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Assessing River Condition

There are many programs across Australia that assess river condition – from large-scale national programs such as the National River Health Program and the National Land and Water Resources Audit to small-scale studies undertaken by local government, regional catchment authorities and community based organisations such as Waterwatch.

There is no Australian 'standard' for assessing and reporting river condition. In general, each program reports its chosen indicators within a framework that is designed to address their management concerns. The challenge for regional catchment authorities is to compile the available data in a way that is useful for guiding their own river management.

This brochure has been produced to assist regional catchment authorities assess, interpret and report ecological condition of rivers in their catchments **using information from existing programs.**

Why Assess River Condition?

Good planning is critical for effective and efficient river management. The first step in developing a management plan is to understand the ecological condition of the river and the issues influencing river condition. In many cases you will need to know something of the condition of the surrounding catchment to do this.

River condition is the state of the river – this includes the water, the river bed and banks, the floodplain, the plants and animals that live there and the biological, chemical and physical processes that occur. Some, or all of these things, can be measured in an assessment of river condition.

An assessment of the river's condition will help determine pressures that are likely to be affecting the river. An assessment of river condition also provides the baseline assessment that, when combined with follow up assessments, allows you to answer questions like 'has the ecological condition of the river improved or changed?'

Assessing river condition is a critical first step in management planning. However, regional catchment authorities will recognise that undertaking field monitoring for a broad-scale assessment can sometimes be expensive, time consuming and technically demanding. This does not mean that on-going monitoring programs should not be developed and implemented by regional catchment authorities, but the first step in river management planning should be to consider existing information about the condition of the river. Fortunately, a considerable amount of information about the condition of Australia's rivers has already been collected.

This brochure is designed to help regional catchment authorities access and interpret this existing information to produce an initial assessment of river condition tailored to their management needs. In some areas there will not be sufficient data to provide an adequate assessment. In these cases an initial assessment might simply highlight the gaps that need to be filled to meet your final information needs. This brochure does not contain information on how to measure indicators in the field.

A considerable amount of information about the condition of Australia's river systems has already been collected. *Photo courtesy of the Border Mail.*

The River Murray, a highly regulated river system.

Approaches to river condition assessment

River condition and river health are sometimes used interchangeably. This section discusses the use of the term river health and how it can differ from river condition. One of the key concepts in river health assessment is the reference condition. This section describes the different ways in which reference is defined and warns against confusing it with target condition.

Various frameworks and models have been developed to assess and interpret river condition. This section describes two useful frameworks commonly used in Australia. A knowledge of these frameworks allows you to more effectively interpret information from various programs. This section also describes how conceptual models of the river can be used to improve assessment and understanding of river condition.

River Health

Ecological condition is often referred to as the 'health' of a river, and an assessment of ecological condition is generally described as an assessment of 'river health'. Because ' health' is a value-laden concept, river health means different things to different people. This is unfortunate given its widespread use.

River health is often described as being comparable to human health. Some argue that river health, like human health, combines features of the natural system with the goals and values of the community, to produce an overall assessment of health. Assessment of human health recognises that social judgements play a large role in what is healthy and that over time these judgements can change. If river health is considered in the same way as human health, what a community considers as a healthy river will change as community values change. An identical ecological condition could be described as either healthy or unhealthy depending on the definition used and on the judgment of the person or community doing the valuing.

The appropriate mix of human and ecological values used to define a healthy river is hotly debated. At one end of the spectrum, it is argued that river health should be described solely by ecological criteria. This view argues that a wilderness area is healthy and human disturbance reduces health. The counter argument is that river health should be defined by the river's ability to meet community expectations and uses. In other words, human alteration does not reduce health as long as all of the community's expectations are met. The community's expectations include environmental, recreational and aesthetic as well as production expectations. It also means considering the expectations of future generations – your children and their children.

While there is no right or wrong answer, the different ways that river health has been defined has led to considerable confusion. Therefore, if you use the term river health, it is important that you clearly describe the basis for your definition. When you use information from other assessments, you should be very clear about how 'healthy' is defined. Is their definition the same as yours?

Conversely, river condition is a less subjective term, relying more on ecological concepts and principles and less on social values. For example, programs such as the Sustainable Rivers Audit and the South East Queensland Regional Water Quality Management Strategy consider river condition in purely ecological terms and do not incorporate community values. River condition assessed from these programs needs to be considered along with the socio-economic and cultural values to decide on the community's objectives and targets for river management.

Rivers in good ecological condition support healthy populations of native fish, such as this Trout cod, *Maccullochella macquariensis*. Photo: G. Schmida.

Reference and Target Condition

Reference and target condition are different concepts and should not be confused:

- *Reference condition* provides a benchmark from which you can determine how far, and in what direction, the river's condition has changed,
- *Target condition* represents your management goal.

