Principles and Tools for Protecting Australian Rivers

N. Phillips, J. Bennett and D. Moulton

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The aim of this review is to identify the principles associated with the protection of riverine ecological values, as well as the methods used for the assessment of these values and some of the key instruments that could be used to protect them (ie. protection tools). Such an approach complements existing tools associated with river restoration. This report is aimed at anyone who is interested in the protection of rivers. This includes planners and policy makers, river managers, community groups and individuals. It provides a background for such users to the current thinking on river protection and a guide to obtaining further information. It is not intended as a prescriptive document and hence does not, for example, provide an exhaustive list of legislation from all States. It is intended as a guide to the types of information that could be useful in the consideration of river protection.

As this is a relatively new component of river management, there is limited reference material of direct relevance for use in this document. As such, this document builds largely on work undertaken by Dunn (2000) and the Queensland Environmental Protection Agency (various documents). The document also has direct linkages with a number of recently produced documents, notably Koehn *et al*. (1999) and Rutherfurd *et al*. (1999, 2000). Dunn (2000) provided the first major synthesis of the ways in which ecological values of waterways are identified and protected in Australia. The Queensland Environmental Protection Agency, in conjunction with other research partners, is developing a 'tool-kit' of guidelines for protection of rivers through the Land & Water Australia-funded project "Environmental Planning and Evaluation Guidelines for Rivers and Floodplains", which will provide a conceptual framework for river protection, along with a number of related guidelines which operationalise the conceptual framework. Finally, Koehn *et al*. (1999) developed a planning framework aimed principally at restoring rivers, while the work of Rutherfurd *et al*. (2000) provides a step-by-step guide to river restoration.

This review is divided into three major sections.

Firstly, the major principles associated with the protection of rivers are discussed. These principles define the reasons why we protect rivers. Examples of principles of relevance to the protection of rivers are presented in appendixes, while a synthesis of the ecological outcomes resulting from application of such principles was undertaken to produce a core set of principles for river protection. These principles are that:

- the ecological value of rivers be protected;
- rivers be managed in an ecologically sustainable manner;
- rivers be managed to ensure their benefit to future generations;
- State, national and international agreements that affect river management be reflected in river management strategies;
- the biological, hydrological and geomorphological diversity of rivers be maintained;
- the ecological structure and functioning (ecological integrity) of rivers be maintained;
- natural streamflow characteristics be maintained or mimicked through the provision of water for the environment;
- the longitudinal, lateral and vertical dimensions of rivers be incorporated into river management strategies; and
- the non-substitutable nature of rivers be recognised in river management.

Secondly, the review describes the process and key elements required to develop and implement the protection component of any river management plan. It is not the intention of this document to propose the development of stand-alone river protection plans. Rather this document promotes the use of existing planning mechanisms, with an increased awareness of specific river protection requirements. As such, a river protection plan can be considered as a subset of existing river management plans. There are many examples of planning processes for natural resources and these have the following common stages:

- establishing a vision;
- developing a plan;
- implementing the plan; and
- monitoring and review.

Each of these steps should involve the range of stakeholders that may be affected by any plan element, and include the community and relevant industries, as well as planners. This is also a dynamic process which allows for continuing improvement. The aim should be to use best scientific information and management practices at each step of the process.

This report concentrates largely on the second stage of the planning process—developing a plan. Within this stage, the identification of values and threats, the determination of priorities, and choice of the most effective protection instruments are undertaken. Each of these elements is discussed in detail in the review and summarised below:

1. determining the criteria to use in assessing ecological values—such criteria include diversity, rarity, condition/naturalness, representativeness and special features;
2. deciding on the method of value assessment—the choice of methodology used is dependent on numerous factors such as information available, resources, expertise and the objective of the assessment;
3. setting priorities for management actions (including protection and restoration)—setting priorities generally involves identifying relative values, assessing the threats to these values and identifying the appropriate actions to be taken to maintain the values; and
4. determining the most appropriate tools/instrument(s) for protecting the identified values. Tools which can be used to protect identified values are presented and barriers/constraints to their effective uptake are discussed. Such tools include:
   - legislative instruments;
   - non-legislative instruments such as agreements, policies, strategies, programs and codes of practice;
   - planning instruments;
   - voluntary property-based instruments;
   - financial and other motivational instruments; and
   - voluntary action groups.

