landscape. **This rating may no longer exist in the region.**	Least impacted streams with largely natural vegetation communities, such as occurs surrounding the permanent and semi-permanent waterholes on Cooper and Diamantina creeks. Very few introduced species present, habitat structure unaltered by human activities and little evidence of nutrient enrichment or riparian disturbance. May also apply to more ephemeral waterholes and sites that lack any recent indications of stock damage or nutrient enrichment effects.	Slightly modified and likely to be showing initial signs of enrichment and some modification of natural habitat features. Likely to occur in streams or waterholes with large areas of natural vegetation remaining. Generally only applies for well-vegetated, permanent or near permanent freshwater habitats but may also include more ephemeral waters with only minor habitat changes and evidence of slight addition of nutrient from the surrounding land uses.	Moderate changes to native vegetation and habitats but retains major natural features present in watercourses from the region. Some localised nutrient enrichment likely to occur, in addition to upstream sources, due to the extent of stock accessing the site.	Substantially modified and likely to retain only limited areas of native vegetation and show evidence of clearly altered habitats. Stock grazing damage to riparian habitats likely to be widespread and evidence of large amounts of nutrients being added to sites from local sources. May occur near urban centres or major roads, areas where historical damage to waterholes may have occurred in the past and contributed to the poor condition of individual waterholes. May also occur at waterholes damaged by leaking septics from nearby rural homesteads or where stock concentrate near waters due to local farming practices.	Severely altered and likely to only occur in the region in urban stream reaches. Sites assigned to this rating will typically be affected by a toxicant or other disturbance that significantly limits the diversity and abundance of aquatic life present in a stream. Given the land uses in the Lower Eyre Basin, **this rating is not likely to occur in the region.**

Rating	Excellent	Very good	Good	Fair	Poor	Very poor
Biological assemblages	Native assemblages of plants and animals, as naturally occurs for the landscape. Typically native gum tree overstorey with range of native understorey plants, including different age classes but no introduced species. More saline landscapes may lack gum trees and often comprise paperbarks or acacia overstorey species. Aquatic macroinvertebrate assemblages usually comprise some riverine species and non-insect groups, and a wide range of insect species. No obvious symptoms of stress or presence of any introduced aquatic species. Include a range of short- and long-lived life-history strategies, and wide range of traits which confer local ecosystem resilience to disturbance. More permanent habitats	Least disturbed assemblages. Vegetation largely native trees over predominantly native understorey but typically includes some introduced species. Aquatic macroinvertebrate assemblages typically with high richness; intolerants and specialist taxa often dominate abundances but more ephemeral habitats include rich insect fauna; may include some introduced species present in low abundances.	Good richness; generalist assemblage that includes at least some non-insect species for the permanent waterholes but more ephemeral habitats may only support aerially dispersed insects such as beetles, waterbugs and dipterans; emerging symptoms of stress in relation to nutrient enrichment evident due to the dominance by organic feeders; vegetation is slightly altered from the natural assemblage expected for the landscape, comprising predominantly native trees with a few weeds and introduced species present; extent of the well vegetated bank cover typically >50%.	Impaired assemblages; generalists and tolerant taxa dominate numbers which usually includes some very abundant taxa; more sensitive and rare taxa, if present, only occur in very low numbers; absence of some taxa expected for the available habitats present; vegetation showing obvious change from natural assemblages in the landscape, comprising at least some trees present in or near the riparian zone that is dominated by introduced plants; extent of the moderately well vegetated bank cover typically <50%.	Degraded assemblages; tolerant and generalist insect taxa dominate but numbers usually reduced, although 1–2 generalist taxa may be present in high abundances; only 1–2 rare or non-insect species present in low abundances or absent; often few or only 1–2 scattered trees occur as small patches over an understorey dominated by introduced plants; extent of the poorly bank vegetative cover typically <25% cover.	Severely degraded assemblages with few taxa and generally low abundances; may have large numbers of 1–2 tolerant taxa such as oligochaetes, mosquito larvae or midges (eg *Chironomus, Procladius* and *Tanytarsus)*; vegetation typically expected to comprise introduced species with little to no remnant native vegetation.