The target condition may be the same as the reference condition, but it usually won't be. In most cases, target condition is somewhere between current condition and an undisturbed condition. The exact place between undisturbed and current condition will depend on the river condition objectives determined for the river.

Most assessment programs compare current condition against a reference condition to determine river condition. A commonly used reference condition is an undisturbed or 'natural condition'. This is difficult to define and describe. Some programs, such as Victoria's Index of Stream Condition, the Sustainable Rivers Audit and the National Land and Water Resources Audit Assessment of River Condition, define reference as what is thought to have existed in Australia before European settlement. Some argue that this ignores the fact that Aboriginal people actively managed the Australian environment prior to European settlement, and that ecosystems would have changed in the last 200 years even without European settlement.

Describing a river's natural condition is difficult once the river has been modified. One way of describing 'natural' is to compare it with similar rivers which appear to be undisturbed. However, almost all rivers in Australia have been subject to some level of human disturbance. When there are no comparable undisturbed rivers, a combination of historical data, minimally disturbed sites, modelling and professional judgement has been used to describe 'natural'.

Reference can be defined in other ways. For example, the AUSRIVAS protocol (river condition assessment based on macroinvertebrates) uses the best available 'minimally disturbed' condition. The difficulty here is determining how much a site can be disturbed while still being considered 'minimally disturbed'. The NSW Rivers Survey uses the sites assessed as being in the best condition during the program as reference, explicitly recognising that this definition of reference is not the same as the undisturbed condition and can potentially be significantly modified.

When using existing datasets for an assessment you have to be very clear about the definition used for reference condition.

Setting targets for river condition is usually a process undertaken by the regional catchment authority in consultation with the community and government. It is also likely that there will be existing State and national targets and legislative objectives that the regional authority will need to consider in this task. Setting targets is beyond the scope of this brochure. How to set appropriate river condition targets will be a topic for a future brochure in this series.

The Lindsay River, an anabranch of the Murray, provides good habitat for biota. *Photo: B. Bachman.*

The condition of lowland rivers is influenced by the connections between the river channel and wetlands and the condition of the surrounding catchment. Shown here, Ryan's Billabong. *Photo: B. Bachman.*

Assessment Frameworks

Frameworks are used to help choose, interpret and report river condition indicators for an assessment program. The framework provides the context in which the indicators were chosen and reported and it will influence the output of the condition assessment. Often the framework used by a program is inferred rather than made explicit.

Two common frameworks are the Condition-Pressure-Response Framework and the River Ecosystem Framework. They are both scientifically valid, with their own strengths and weaknesses.

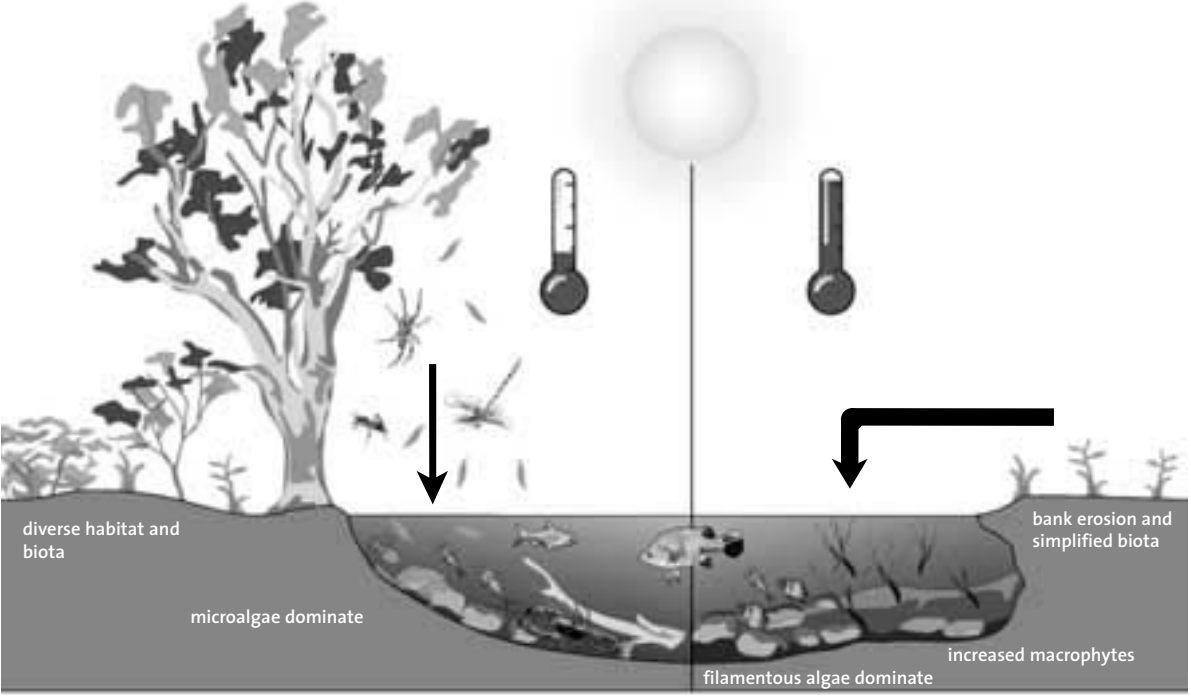
1. The Condition-Pressure-Response (CPR) Framework (sometimes called Pressure-State-Response) is based on the management feedback cycle and is commonly used for State of the Environment reporting. It recognises the pressures that affect the condition of the river and the management responses designed to remove or reduce those pressures. The CPR Framework organises indicators into three broad categories – condition, pressure and response indicators:
   - Condition indicators – these provide information about the condition of the river based on assessments of the status of the environment and ecological function. Examples include surface water quality, macroinvertebrate assessment of river health and extent and condition of wetlands.
   - Pressure indicators – these provide information about pressures that human activities place on the environment. Examples include clearance of riparian vegetation, number of dams and weirs, volume of water diverted and agricultural run-off.
   - Response indicators – these provide information about the responses we make to address environmental issues. Examples include information about the fencing of riparian zones and the provision of fishways and environmental flows.