Case studies are presented and discussed in relation to how they address each of the elements discussed above.

Finally, a discussion on how this document fits with other documents and processes related to river management is also presented.

Relevant contacts for advice on river protection in each State/Territory are provided, along with a bibliography detailing supporting documentation.

1 Introduction

1.1 Context of this report

The Queensland Environmental Protection Agency (QEPA) has been commissioned by the National Rivers Consortium (NRC) to produce a report which identifies the principles associated with the protection of riverine ecological values, as well as the methods used for the assessment of these values and instruments to protect them (ie. protection tools). As this is a relatively new component of river management, there is limited reference material of direct relevance for use in this document. As such, this report builds on the work undertaken by Dunn (2000) on identifying rivers of high ecological value. Dunn's work provided the first major synthesis of the ways in which ecological values of waterways are identified and protected in Australia. The QEPA, in conjunction with research partners, is also developing a 'tool-kit' of guidelines for protection of rivers through the Land & Water Australia (LWA, formerly LWRRDC)-funded project "Environmental Planning and Evaluation Guidelines for Rivers and Floodplains", which will provide the following guidelines:

- **Ecological Value Guideline for Waterways (Ecological Value Guideline)** describing a method for defining the ecological value of waterways;
- **Planning Guideline for Waterway Protection (Planning Guideline)** on developing protection/ conservation strategies (or plans);
- **Ecological Sustainability Guideline for Waterways (Sustainability Guideline)** to identify the state of knowledge on ecological sustainability of waterways; and
- **Evaluation Guideline for Ecological Assessment (Evaluation Guideline)** for evaluating/assessing ecological sustainability of water resource development plans and projects.

There are also links between the above guidelines and the current report. The Ecological Value Guideline will provide guidance on the assessment process for defining ecological values of waterways. Some of this information is also presented within this report. This report on principles and tools for the protection of rivers provides the basis for defining conservation strategies/plans. The Planning Guideline will build on this report to produce a guideline to assist in the conservation planning process.

1.2 Links to related work

This report also relates to recent work undertaken by Koehn *et al*. (1999), which developed a framework principally for restoring rivers, along with Rutherfurd *et al*.'s (1999, 2000) work which provided a step-by-step guide to river restoration. Both of these reports have also been produced for LWA. This report provides the basis for developing a river protection plan. Such a plan can be linked with the planning processes described by both Koehn *et al*. (1999) and Rutherford *et al*. (2000).

This report is aimed at anyone who is interested in the protection of rivers. This includes planners and policy makers, river managers, and community groups and individuals. It provides a background for such users into the current thinking on river protection and a guide to obtaining further information. It is not intended as a prescriptive document and hence does not, for example, provide an exhaustive list of legislation from all States. It is intended as a guide to the types of information that could be useful in the consideration of river protection.

1.3 Background

The specific protection of rivers is but one action that can be undertaken as part of river management. Other actions include restoration or rehabilitation of degraded areas, planning, policy and regulation, development control (catchment and in-stream), land management, storage operation, water diversion and flow regulation, flood control, in-stream management (eg. provision of environmental flows) and waterways creation, including channel and drainage construction. Boon (2000) suggests that the relationship between rivers and people emphasises the importance of an integrated approach to river management. The protection of the ecological values of a river should be a common consideration in all of the above river management activities. In this way, a conservation ethic that permeates all sectors of society may be achievable.

1.3.1 Definitions

Conservation can be defined as all the processes and actions of looking after a place (ie. managing) so as to retain its natural significance. This always includes protection, maintenance and monitoring (AHC, 1996). The Australian Natural Heritage Charter defines *protection* as "taking care of a place by maintenance and by managing impacts to ensure that natural significance is retained" (AHC, 1996). For the purposes of this document, *maintenance* is defined as the continuous protective care of the biological diversity and geodiversity of a place, and is to be distinguished from repair (AHC, 1996). *Repair* involves restoration, remediation and rehabilitation (AHC, 1996). *Monitoring* means collecting information to detect changes in condition of the natural integrity of a place, with reference to a baseline condition (AHC, 1996). On this basis, *river protection* can be defined as the maintenance of existing ecological values and the management of impacts on these values. *Ecological value* can be considered as the natural significance of ecosystem structures and functions, expressed in terms of their quality, rarity and diversity. Significance can arise from individual biological, physical or chemical features or a combination of features. The term *river* has been left deliberately open. Dunn (2000) uses a definition similar to that used by the World Conservation Monitoring Centre—"a river system is a complex but essentially linear body of water draining under the influence of gravity from elevated areas of land towards sea level". Of course, many Australian rivers contain no surface water for much of the time, so the presence of water itself is not a prerequisite.