Rating	Excellent	Very good	Good	Fair	Poor	Very poor
	likely to provide a significant refuge but more ephemeral and naturally saline waters will typically be dominated by a range of generalist insects. Abundances of all aquatic species generally low.					
Water chemistry conditions	As naturally occurs; no human contaminants present and stock or pest species elsewhere in the catchment not impacting on the local water quality (eg nutrients, hormones). Freshwater streams likely to be naturally very turbid but more saline waters will be clear and coloured.	Least disturbed with high proportion of natural features. Water likely to be naturally turbid and well oxygenated, and show no evidence of significant eutrophication effects (eg large algal or plant growths, blackened sediments due to organic enrichment).	Largely unremarkable water quality but with at least some nutrients present at higher than expected concentrations, coupled with at least one plant indicator showing emerging signs of enrichment effects (eg either chlorophyll *a* >10 ug/L, macrophyte extent >35% cover and/or filamentous algae >10% cover) but site not overwhelmed.	Fair water quality with generally saturated dissolved oxygen (when sampled during the day), nutrients present at high concentrations and corresponding high levels of algal and plant growths (eg chlorophyll a >10 ug/L, macrophyte extent >35% cover and/or filamentous algae >10% cover) evident on occasions.	Poor water quality with generally saturated dissolved oxygen (when sampled during the day), nutrients present at very high concentrations and high plant productivity evident throughout the site (eg chlorophyll a >>10 ug/L, macrophyte extent >35% cover and filamentous algae >10% cover most of the time).	Very poor water quality with at least one parameter at a toxicant concentration that limits aquatic diversity; often very low dissolved oxygen and may be saline and enriched in nutrients but algal and plant growth limited.

Rating	Excellent	Very good	Good	Fair	Poor	Very poor
Physical habitat and flow patterns	Natural habitat and flow patterns; no dams or abstractions present; range of fine sediment types typically present and not always anaerobic.	Near natural habitat and flow regimes; mostly well vegetated catchments with few dams present; range of fine sediment types present and not always anaerobic.	Good habitat structure and flow patterns; many small dams may be present in the catchment (highlands in Queensland); range of fine sediment types present and not always anaerobic.	Fair habitat structure and flow patterns; many small dams may be present in the catchment (highlands in Queensland); anaerobic fine sediments usually present, except for coarse sandy sediments or when large algal growths oxygenate the sediments.	Poor habitat structure and flow patterns; may have many dams present in the catchment (Queensland); anaerobic fine sediments usually present except when large algal growths are present and aerate the sediments.	Severe modifications to physical habitat and flow patterns; may have many dams present in the catchment (Queensland); generally cleared agricultural or urban sites; anaerobic fine sediments often dominate.

Table 3 List of biota expected to occur for each rating in the Flinders Ranges in autumn and spring 2017

Note that streams in an excellent condition probably no longer occur in the region and would be expected to support some sensitive and rare species, similar to sites in Very Good condition, but have no introduced species present. Similarly, streams in Very Poor condition would not be expected to occur due to the absence of large cropping or irrigated agricultural disturbance or urban centres; although may occur if a major contaminant spill occurred from a tailings dam from a mine or accident involving a tanker. Very Poor sites would be expected to only include a few tolerant species and have water quality too poor to support fish.

Some rare and sensitive species collected in earlier years were not detected in 2012 or 2017, including stoneflies (*Dinotoperla evansi, Riekoperla naso* and *Leptoperla tasmanica* from around Mt Remarkable) and selected caddisflies (eg *Orphninotrichia* and *Apsilochorema*). Flinders Purple-spotted Gudgeon and hardyhead fish were not recorded in 2017. Other species noted in the taxa list for Flinders Ranges streams in 2012 missing in 2017 included the mite family Hygrobatidae**,** mollusc *Pygmanisus*, beetles *Necterosoma regulare* and *Sperchus*, dipteran family Dixidae and chironomids *Harnischia* and *Rheotanytarsus,* and the caddisflies *Lectrides varians* and *Oecetis.*