Macroinvertebrate sampling is used in a variety of assessment programs.

2. The River Ecosystem Framework (sometimes called hierarchical model of river function) presents information in a way that attempts to allow the causes and extent of changes in the river ecosystem to be traced. The River Ecosystem Framework has been used in several programs including the National Land and Water Resources Audit Assessment of River Condition (NL&WRA), Victoria's Index of Stream Condition and the South East Queensland Regional Water Quality Management Strategy (SEQRWQMS).

   The River Ecosystem Framework is based on the premise that catchment-scale features affect the physical and chemical characteristics of the river and that these directly influence the biota. The indicators can be grouped into three broad categories:
   - Catchment-scale features include catchment geology and soil types, land use and the barriers to flow along the river (e.g. dams and weirs) and between the river and the floodplain (e.g. levees).
   - The physical and chemical features of the river include condition of snags, riparian vegetation, the shape of the river channel, water quality (e.g. nutrients, salinity, dissolved oxygen) and hydrology.
   - Biotic features include the composition of communities of fish, macroinvertebrates, algae, riparian vegetation, and waterbirds as well as measures of ecological function. Measures of ecological function include attributes such as the rate of biological production and respiration.

You should decide on the framework within which you will use your data. For some programs this may be decided for you. The choice of framework will depend on your management objectives and the level of information you have about your catchment. The CPR Framework includes management responses within the framework – the River Ecosystem Framework doesn't. If you are unsure of the pressures on your river, the River Ecosystem Framework provides a framework that will help you predict these, including their source and extent.



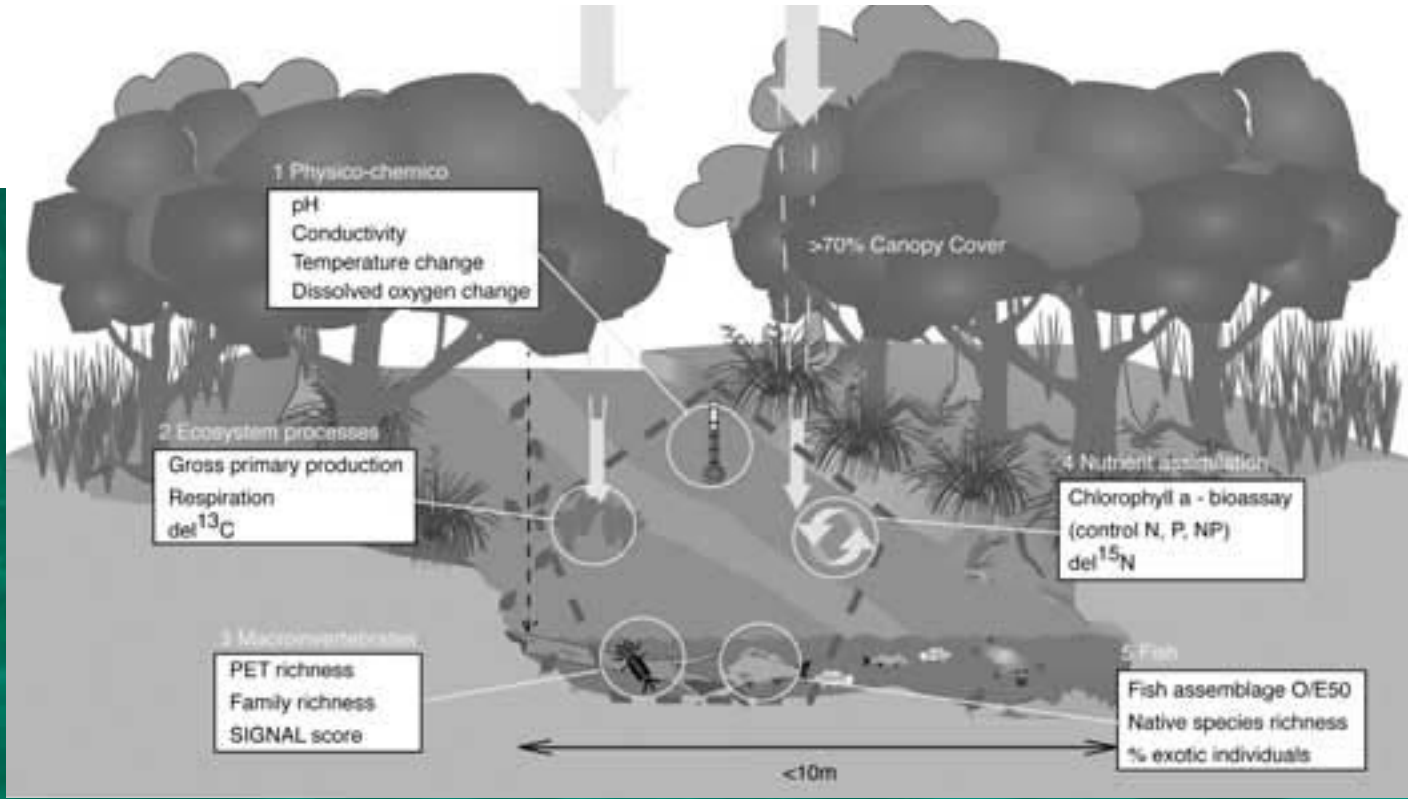
Conceptual model showing the effects of loss of riparian vegetation and catchment degradation on rivers. From the National Land and Water Resources Audit Assessment of River Condition.