1.3.2 Why protect rivers?

Dunn (2000) discusses the conservation status of Australia's rivers and draws on the outcomes of the State of the Environment report (DEST, 1996). Basically our rivers have suffered considerably as a consequence of human occupation and subsequent land clearing, water regulation, impacts on water quality, river engineering, urbanisation and introduced species (DEST, 1996). Widespread degradation is evident in many aquatic environments (eg. Lake and Marchant, 1990). Such degradation includes reduced habitat and water quality, loss or reduction in many native species and introduction of exotic species. In addition, high quality freshwater habitats such as rivers provide services to society from amenity and recreation, to flood control and good raw drinking water. Degraded habitats may be health and safety hazards.

1.3.3 What aspects of rivers do we want to protect?

This report is targeted largely at the protection of ecological values of rivers. Geomorphological and hydrological values are included as part of such values, as they significantly influence the ecological components of river systems. Dunn (2000) surveyed a range of river researchers/managers to determine the key criteria that define the aspects of rivers that should be protected. Dunn (2000) described each of these in detail. A summary of criteria identified by the survey recipients is listed below.

- *Rarity*—what is the relative occurrence of river features?
- *Naturalness*—how much has human occupation affected the river ?
- *Diversity*—what is the range of biological and physical features which define the river?
- *Representativeness*—how well does the river reflect its type?
- *Special features*—are there distinctive features of a river which require specific management?

This report uses these criteria as the basis for defining the ecological value of waterways.

1.3.4 What are some of the complexities of river protection?

Conservation planning and management for rivers is conceptually difficult because:

- rivers are longitudinal systems and also have lateral and vertical components;
- rivers flow through different biomes (from mountain tops to the coast);
- land adjacent to rivers may be under different jurisdictions and ownership;
- rivers cannot be neatly fenced in as protected areas; and
- conditions in any part of a river are virtually dependent on remote events upstream and in the catchment (O'Keefe *et al*., 1987).

Australian rivers also vary temporally, with many rivers drying out for long periods. This seasonal and longer term variation in physical features results in a distinctive faunal and floral community, as well as a distinctive geomorphology, which is the result largely of the nature of the geology of the catchment, its size and rainfall patterns.

The fauna of rivers is often less familiar to the wider community than its terrestrial counterparts, in particular the diverse invertebrate fauna. These species tend to be less visible than their terrestrial counterparts. Therefore, justification for protection of such species may be less convincing. However, there are aquatic species that occupy a significant place in society, as a consequence of their social values eg. as a food resource and their role in Aboriginal story telling. Further, water is often a limiting factor for many developments, potentially creating tension between public and private use. River

management requires consideration of a wide spectrum of issues at a range of temporal and spatial scales (Ormerod, 1999).

1.3.5 What are the consequences of not protecting?

The consequences of not protecting rivers are many and varied and relate largely to a loss of ecological values (Boon, 2000). These impacts can be expressed as loss of ecological structure (eg. biodiversity) and function (eg. ecological processes) and an overall loss of ecological integrity (Lake and Marchant, 1990; Barmuta *et al*., 1992). Ecological integrity can be defined as the protection of biodiversity, essential ecological processes, and life support systems (Commonwealth of Australia, 1992). Such a state may still retain some ecological integrity and it is then a matter of social judgment as to the acceptability of such a change. The implications for the human community are less clear. We have yet to come to fully recognise and value the ecosystem services and other less tangible benefits we get from river systems. Cost/benefit analysis is a common method for assessing such effects, but rarely includes the true environmental costs of an action that can result in an altered ecosystem. This document concentrates largely on the ecological consequences of not protecting rivers, although there is considerable overlap with social consequences, such as loss of recreational values.