Rating	Very Good	Good	Fair	Poor
Attribute 1 – Rare and/or regionally endemic	**Acarina** several families may be present in low numbers (including *Limnesiidae, Unionicolidae, Pionidae, Oxidae*); **Mollusca** *Isidorella*; **Crustacea** *Melitidae*	**Acarina** several families may be present in low numbers (including *Limnesiidae, Unionicolidae, Pionidae, Oxidae*); **Mollusca** *Isidorella*; **Crustacea** *Melitidae*	**Acarina** more than one family may be present (including *Limnesiidae, Unionicolidae, Pionidae, Oxidae*); **Mollusca** *Isidorella*; **Crustacea** *Melitidae*	None present
Attribute 2 – Sensitive, rare or vulnerable specialist taxa with narrow environmental requirements	Wide range of beetles present in low numbers, including some rarely collected species (eg Anacaena (formerly *Paranacaena*), *Necterosoma dispar, Hyphydrus)*; several flow-dependent species may be present, sometimes in large numbers including the beetle *Platynectes,* biting midge *Forcipomyia*, blackfly *Simulium ornatipes*, fly family Dolichopodidae, and caddisfly *Cheumatopsyche*); **Ephemeroptera** *Thraulophlebia inconspicua* (southern region, freshwater streams only), *Offadens congruens*	Wide range of beetles present in low to moderate numbers, including some rarely collected species eg Anacaena (formerly *Paranacaena*), *Necterosoma dispar, Hyphydrus*; several flow-dependent species may be present in generally low to moderate numbers (including the beetle *Platynectes,* biting midge *Forcipomyia*, blackfly *Simulium ornatipes*, fly family Dolichopodidae, and caddisfly *Cheumatopsyche*); **Ephemeroptera** *Thraulophlebia inconspicua* (southern region, freshwater streams only), *Offadens congruens*	Wide range of beetles present, including some rarely collected species eg Anacaena (formerly *Paranacaena*), *Necterosoma dispar, Hyphydrus*; several flow dependent species may be present (including the beetle *Platynectes,* biting midge *Forcipomyia*, blackfly *Simulium ornatipes*, fly family Dolichopodidae, and caddisfly *Cheumatopsyche*); **Ephemeroptera** *Thraulophlebia inconspicua* (southern region, freshwater streams only)	Saline tolerant beetles with limited distribution in region may be present (eg *Necterosoma penicillatus, Limnoxenus zealandicus*); and at least one flow-dependent species may be present in low numbers (eg *Simulium ornatipes*)

Rating	Very Good	Good	Fair	Poor
Attribute 3 – Sensitive, ubiquitous taxa	**Ephemeroptera** *Cloeon* and (often in large numbers), *Tasmanocoenis tillyardi*	**Ephemeroptera** *Cloeon* and *Tasmanocoenis* (indicator permanent, freshwater with salinity <3,000 mg/L)	**Ephemeroptera** *Cloeon* and *Tasmanocoenis* (indicator permanent, freshwater with salinity <3,000 mg/L)	None present (too salty, lacks coarse sediments or too ephemeral)
Attribute 4 – Opportunistic or generalist taxa	**Mollusca** several types of non-operculate molluscs (eg *Ferrissia, Glyptophysa, Bullastra (formerly Austropeplea*) from permanent springs; **Diptera** wide range families present; **Trichoptera** several genera including *Hellyethira*, *Hydroptila*, *Ecnomus* often present at same sites	**Mollusca** several types of non-operculate molluscs eg *Ferrissia, Glyptophysa, Bullastra (formerly Austropeplea*) from permanent springs; **Diptera** wide range families present; **Trichoptera** several genera including *Hellyethira*, *Hydroptila*, *Ecnomus* often present at same sites	**Mollusca** several types of non-operculate molluscs eg *Ferrissia, Glyptophysa, Bullastra (formerly Austropeplea*) from permanent springs; **Diptera** few families present often in large numbers; **Trichoptera** *Ecnomus* (often lowland streams)	**Mollusca** none present; **Diptera** Few families present, occasionally in large numbers; **Coleoptera** Few genera typically present, sometimes present in large numbers
Attribute 5 – Tolerant taxa	**Turbellaria; Crustacea** *Austrochiltonia* (few at fresh sites, large numbers at saline sites), *Cherax destructor;* **Coleoptera** Scirtidae (often large numbers at upwelling zones), low numbers more saline tolerant beetles at freshwater sites such as *Limnoxenus zealandicus, Laccobius zietzi, Necterosoma penicillatus*; **Hemiptera** often several genera present including *Micronecta, Agraptocorixa, Anisops, Microvelia;* **Diptera** Stratiomyidae, Tabanidae; Culicidae *Anopheles;* Ceratopogonidae (eg *Dasyhelea*); Chironomidae (*Procladius, Paramerina, Cricotopus, Tanytarsus, Chironomus*); **Odonata**	**Turbellaria; Crustacea** *Austrochiltonia* (few at fresh sites, large numbers at saline sites), *Cherax destructor;* **Coleoptera** Scirtidae (often large numbers at upwelling zones), low numbers more saline tolerant beetles at freshwater sites such as *Limnoxenus zealandicus, Laccobius zietzi, Necterosoma penicillatus*; **Hemiptera** often several genera present including *Micronecta, Agraptocorixa, Anisops, Microvelia;* **Diptera** Stratiomyidae, Tabanidae; Culicidae *Anopheles;* Ceratopogonidae (eg *Dasyhelea*); Chironomidae (*Procladius, Paramerina, Cricotopus, Tanytarsus, Chironomus*); **Odonata**	**Turbellaria; Crustacea** *Austrochiltonia* (few at fresh sites, large numbers at saline sites), *Cherax destructor;* **Coleoptera** Scirtidae (often large numbers at upwelling zones), low numbers more saline tolerant beetles at freshwater sites such as *Limnoxenus zealandicus, Laccobius zietzi, Necterosoma penicillatus,* **Hemiptera** *Micronecta, Agraptocorixa, Anisops;* **Diptera** Stratiomyidae, Tabanidae, Culicidae *Anopheles;* Ceratopogonidae (large numbers at saline sites with large algal growths); Chironomidae (*Procladius, Paramerina, Cricotopus, Tanytarsus*	**Turbellaria; Mites** Arrenuridae and Unionicolidae (Koenikea);**Crustacea** *Austrochiltonia* (few at fresh sites, large numbers at saline sites), *Cherax destructor;* **Coleoptera** *Limnoxenus zealandicus, Laccobius zietzi, Necterosoma penicillatus,* **Hemiptera** *Micronecta, Agraptocorixa, Anisops;* **Diptera** Stratiomyidae; Ephydridae (saline waters), Culicidae *Anopheles;* Ceratopogonidae (large numbers at saline sites with large algal growths); Chironomidae (*Procladius, Tanytarsus, Chironomus*); **Odonata** *Hemianax papuensis,*