Conceptual Models of River Function

Several assessment programs have used conceptual models to show what healthy and unhealthy rivers look like. Conceptual models are used to highlight the predicted relationships between the biota and the physical and chemical environment. These models are essentially a pictorial representation of how the river is thought to function. They are usually drawn to describe a natural river and sometimes a degraded river.

Conceptual models can be useful diagnostic tools – they can be drawn to show how the river might respond to human disturbance, such as clearing riparian vegetation. Conceptual models help to target management and monitoring of the river and catchment by helping you identify the critical parts of the river and catchment that are likely to respond to stressors and also management. They can also be used as reporting tools where the conceptual model can be re-drawn to show current condition, highlighting what has changed and what needs to be managed to improve condition.

The South East Queensland Regional Water Quality Management Strategy and the NL&WRA Assessment of River Condition provide good examples of how conceptual models can be effectively used by a regional catchment body. The Framework for the Sustainable Rivers Audit also contains examples of conceptual models for most river types in the Murray-Darling Basin.



The South East Queensland Regional Water Quality Management Strategy has developed five groups of indicators for ecosystem health monitoring of southeast Queensland streams, as shown in this conceptual model.

Compiling data on river condition

In compiling an assessment of river condition you will come across data for many types of indicators and data of variable quality. This section considers the types of indicators and the amount of data needed, and how to compile these for your assessment of ecological condition.

Indicators

Indicators are measurable attributes that provide information about what you are interested in. A good indicator has a strong ability to predict the thing that it is supposed to indicate. When you call something an indicator you should also describe what it indicates; for AUSRIVAS O/E can be an indicator of river condition (see page 8).

Many different indicators have been used in assessments of river condition across Australia. For example, 134 different indicators were used to report condition of inland waters in eight recent State of the Environment reports. The indicators in your river assessment will be constrained by the available data – but should you use all the indicators for which you have data in your assessment?

There are a number of considerations in choosing indicators. You should determine whether the indicators you select provide:

- an assessment that has relevance for management and, if appropriate, for the community; and
- a robust assessment of environmental change resulting from human disturbance.

Macroinvertebrates, such as this mayfly larva, are part of the food web in lowland rivers and can be useful indicators of river condition.

Indicators should only be selected on the basis that you have access to data for that indicator of sufficient quality and quantity so that the output:

- can be confidently interpreted;
- is scientifically credible; and
- is based on a good understanding of how the indicator links to river health.

Often a monitoring program will measure something that is important in its own right, rather than being an indicator of something else. These are sometimes called attributes, to differentiate them from indicators.

Measuring water quality in Paddys River, ACT. *Photo: A. Tatnell.*

Types of Indicator

River condition was traditionally assessed by simply reporting chemical and physical indicators such as nutrient concentrations, temperature and flow. Over the last decade biotic indicators, particularly macroinvertebrates but also fish, waterbirds and algae, have been included in assessments of ecological condition of rivers.

These biotic indicators were generally based on an assessment of what biota was found in the river. For example, the AUSRIVAS Observed/Expected score is based on whether or not the macroinvertebrates you would expect to find if a site were in reference condition are found at the site. Indicators that describe the types and numbers of animals are measures of community pattern or organisation.