1.3.6 How is river protection currently being addressed?

Effective river protection or conservation must involve both 'conservationists' and those that exploit natural resources, together with researchers, planners, educators and the general public (Boon and Baxter, 1999). There is very little direct protection of rivers being undertaken in Australia. This situation is not dissimilar to that in other countries. For example, Collier (1993) reported that, in New Zealand, conservation efforts had historically focused largely on preserving fisheries values. Allan and Flecker (1993) claim that the strong global interest in biodiversity has concentrated efforts into ecosystems such as tropical moist forest, to the detriment of other systems, such as aquatic environments, with perceived lower biodiversity levels. Dunn (2000) describes the current status of river protection in Australia, with mostly indirect protection being achieved through compliance with the Council of Australian Governments' water reform agenda agreed between State and Federal governments (this incorporates the National Water Quality Management Strategy; ARMCANZ and ANZECC, 1994). This agreement calls for the protection of environmental values and for providing water allocations for maintenance of these values—where they are flow-dependent. Protection of water quality is another indirect instrument for the protection of ecological values. Direct protection instruments, for example through protection of representative river ecosystems by special designation, are not generally applied. Historically, a lot of what river protection that has been achieved has been as a secondary outcome of the need to prevent the erosion of farmland or the need to implement sustainable land use practices etc. (Pen, pers. comm., Sept 2000). Section 3 of this report discusses (in more detail) the range of instruments which could potentially protect waterway ecological values.

1.4 Developing and implementing a river protection plan

It is not the intention of this document to propose the development of stand-alone plans for the protection of rivers. Rather this document promotes the use of existing planning mechanisms, with an increased awareness of protection requirements specific to rivers. ***As such, a river protection plan can be considered as a subset of existing river management plans.*** The Planning Guideline referred to in section 1.1 of this document further discusses how protection requirements can be incorporated into the river planning process.

There are many examples of planning processes for natural resources, which have common stages. Appendix 1 illustrates examples of river planning processes. Figure 1 provides a synthesis of the key elements common to all of these processes. The key stages are to:

- establish a vision—this step allows a clear direction to be set on what is to be achieved;
- develop a plan—planning is an essential component of the process and incorporates tasks such as assessing the current situation, identifying and assessing the problem and alternative solutions, setting priorities, identifying tasks that need to be undertaken, setting specific objectives for these tasks, identifying limitations to achieving these objectives (eg. funding, timing) and allocating responsibility for the tasks;
- implement the plan—this step involves putting into practice the elements of the plan and is the step at which results will be seen; and
- monitor and review—the success of the plan needs to be monitored against measurable criteria to ensure that the objectives established for specific tasks, and ultimately the vision established, are being met. After such monitoring, a review of the plan may be required.

Each of these steps should involve the range of stakeholders that may be affected by any plan element and include the community and relevant industries, as well as planners. This is also a dynamic process which allows for continuing improvement. The aim should be to

use the best scientific information and management practices at each step of the process.

This report concentrates largely on the second stage of the planning process—developing a plan. Within this stage, the identification of values and threats, the determination of priorities and the choice of the most effective protection instruments are undertaken. Dunn (2000) defines the key elements for effective river protection as being:

- definition—what **key criteria**/attributes are required to define ecological value of rivers?
- evaluation—what **assessment methods** should be used to define river ecological values?
- selection—how is **priority setting** undertaken?
- management actions—what **protection instruments** are available?

Effective river protection requires implementation of the most appropriate tools to address each of these elements and needs to be developed on a case-by-case basis.

The existing information on each of these elements is synthesised to provide a reference point from which users of this report can begin the process of developing and implementing a river protection plan for their particular river(s).

1.5 Scope and limitations

The overall scope of the review is as follows.

Generally, it:

- aims at protection of ecological values based on ecological, hydrological and geomorphological features (ie. it does not address other values eg. economic, social or cultural);
- includes aquatic, riparian and floodplain ecosystems (including groundwater dependent ecosystems);
- has river ecology as its core;
- takes a holistic approach to river protection;
- is aimed at the continuum of waterway ecological values and is not targeted specifically at high value waterways; and
- follows the principles of best achievable practice.