Rating	Very Good	Good	Fair	Poor
	Hemianax papuensis, Diplacodes, Orthetrum, Hemicordulia tau; **Trichoptera** *Triplectides australis*	*Hemianax papuensis, Diplacodes, Orthetrum, Hemicordulia tau;* **Trichoptera** *Triplectides australis*	*Chironomus*); **Odonata** *Hemianax papuensis, Diplacodes, Orthetrum, Hemicordulia tau;* **Trichoptera** *Triplectides australis*	*Hemicordulia tau;* **Trichoptera** *Triplectides australis*
Attribute 6. Non-endemic or introduced taxa	**Fish** None present	**Fish** Gambusia (low numbers). Note also that the yabby may not naturally occur in the region but has been included in the table above as a tolerant taxon	**Fish** Gambusia (possibly many). Note also that the yabby may not naturally occur in the region but has been included in the table above as a tolerant taxon	**Fish** Gambusia (possibly many). Note also that the yabby may not naturally occur in the region but has been included in the table above as a tolerant taxon

Table 4 List of biota expected to occur for each rating in the eastern side of Lake Eyre Basin in autumn 2017

Note that streams in an Excellent condition probably no longer occur in the region and would be expected to support some sensitive and rare species, similar to sites in Very Good condition, but have no introduced species present. Similarly, streams in Very Poor condition would not be expected to occur due to the absence of large cropping or irrigated agricultural disturbance or urban centres; although may occur if a major contaminant spill occurred from a tailings dam from a mine or accident involving a tanker. Very Poor sites would be expected to only include a few tolerant species and have water quality too poor to support fish. Also note that the region lacks any stoneflies and no flow-dependent species were recorded due to the lack of permanent, flowing water habitats and ephemeral nature of many of the waterholes that typically occur in the Lower Eyre Basin.

Taxa not seen in 2017 from the Eastern Lower Eyre Basin but recorded previously in 2012 included the mites *Limnesia* and Arrenuridae (ephemeral or saline sites); mollusc *Ferrissia;* hemipteran (waterbugs) *Agraptocorixa, Enithares* and *Sigara;* and caddisflies *Ecnomus* and *Cheumatopsyche.*