Significant effort is now being put into developing direct measures of ecosystem processes to incorporate into assessments of river condition – these include measures of photosynthesis and respiration, fish recruitment and rates of nutrient processing, among others. As more ecological process indicators are developed and tested they will be incorporated into river condition assessments. Recent programs such as South East Queensland Regional Water Quality Management Strategy and the Sustainable Rivers Audit include indicators of ecosystem processes.

Fish are often used as indicators of river condition. Shown here, Crimson-spotted rainbowfish, Melanotaenia fluviatilis. *Photo: B. Gawne*

While it is generally recognised that the biota are the primary indicator of the ecological condition of a river, it is still important to report other environmental variables, such as water quality, hydrology and habitat indicators because:

- assessing biota will tell you about the condition of the plants and animals but it will not tell you why. For example, you may know that the native fish population is in poor condition but how do you address this without knowing the reason why?
- there may be a time-lag between environmental disturbance and biotic response, in which case other indicators can provide an early warning – for example, a reduction in floods on the floodplain could lead to a decline in river redgum forests, but this may take decades to show. Therefore, frequency of floods is a potential indicator of redgum forest condition.
- a response detected by the biotic indicator without any indication from the environmental indicators suggests that there is an important environmental variable not being assessed – for example, there may be an undetected toxicant in the river that may be stressing some of the biota.

Scale of Your Assessment

Before undertaking an assessment you need to decide on two aspects of geographic scale. The geographic extent of the assessment – in other words, how much of the river and its catchment needs to be assessed – and the scale at which the assessment will report: at a single place on the river, the reach (which may be from 100s of metres to 100s of kilometres), or the whole river?

Recording habitat characteristics to assess the condition of the Murrumbidgee River. *Photo: S. Nichols*

The health of floodplain vegetation will influence river condition. Shown here, the River Murray flowing through the Barmah-Millewa Redgum Forest, Victoria. *Photo: D. Eastburn.*

Geographic extent

To understand the condition of a river you should consider how the river fits into the broader landscape. You need to know what is upstream, what is downstream and what is in the surrounding catchment. For example, a major weir downstream of your reach could significantly influence the migration of native fish into the part of the river with which you are concerned, just as upstream water diversions can change the extent of wetland flooding as well as changing the amount and type of habitat within the river. Water quality will be affected by land use in the surrounding catchment.

Unless you are aware of what is going on upstream, downstream and in the surrounding catchment, you will not understand what is happening in the part of the river that you are attempting to manage. Another aspect of considering the geographic scale of your assessment is the significance of your 'patch' in the overall health of the river. Are there no birds in your wetlands because the wetland is in poor condition or is it because the breeding grounds elsewhere are in poor condition?

Reporting scale

The reporting scale should match the management requirements of your assessment. Do you need to know ecological condition at a specific site or is an integrated assessment of condition at the reach scale appropriate? If you are managing a single site or a small stretch of river (such as a local swimming area), then it will be important to assess and report at a similar resolution. Alternatively, if you seek to understand the impacts of broad-scale issues to prioritise works at a river-basin scale, then reach-scale assessment and reporting are appropriate. The assessment and reporting scale will be determined by the purpose for undertaking the assessment.

How Accurate Does the Assessment Need to be?

Before an assessment can be made, data must be collated from existing databases. But how much data is required? Many assessments have been undertaken only to find that too few measurements were collected to enable those undertaking the assessment to draw reliable conclusions, or that much extra effort was used in collating data that did not help with the assessment. To determine how much data you need, you should consider what management decisions hinge on the assessment. How much different from a target does a measurement have to be to trigger a management action? Do you aim to detect trends over time? If so, how big an effect do you want to be able to detect – a change of 10%, 50% or 100% and over what time frame?

There is a trade-off between the amount of data required and increasing the reliability of the assessment.

What are the consequences of not detecting a change in river condition? Shown here, Broken River, Victoria. *Photo: C. Merrick*

Two considerations in determining this trade-off are the accuracy and precision of the data. Accuracy of the data refers to how close the estimate is to the true value, which is largely influenced by the methods used. Precision refers to how close together repeated measurements of the same indicator are. This is influenced by how variable the indicator is that is being measured. For example, in an assessment of bird numbers on a wetland, accuracy refers to how close to the actual number of birds the count is. Precision refers to how close together five repeat counts of the same bird colony would be.

When deciding on the amount of data required for the assessment you need to consider what is an acceptable level of uncertainty, or error. Error in this sense is not the same as a mistake. Error comes about because, for most indicators, we cannot measure an entire site and must use samples from the site to estimate actual values. Therefore you will have to use statistical analysis to interpret your assessment. For example, when you analyse your assessment you may hypothesise 'that the assessed condition is the same as the target condition'. You will then use statistical techniques to test this hypothesis. In testing this hypothesis, you can make one of two types of statistical error:

- You might assess that condition of the river is worse than target condition when in fact it is the same as target condition – i.e. you falsely detected a change; or,
- You might assess that the condition of the river is the same as target when in fact it is worse than target condition – i.e. you failed to detect a change.