Principles and tools

The report:

- reviews and assesses existing protection principles and tools;
- provides a range of options for protection by discussing tools used or potentially of use for river protection ;
- provides a qualitative indication of the scope of the tools;
- promotes the use of rigorous scientific methods where possible;
- provides case studies to illustrate the application of protection principles and tools;
- does not provide an exhaustive review of the literature, but rather is illustrative; and
- does not include any results of field trialing of methods and tools (other than by identifying potential case studies).

Relevance

The report:

- is intended to be relevant throughout Australia and can also be utilised to produce a national perspective, while also having local applicability;
- draws on experiences at international, national, State, regional and local government and community levels;
- addresses a range of skill levels (eg. community groups, government agencies, scientists);
- is capable of being implemented through existing agencies and structures where possible;
- has a catchment planning focus but is relevant to a range of spatial scales (reach through to catchment); and
- links science, communities, stakeholders, policy makers/planners and management in the process of river protection.

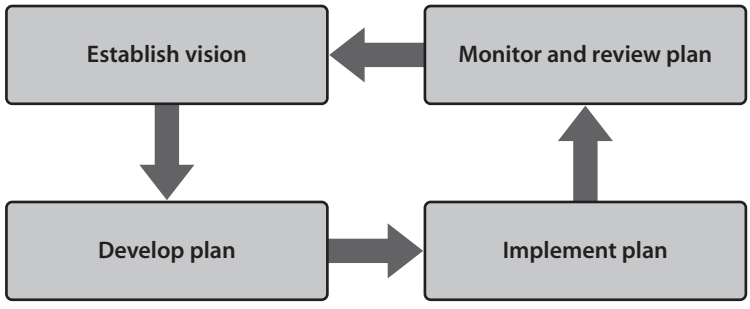

Figure 1. Key elements in the development of a river protection plan

1.6 Methods

A range of existing information obtained from written and electronic media has been used to produce this document. A reference panel was established to review the scope and subsequent content of the report. This panel consisted of:

- Dr Phil Price, Land & Water Australia;
- Dr John Koehn, Arthur Rylah Institute for Environmental Research, Department of Natural Resources and Environment, Victoria;
- Mr John Riddiford, North East Catchment Management Authority, Victoria;
- Dr Helen Dunn, University of Tasmania; and
- Dr Luke Pen, Water Resources Commission, Western Australia.

An internal QEPA reference group was also established and included personnel with a range of expertise in conservation biology. Interstate and international information sources were also utilised where possible.

1.7 Components of the report

This report is divided into three main sections. Firstly, the major principles associated with the protection of rivers are discussed. These principles define the reasons why we protect rivers. Secondly, the report describes the process and key elements required to develop and implement a river protection plan. These elements include determining the criteria to use in assessing ecological values, deciding on the method of value assessment, assessing threats to the identified values, setting priorities for management actions (including protection and restoration) and determining the most appropriate instrument(s) for protecting the identified values. Tools which can be used to address each of these elements are presented and barriers/constraints to their effective uptake are discussed. Case studies illustrate some of these elements. Contacts for protection in each State/Territory are provided, along with a bibliography of supporting documentation. Finally, a discussion on how this document fits with other documents and processes related to river management is presented.

2 Principles of River Protection

Many of the principles that govern the management of natural resources throughout Australia are relevant to the protection of rivers. However, rivers also have features which distinguish them from other natural resources and which require special recognition. Such features include the non-renewable nature of rivers and their longitudinal, lateral, vertical and temporal variation. Appendix 2 provides examples of the types of principles that applicable to the protection of rivers. For each principle, the ecological outcome is presented. This outcome reflects the consequences to the environment of adopting the principle and allows for commonalities across principles to be determined.

The key ecological outcome that relates to the protection of ecological values of rivers is ecologically sustainable rivers. Within this context, specific outcomes include:

- maintenance of rivers for future generations;
- maintenance/protection of ecological values;
- protection of significant/rare/unique features;
- maintenance/protection of biodiversity and ecological processes;
- minimisation of ecological damage;
- maintenance of natural streamflow characteristics; and
- protection of significant species/taxa/ecosystems.