Rating	Very Good	Good	Fair	Poor
Attribute 1 – Rare and/or regionally endemic	**Acarina** *Unionicola*; **Mollusca** *Centrapala, Thiaridae*; **Diptera** *Coelopynia pruinosa, Harnischia; Alluaudomyia*; **Ephemeroptera** *Caenidae (Wundacaenis)*; **Odonata** *Austrogomphus*	**Acarina** *Unionicola*; **Mollusca** *Centrapala, Thiaridae*; **Diptera** *Coelopynia pruinosa, Harnischia; Alluaudomyia*; **Ephemeroptera** *Caenidae (Wundacaenis)*; **Odonata** *Austrogomphus*	**Acarina** *Unionicola, Arrenuridae (ephemeral sites)*; **Mollusca** *Centrapala, Thiaridae*; **Diptera** *Coelopynia pruinosa, Harnischia*	None present
Attribute 2 – Sensitive, rare or vulnerable specialist taxa with narrow environmental requirement	None present	None present	None present	None present
Attribute 3 – Sensitive, ubiquitous taxa	**Ephemeroptera** *Cloeon* (often in large numbers), *Tasmanocoenis*; both taxa indicators of permanent, freshwater habitats in the region	**Ephemeroptera** *Cloeon* and *Tasmanocoenis*; both taxa indicators of permanent, freshwater habitats in the region	**Ephemeroptera** *Cloeon* and *Tasmanocoenis*; both taxa indicators of permanent, freshwater habitats in the region	**Ephemeroptera** *Cloeon* and *Tasmanocoenis*, if present, in very low numbers
Attribute 4 – Opportunistic or generalist taxa	**Mollusca** *Glyptophysa, Corbicula,* Hyriidae *(Velesunio)*; **Crustacea** *Macrobrachium*; **Coleoptera** typically more than 5 genera; **Diptera** rich diversity of Chironomidae (3 subfamilies	**Mollusca** *Glyptophysa, Corbicula,* Hyriidae *(Velesunio)*; **Crustacea** *Macrobrachium*; **Coleoptera** typically at least 3–5 genera; **Diptera** Chironomidae (usually at least 2 subfamilies	**Mollusca** *Glyptophysa, Corbicula,* Hyriidae *(Velesunio)*; **Crustacea** *Macrobrachium*; **Coleoptera** typically at least 2 or 3 genera; **Diptera** Chironomidae (usually at least 2 subfamilies	**Mollusca** *Glyptophysa, Corbicula*; **Crustacea** *Macrobrachium*; **Coleoptera** typically less than 2 genera; **Diptera** Chironomidae (often 2 subfamilies present and include

Rating	Very Good	Good	Fair	Poor
	typically present and include more than 5 genera); **Odonata** Coenagrionidae, Gomphidae; **Trichoptera** *Hellyethira, Triplectides australis*	present and include more than 5 genera); **Odonata** Coenagrionidae, Gomphidae; **Trichoptera** *Hellyethira, Triplectides australis*	present and include more than 3 genera); **Odonata** Coenagrionidae, Gomphidae; **Trichoptera** *Hellyethira, Triplectides australis*	less than 3 genera); **Odonata** Coenagrionidae; **Trichoptera** *Triplectides australis*
Attribute 5 – Tolerant taxa	**Annelida** *Glossiphonidae,* oligochaeta; **Acarina** Oribatidae; **Crustacea** *Cherax;* **Diptera** Culicidae *Anopheles*, *Culex*; Ceratopogonidae; **Hemiptera** *Micronecta; Anisops, Microvelia;* **Zooplankton** copepods and cladocerans abundant and typically in 1000s	**Annelida** *Glossiphonidae,* oligochaeta; **Acarina** Oribatidae; **Crustacea** *Cherax;* **Diptera** Culicidae *Anopheles*, *Culex,* Ceratopogonidae; **Hemiptera** *Micronecta; Anisops, Microvelia*; **Zooplankton** copepods, cladocerans and ostracods in large numbers	**Annelida** *Glossiphonidae,* oligochaeta; **Acarina** Oribatidae; **Crustacea** *Cherax;* **Diptera** Culicidae *Anopheles*, *Culex,* Ceratopogonidae; Syrphidae *Eristalis;* **Hemiptera** *Micronecta; Anisops, Microvelia*; **Zooplankton** copepods, cladocerans and ostracods in large numbers	**Annelida** *Glossiphonidae,* oligochaeta; **Acarina** Oribatidae; **Diptera** Culicidae *Anopheles*, *Culex,* Ceratopogonidae; Syrphidae *Eristalis;* **Hemiptera** *Micronecta; Anisops, Microvelia*; **Zooplankton** typically limited to variable numbers of ostracods in more ephemeral, saline sites
Attribute 6 – Non-endemic or introduced taxa	**Fish** Gambusia, Goldfish and Sleepy Cod	**Fish** Gambusia, Goldfish and Sleepy Cod	**Fish** Gambusia, Goldfish and Sleepy Cod	**Fish** Gambusia, Goldfish and Sleepy Cod

Table 5 List of biota expected to occur for each rating in the Western side of Lake Eyre Basin in autumn 2017

Note that streams in an Excellent condition probably no longer occur in the region and would be expected to support some sensitive and rare species, similar to sites in Very Good condition, but have no introduced species present. Similarly, streams in Very Poor condition would not be expected to occur due to the absence of large cropping or irrigated agricultural disturbance or urban centres; although may occur if a major contaminant spill occurred from a tailings dam from a mine or accident involving a tanker. Very Poor sites would be expected to only include a few tolerant species and have water quality too poor to support fish. Also note that the region lacks any stoneflies and flow-dependent species due to the lack of permanent, flowing water habitats and ephemeral nature of many of the waterholes that occur in the Lower Eyre Basin.