You need to consider the management consequences of wrongly assessing river condition. What are the consequences of concluding that the river is in worse condition than it really is? Are these consequences worse than concluding that the river is in good condition when it is actually degraded? If the river is in better condition than your assessment indicates, you may use your limited resources on unnecessary work. On the other hand, if the condition of the river is worse than your assessment indicates, you may not take action until it is too late.

For regional catchment authorities the consequences of failing to detect a change are generally worse than falsely detecting a change. It is almost always much more expensive to repair a damaged ecosystem than it is to protect a vulnerable one – assuming that you can repair a damaged ecosystem!

So how can the possibility of failing to detect a deterioration in river condition be reduced? This can be done by increasing the number of samples, or by deciding to accept an increased risk of falsely detecting a deterioration in river condition. The consequence of doing this is that you will think the condition is worse than it really is more often, but at least you reduce the chance of missing that critical warning! This is an example of taking a 'Precautionary Approach'.

In general, the amount of data required to reduce the chance of an error rises exponentially with the reduction in probability of an error, in other words, to halve the chance of an error you will need four times the amount of data. There are statistical techniques (e.g. Power Analysis) that can be used to describe the trade off between the amount of data and error but they are complex and depend on the indicator and the situation. If this is a critical issue for your assessment you should seek statistical advice.

Electrofishing is one way of assessing fish populations.

Aggregation and Integration

To interpret and report your assessment you will need to decide if and how you will combine indicator data. The process of combining indicator data is called aggregation and integration.

Aggregation

Aggregation refers to how you combine data about the same indicator from different sites to provide a reach or catchment-scale assessment. Perhaps this could be done by simply averaging data from each site. The problem with this is the way sites are distributed across your river system – will a few high scores on small tributaries obscure a poor score for the main river? To overcome this, programs such as the National Land & Water Resources Audit and the Snapshot of the Murray-Darling Basin River Condition weight site data by the cumulative catchment area or amount of river upstream of the site, hence downstream sites have a greater influence on the assessment score than upstream sites.

When using data from existing programs you need to be sure that you understand if and how data have been weighted.

Integration

Integration refers to how you combine different indicators to form an index or indices to provide an overall index of river condition. There are several levels of integration that are commonly used.

Almost all programs integrate similar indicators to form a composite index. For example, the National Land & Water Resources Audit's hydrological disturbance index combines indicators that have been developed to describe the changes in river flows from the present to natural. The hydrology disturbance index combines four indicators: seasonal period, seasonal amplitude, mean annual flow, and the change in the flow duration curve. The SEQRWQMS combines indicators of 'stream metabolism' into one index. The Snapshot of the Murray-Darling River Condition and the NL&WRA Assessment of Stream Condition combine all biotic indicators into a single biotic index and all other indicators into a single physical and chemical index, which they call the 'environmental' index. A few programs integrate all indicators to provide a single index of river condition. This is done, for example, in Victoria's Index of Stream Condition to provide an overall score. However, this program also reports the five sub-indices (water quality, hydrology, aquatic life, physical form and streamside zone) which are combined to produce this overall score independently.

The main argument for integrating indicators and indices to produce a single score is that it is often easier to communicate the assessment of river condition to the community in this way. For example, a river score of 9 out of 10 is obviously better than 5 out of 10 – but it doesn't tell you why. There are several reasons why you should be cautious about integration:

- information is lost during the integration;
- sites with very different types of impairment may end up with the same score; and
- there may be valid statistical and management reasons for not combining indices.

Think of a river condition index like a an index of the stock market. The index value gives you an overall feeling for the 'health' of the system (the stock market in this case) but you would want to look at individual share prices and trends to make an investment (management) decision.

If indicators are combined to produce a single index of river condition the scores of each of the major indices should also be reported, as for example, in the Victorian Index of Stream Condition.

Measuring aquatic primary production, one of the indicators of ecosystem processes. This data could be integrated into an indicator to describe river condition. *Photo: R. Ashdown*

Implementation / Doing the Assessment

This section describes why it is important to consider using existing information as a first step in describing river condition. It also describes the things that you should be aware of before using existing information and datasets. A brief description of various National and State programs and where to find online data is also presented.

Should I Use Existing Data?

Without doubt, regional catchment authorities should look to using existing information on river condition as the first step in developing river and catchment management plans. This does not mean that on-going sampling programs should not be developed and implemented, rather that the first step in a regional catchment authority's assessment program should be to collate and analyse existing information about the condition of the river. In some areas there will not be sufficient data to provide an adequate assessment. In these cases an initial assessment can be done using existing information. This assessment will highlight the gaps that need to be filled to provide an assessment to meet your information needs.