Taxa not seen 2017 but recorded in 2012 included the following: Turbellaria, mites *Limnesia* and *Eylais*; crustacean *Conchostraca;* Coleoptera *Dineutus*; dipteran *Paraborniella;* hemipteran (waterbug) *Agraptocorixa;* odonate damselfly family Coenagrionidae, and caddisfly *Lectrides.*

Rating	Very Good	Good	Fair	Poor
Attribute 1 – Rare and/or regionally endemic	**Acarina** *Unionicola*; **Diptera** *Coelopynia pruinosa, Harnischia*	**Acarina** *Unionicola*; **Diptera** *Coelopynia pruinosa, Harnischia*	**Acarina** *Unionicola*; **Diptera** *Coelopynia pruinosa, Harnischia*	None present
Attribute 2 – Sensitive, rare or vulnerable specialist taxa with narrow environmental requirements	Regionally rare freshwater species include: **Hydrozoa** *Hydra*; **Diptera** *Larsia, Nanocladius*; **Trichoptera** *Oecetis*	Regionally rare freshwater species include: **Hydrozoa** *Hydra*; **Diptera** *Larsia, Nanocladius*; **Trichoptera** *Oecetis*	Regionally rare freshwater species include: **Hydrozoa** *Hydra*; **Diptera** *Larsia, Nanocladius*; **Trichoptera** *Oecetis*	None expected to be present due to combined effects of gross nutrient enrichment and salinization
Attribute 3 – Sensitive, ubiquitous taxa	**Ephemeroptera** *Cloeon* (often in large numbers), *Tasmanocoenis*; both taxa indicators of permanent, freshwater habitats in the region	**Ephemeroptera** *Cloeon and Tasmanocoenis*; both taxa indicators of permanent, freshwater habitats in the region	**Ephemeroptera** *Cloeon and Tasmanocoenis*; both taxa indicators of permanent, freshwater habitats in the region	None likely to be present
Attribute 4 – Opportunistic or generalist taxa	**Mollusca** *Ferrissia, Glyptophysa, Hyriidae (Velesunio*); **Decapoda** *Macrobrachium, Cherax*; **Coleoptera** typically more than 5 dytiscid genera; **Diptera** rich diversity of *Chironomidae* (3 subfamilies typically present and include more than 7 genera); **Odonata** *Hemicordulia*,	**Mollusca** *Ferrissia, Glyptophysa, Hyriidae (Velesunio)*; **Decapoda** *Macrobrachium, Cherax*; **Coleoptera** typically 3–5 dytiscid genera; **Diptera** *Chironomidae* (usually at least 2 subfamilies present and include more than 5 genera); **Odonata** *Hemicordulia, Diplacodes*;	**Mollusca** *Ferrissia, Glyptophysa, Hyriidae (Velesunio)*; **Decapoda** *Macrobrachium, Cherax*; **Coleoptera** typically 2 or 3 dytiscid genera; **Diptera** *Chironomidae* (usually at least 2 subfamilies present and include more than 3 genera); **Odonata** *Hemicordulia, Diplacodes*;	**Mollusca** *Glyptophysa*; **Decapoda** *Macrobrachium*; **Coleoptera** typically less than 2 genera including *Necterosoma penicillatus* at saline sites; **Diptera** *Chironomidae* (often 2 subfamilies present and include less than 3 genera); **Odonata** *Hemicordulia*;

Rating	Very Good	Good	Fair	Poor
	Diplacodes; **Trichoptera** *Triplectides australis, Ecnomus*	**Trichoptera** *Triplectides australis, Ecnomus*	**Trichoptera** *Triplectides australis, Ecnomus*	**Trichoptera** *Triplectides australis* (not found highly saline sites)
Attribute 5 – Tolerant taxa	**Diptera** Culicidae *Anopheles*, Ceratopogonidae; Chironomidae (*Procladius, Cladotanytarsus, Tanytarsus, Dicrotendipes);* **Hemiptera** *Micronecta, Anisops*; **Zooplankton** copepods and cladocerans abundant and typically in 1000s	**Diptera** Culicidae *Anopheles*, Ceratopogonidae, Chironomidae (*Procladius, Cladotanytarsus, Tanytarsus, Dicrotendipes)*; **Hemiptera** *Micronecta, Anisops*; **Zooplankton** copepods, cladocerans and ostracods in large numbers, typically up to 1000s	**Diptera** Culicidae *Anopheles*, Ceratopogonidae, Chironomidae (*Procladius, Cladotanytarsus, Tanytarsus, Dicrotendipes)*; **Hemiptera** *Micronecta, Anisops*; **Zooplankton** copepods, cladocerans and ostracods in large numbers, typically in 100s to 1000s	**Diptera** Culicidae *Anopheles*, Ceratopogonidae, Chironomidae (*Procladius, Tanytarsus, Dicrotendipes)*; **Hemiptera** *Micronecta,, Anisops*; **Zooplankton** typically limited to variable numbers of ostracods in more ephemeral, saline sites
Attribute 6 – Non-endemic or introduced tax	**Fish** Gambusia, Goldfish	**Fish** Gambusia, Goldfish	**Fish** Gambusia, Goldfish	**Fish** Gambusia, Goldfish