There is a large and growing amount of information about river condition. Much of regional Australia is covered by the

Collecting information about biota on an inundated floodplain, Cooper Creek.

A first step in a regional catchment authority's assessment program should be to collate and analyse existing information about the condition of the river. *Photo: A. Tatnell.*

National Land and Water Resources Audit's Assessment of River Condition and there are many other national, State and regional programs that assess aspects of river condition. Much of the data from these programs can be accessed using the world wide web.

If you cannot get the information you require for your assessment from existing databases you may have to collect your own data on river condition indicators. However, you should not do this until all available information has been considered within your framework and after considering the requirements of your assessment.

Using Existing Data

Before you use data collected by other programs there are several things that you need to know about their datasets. These include knowledge about how the data was collected, the quality of the data, geographic extent of the data, currency (i.e. units etc.), processing history, accuracy and availability of the data. This type of information, (i.e. data about data) is called metadata. Metadata allows you to identify quickly whether a dataset is likely to be useful to you or not. Reputable databases will be supported by metadata. If you use data from a database that is not supported by metadata you cannot have much confidence in your assessment.

Metadata allows you to recognise the limitations of the dataset and whether there is a serious mismatch between your requirements and what assessment the existing dataset can deliver.

Ecological Assessment vs Campaign Monitoring

Caution needs to be taken when using data that have been collected by a monitoring program designed to assess a particular issue or management action. Sometimes called campaign or performance monitoring, this is not the same as monitoring to assess broad-scale ecological condition. Similarly, caution is needed when using data from a compliance monitoring program. Examples of campaign and compliance monitoring are assessing the impact of:

- discharge from a sewage treatment plant;
- an environmental flow; and
- improvements to the riparian zone.

Even though similar indicators may be used, the way the programs are designed is fundamentally different. In campaign monitoring the sampling is deliberately focussed toward investigating an issue. For example, data from a program to monitor discharge from a sewage treatment plant to a river would give a misleading picture of condition if they were the only data included. This is because your assessment would be highly skewed to the place of sewage discharge which most probably does not represent the river as a whole.

Both campaign monitoring and broad-scale ecological assessment are required to effectively manage a river – but they are designed to serve different purposes. Care is needed when incorporating campaign monitoring data into an assessment of river condition to ensure that the data are truly representative of the area being measured.

Determining the ecological effects of an environmental flow will require a specifically designed monitoring program. Shown here, Bendora Dam, ACT.

Major Programs

Across Australia there are many national, State and regional programs that assess aspects of river condition and many will contain potentially valuable information for your assessment. Unfortunately, most of these programs are not ongoing. While they will be valuable for the first assessment many will become outdated unless they are maintained over a reasonable cycle.

When using data from any program, you need to be aware of when the data were collected. Also, different programs recycle the same data, perhaps within different assessment frameworks. For example, data collected for the National River Health Program has been used in State of the Environment Reporting, the Snapshot of the Murray-Darling Basin River Condition and in the National Land and Water Resources Audit. Be careful that you don't end up using the same data, but collated from different programs, several times over!

Table 1 provides an overview of some of the major State and national programs describing the geographic extent, reporting scale and indicators. Most of these programs are supported by internet sites.

There will be other State and regional programs that have collected data useful to your assessment. The challenge is to find this information. Several States have developed web-based retrieval systems for environmental data that help with this. These websites provide the user with location-specific environmental data. Examples of useful internet-based data sources include:

- Victorian Water Resources Data Warehouse (http://www.vicwaterdata.net/)
- NSW Community Access to Natural Resources Information (CANRI) Program (http://www.canri.nsw.gov.au/index.html)
- ACT Water Quality Database (http://www.act.gov.au/Water_Quality/)
- South Australian Environmental Data Inventory (http://www.environment.sa.gov.au/sustainability/er_data.html)

Table 1. State and National Programs

Program	*Geographic extent*	*Reporting scale*	*Index/Indicators*	*Comments*
National Land & Water Resources Audit Assessment of River Condition http://www.nlwra.gov.au/	National	Reach 5-100 km	• Macroinvertebrates • Hydrology • Catchment disturbance • Nutrient and suspended load • Habitat	First assessment in 2002 This program compiles data from other sources
State of the Environment http://www.ea.gov.au/soe/	National, State, Local	Local (reach, wetland etc)	EA considered 56 indicators for further evaluation and refinement	This program compiles data from other sources
National River Health Program http://www.ea.gov.au/water/rivers/nrhp/	National	Habitat within site	• Macroinvertebrates	Provides data to other programs
Index of Stream Condition http://www.nre.vic.gov.au/web/root/Domino/vro/vrosite.nsf/pages/stream_cond_index	Victoria	Reach 10-30 km	• Hydrology • Physical form • Streamside zone • Water quality • Macroinvertebrates	Assessed every 5 years
South East Queensland Regional Water Quality Management Strategy (now called Moreton Bay Waterways Project) http://www.healthywaterways.org/	SE QLD		• Fish • Macroinvertebrates • Nutrients • Stream metabolism • Physical/chemical parameters	Program assesses rivers and coastal areas – only freshwater component indicators listed
Snapshot of the Murray-Darling Basin River Condition http://www.mdbc.gov.au/whatson/snapshot-exec.html	Murray-Darling Basin	Reach 5-100 km	• Biota – fish , macroinvertebrates • Hydrological disturbance • Catchment disturbance • Habitat • Nutrient and suspended load	Compiled from other data sources
Sustainable Rivers Audit http://www.mdbc.gov.au/naturalresources/policies_strategies/projectscreens/sra.html	Murray-Darling Basin	Valley Process Zones 10-100s km	• Biota – fish, macroinvertebrates • Water quality • Hydrology • Habitat	This is currently being trialled in four valleys in the Murray-Darling Basin (Condamine-Balonne, Lachlan, Ovens, Lower Murray)