Table 6 Condition ratings given by each panel member and final overall rating for the 37 sites assessed from the Flinders Ranges and Lake Eyre Basin during 2017

Note: Site codes indicate the year sampled.NRM region followed by the site number for that year sampled. Refer to the EPA website for the site map coordinates and the aquatic ecosystem condition regional reports.

[1] denotes the habitats at each site (eg dry sites, or if edge (E) or both edge and riffle (ER) aquatic habitats were present; results for each autumn and spring sampling period were separated by comma, so E, ER means edge was sampled in autumn and both edge and riffle were sampled in spring). NS indicates not sampled in spring for Lake Eyre sites.

Site code	Site name	Habitats[1]	Very Good	Good	Fair	Poor	Very Poor	Final Rating
2017.SAAL01	Italowie Creek, Italowie Gap	E, E	–	1	2	–	–	Fair
2017.SAAL02	Artimore Creek, Nildottie Spring	E, E	–	2	1	–	–	Good
2017.SAAL03	Mount Chambers Creek, Mt Chambers Gorge	E, E	–		3	–	–	Fair
2017.SAAL04	Wilpena Creek, Wilpena Pound	Dry, Dry	–	3		–	–	Good
2017.SAAL05	Paralana Creek, Paralana Hot Springs	ER, ER	–	2	1	–	–	Good
2017.SAAL06	Balcanoona Creek, Weetootla Campground	Dry, Dry	1	2	_	–	–	Good
2017.SAAL07	Baratta Creek, Baratta Springs	E, E	–	–	–	3	–	Poor
2017.SAAL08	Reedy Creek, Reedy Springs	E, E	–	2	1	–	–	Good
2017.SAAL09	Eregunda Creek, Eregunda Spring	ER, ER	1	2	–	–	–	Good
2017.SAAL10	Wirrealpa Creek, Wirrealpa Spring	E, E	–	–	3	–	–	Fair
2017.SAAL11	Arkaroola Creek, Nooldoonooldoona Waterhole	E, E	–	1	2	–	–	Fair
2017.NY12	Kanyaka Creek, Kanyaka Gauge Station	E, E	–	–	3	–	–	Fair
2017.NY13	Spring Creek, near Wilmington	E, E	–	2	1	–	–	Good

Site code	Site name	Habitats[1]	Very Good	Good	Fair	Poor	Very Poor	Final Rating
2017.NY14	Willochra Creek, Partacoona	E, E	–	–	1	2	–	Poor
2017.NY15	Willow Creek, near Willow Waters	Dry, Dry	–	2	1	–	–	Good
2017.SAAL16	Hookina Creek, Mayo Gorge Waterhole	E, E	–	–	–	3	–	Poor
2017.SAAL17	Aroona Creek, downstream from Aroona Dam	E, E	–	–	3	–	–	Fair
2017.SAAL18	Brachina Creek, Brachina Gorge	ER, E	–	3	–	–	–	Good
2017.SAAL19	Tributary of Oratunga Creek, Third Spring	E, E	–	2	1	–	–	Good
2017.SAAL20	Parachilna Creek, Mount Mary	ER, ER	–	3		–	–	Good
2017.NY21	Pekina Creek, downstream from Pekina Reservoir	E, E	–	1	2	–	–	Fair
2017.SAAL22	Bunyeroo Creek, Bunyeroo Gorge	ER, E	–	2	1	–	–	Good
2017.SAAL23	Nilpena Creek, Nilpena	E, E	–	–	3	–	–	Fair
2017.NY24	Willochra Creek, downstream from junction with Castle Springs	E, E	–	–	1	2	–	Poor
2017.SAAL25	Puttapa Creek, Puttapa Springs	E, E	–	3	–	–	–	Good
2017.SAAL26	Macumba Creek, Alguchina Waterhole	E, NS	–	3	–	–	–	Good
2017.SAAL27	Neales Creek, Stewart Waterhole	E, NS	–	3	–	–	–	Good
2017.SAAL28	Lindsay Creek, Eringa Waterhole	E, NS	–	1	2	–	–	Fair
2017.SAAL29	Neales Creek, Hookeys Waterhole	E, NS	–	3	–	–	–	Good