Table 1. State and National Programs – Continued

Program	*Geographic extent*	*Reporting scale*	*Index/Indicators*	*Comments*
Wildrivers http://www.heritage.gov.au/anlr/code/arc.html	National	Reach 10-100 km	• Catchment characteristics • In-stream characteristics	This program compiles data from other sources using data on human disturbance within catchment and river
Waterwatch http://www.waterwatch.org.au/index.htm	National	Sites of interest	• Habitat • Macroinvertebrates • Water quality	Individual Waterwatch groups determine their own indicators with some State coordination
NSW Rivers Survey	NSW	Reach 10-50 km	• Fish	NSW Rivers Survey used a modified Index of Biotic Integrity which is based on attributes of the fish population
Stressed Rivers Assessment	All NSW rivers	Based on sub-catchments	• Hydrological disturbance • Environmental disturbance	Rapid desktop analysis based on available information
Integrated Monitoring of Environmental Flows http://www.dlwc.nsw.gov.au/care/water/imef/	NSW – regulated rivers	Reach (length not specified)	IMEF based around a series of experimental studies. Data collected includes biota, water quality, habitat , hydrology, riparian vegetation	IMEF is a monitoring program to determine the ecological effects of environmental flow releases – contains data for river condition assessment
PBH Framework http://www.dlwc.nsw.gov.au/care/water/assess_synopsis.html	Some NSW unregulated rivers	Reach 200 m	• Biota (diatoms, macrophytes, riparian vegetation, macroinvertebrates, fish) • Water quality • Water use • Physical habitat	Uses the Multi-Attribute River Assessment (MARA) technique. This program identifies conservation values as well as river health
State of Rivers	Some QLD and NSW catchments	Reach 1-3 km	• Catchment condition • Channel habitat • Aquatic and riparian vegetation • Scenic, conservation and recreational values	
Water Allocation and Management Planning	QLD	Reach 10-180 km	• Geomorphic assessment • Riparian and aquatic vegetation • Macroinvertebrates • Fish • Water quality • Hydrology • Wetlands & floodplains	Approach differs between river basins, though these elements are common.

Communication

River management planning requires that you consider what the broader community wants and values from the river. 'The community' refers to all those who have a stake in the river and includes local communities, government and the broader Australian community. It also includes future generations. For the community to provide meaningful input into the management plan they will need to understand your assessment of river condition and the issues affecting the river. The way your assessment was reached and its results must be clearly communicated.

One way of improving community involvement is to explain the implications of the river condition assessment in terms of the day-to-day lives and expectations of the community. What does your assessment say about the aspects of the river that the community values? To do this you will need to determine what the community values. For example, if the community values swimming and fishing, what are the implications of the assessment on these activities?

Simply reporting the index score of the composition of the 'bug' community may have little meaning to the broader community. The use of canaries to indicate the air quality in coal mines illustrates the point. The mining community was not particularly interested in the health of the canaries, but they did understand that the death of a canary meant that air quality was dangerously poor and they had better leave the mine.

In the same way, the community might not be particularly interested in the fact that several taxa of macroinvertebrates have vanished, but they may be concerned that the river is degrading. For example, a change in the numbers and types of macroinvertebrates may reduce the numbers of native fish in the river because they do not have enough of the right type of food (macroinvertebrates) to eat.

A well communicated assessment of river condition provides the foundation for effective regional planning and management of rivers.

Table 2. Questions to be Considered Before you Undertake an Assessment of River Condition

- Do you need to define reference condition?
- What indicators will you use?
- What is the appropriate geographic scale of your assessment?
- How accurate does your assessment need to be?
- What are the consequences of wrongly assessing river condition?
- How will you aggregate data?
- Will you integrate the data?
- At what scale will you report your assessment?
- Where will you access existing data?
- How good is that data?
- Who is the audience for your assessment?
- How will you communicate the assessment to your audience?

A well communicated assessment of river condition provides the impetus for local action.