Site code	Site name	Habitats[1]	Very Good	Good	Fair	Poor	Very Poor	Final Rating
2017.SAAL30	Neales Creek, Algebuckina Waterhole	E, NS	–	–	3	–	–	Fair
2017.SAAL31	Peake Creek, Peake Crossing	E, NS	–	–	1	2	–	Poor
2017.SAAL32	Yardaparinna Creek, Macumba Homestead	E, NS	–	2	1	–	–	Good
2017.SAAL33	Diamantina Creek, Pandie Pandie Waterhole	E, NS	–	2	1	–	–	Good
2017.SAAL34	Warburton Creek, Ultoomurra Waterhole	E, NS	–	3	–	–	–	Good
2017.SAAL35	Cooper Creek, Cullyamurra Waterhole	E, NS	–	3	–	–	–	Good
2017.SAAL36	Cooper Creek, Coongie Crossing Waterhole	E, NS	–	3	–	–	–	Good
2017.SAAL37	Diamantina River, Birdsville Gauge Station	E, NS	–	3	–	–	–	Good
2017.SAAL38	Warburton Creek, Cowarie Crossing Waterhole	E, NS	–	1	2	–	–	Fair

Table 7 Water chemistry and chlorophyll summary statistics from sites sampled in 2017

Units: chlorophyll – ug/L
nutrients and dissolved oxygen – mg/L
temp – ºC
conductivity – µS/cm
pH – units

a Autumn 2017 data from Flinders Ranges sites

Parameter	n	mean	std dev	median	25th percentile	75th percentile
Chlorophyll a	22	19.03	28.95	6.69	3.18	14.05
Chlorophyll b	22	2.67	6.52	0.63	0.07	2.31
NOx	22	0.11	0.41	0.01	0.00	0.03
TN	22	1.57	1.40	1.15	0.53	2.51
TP	22	0.13	0.18	0.05	0.03	0.17
TKN	22	1.46	1.41	1.05	0.38	1.81
Water temperature	22	15.28	3.48	14.85	13.13	16.88
Conductivity	22	5,512	10,625	1,790	1,226	4,202
Specific conductivity	22	6,835	13,247	2,156	1,540	5,653
Dissolved oxygen (mg/L)	22	8.52	2.96	8.44	6.93	10.16
DO (%)	22	86.16	29.56	85.10	66.30	104.25
pH	22	8.05	0.37	8.04	7.80	8.28

b Autumn 2017 data from Lake Eyre Basin sites

Parameter	n	mean	standard dev	median	25th percentile	75th percentile
Chlorophyll a	13	28.33	28.37	13.30	9.86	43.40
Chlorophyll b	13	1.41	1.44	0.77	0.46	2.52
NOx	13	0.08	0.15	0.01	0.00	0.11
TN	13	2.37	1.24	1.87	1.20	3.07
TP	13	0.35	0.30	0.24	0.08	0.52
TKN	13	2.28	1.24	1.77	1.18	3.07
Water temperature	12	14.89	2.11	14.65	13.40	16.05
Conductivity	13	4,930	13,521	239	181	1,676
Specific conductivity	13	5,999	16,441	273	221	2,220
Dissolved oxygen (mg/L)	13	9.53	2.23	9.56	8.82	10.20
DO (%)	13	96.68	21.83	98.00	89.00	105.00
pH	13	8.12	0.40	8.01	7.78	8.49

c Spring 2017 data from Flinders Ranges sites

Parameter	n	mean	standard dev	median	25th percentile	75th percentile
Chlorophyll a	22	17.71	33.44	5.89	1.47	19.08
Chlorophyll b	22	2.04	5.02	0.24	0.05	2.10
NOx	22	0.11	0.39	0.01	0.01	0.04
TN	22	1.15	1.72	0.36	0.16	1.24
TP	22	0.04	0.07	0.02	0.01	0.05
TKN	22	1.05	1.72	0.30	0.14	1.12
Water temperature	22	19.84	4.97	19.65	15.45	22.98
Conductivity	22	6,668	10,112	2,532	1,640	4,997
Specific conductivity	22	7,382	11,349	2,576	1,907	5,935
Dissolved oxygen (mg/L)	22	11.59	16.83	7.47	7.00	10.54
DO (%)	22	88.29	38.77	79.75	69.73	102.88
pH	22	8.08	0.34	8.07	7.92	8.34