There is some overlap between these ecological outcomes. Also, their general nature means that some particular aspects of rivers which may require specific recognition as a principle for river protection are hidden (eg. specific unique features). Taking these factors into consideration, a synthesis of these ecological outcomes identified for each principle resulted in derivation of the principles for protecting rivers shown in Table 1. These principles may not apply to all rivers. For example, a highly degraded river may still have ecological values worthy of protection but maintenance of natural values would not be possible. Hence, at least some of the principles presented in Table 1 would not be realistic and would need to be adapted. However, the principles in Table 1 provide a benchmark against which to set ecological outcomes for rivers of all values.

Table 1. Principles aimed at protecting rivers

Principles
That the ecological value of rivers be protected
That rivers be managed in an ecologically sustainable manner
That rivers be managed to ensure their benefit to future generations
That State, national and international agreements that affect river management be reflected in river management strategies
That the biological, hydrological and geomorphological diversity of rivers be maintained
That the ecological structure and functioning (ecological integrity) of rivers be maintained
That natural streamflow characteristics be maintained or mimicked through the provision of water for the environment
That the longitudinal, lateral and vertical dimensions of rivers be incorporated into river management processes
That the non-substitutable nature of rivers be recognised in river management processes

3 Developing a River Protection Plan

3.1 Elements of the plan

As outlined in section 1.4, Dunn (2000) defined the key elements for effective river protection as:

- defining key criteria;
- determining appropriate assessment methods;
- priority setting; and
- determining appropriate protection instruments/ processes.

These key elements are now discussed.

3.1.1 Key criteria for determining ecological value

Measures for use in assessing ecological value need to be determined. These measures consist of broad criteria and measurable attributes for each criterion.

3.1.1.1 Criteria

Dunn (2000) undertook a survey of river experts from various fields in both the public and private sector (eg. ecologists, geomorphologists, planners, river managers) to canvass opinion on the criteria that were required to determine ecological value of rivers. An initial list of criteria was developed and this list was reviewed by the river experts. These criteria are summarised in Table 2 and are compared with other studies. The criteria identified are consistent with those used in terrestrial (eg. JANIS, 1997) and marine systems (eg. ANZECC, 1998).

It is interesting to note the interpretations that different authors place on these criteria. Collier (1993) used rarity and representativeness interchangeably. QEPA (1999) considered representativeness in terms of being an outcome of the planning process rather than a determinant of ecological value, as it provides the basis for establishing a reserve system. Dunn (2000) reported that a lower level of importance was given to representativeness than to other criteria by respondents to her survey discussed above. Condition and naturalness are used by some interchangeably. Derivation of naturalness usually requires comparison of current condition with pre-disturbance (usually pre-European) status. Condition usually adopts a referential or 'reference site' approach, whereby the 'least-disturbed' current status would be used as the benchmark against which an assessment of current condition is made. As a consequence of there being relatively few data available to accurately assess pre-European status, the referential approach is widely used (eg. Reynoldson *et al*., 1997; Parsons and Norris, 1996; Davis and Simon, 1995).

Table 2. Criteria used to define ecological value

Criterion	Dunn 2000 (Australia)	O'Keefe *et al*. 1987 (South Africa)[a]	Collier 1993 (NZ)	Stein *et al*., n.d. (C'wealth)	SERCON[c] (Boon *et al*., 1997, 1998 – UK)	QEPA 1999 (Qld)	Burrows, 1998 (Qld)	DLWC, 1998 (NSW)
Naturalness/ condition	✓[b]	✓	✓	✓	✓	✓	✓	✓
Representativeness	✓	×	✓	✓	✓	×	✓	×
Diversity or richness	✓	✓	✓	✓	✓	✓	✓	✓
Rarity/uniqueness	✓	✓	✓	✓	✓	✓	✓	✓
Special features	✓	✓	✓	✓	✓	✓	✓	✓

[a] Criteria used in this method were consistent with the criteria listed in this table, but were not specifically referred to using these terms
[b] A tick indicates that the criterion was used, while a cross indicates that it was not used
[c] A system for evaluating rivers for conservation

3.1.1.2 Attributes

Providing measurable attributes to describe the criteria can be challenging, as few data sets have been collected for the specific task of defining ecological value. However, the lack of measurable attributes should not necessarily be seen as a deterrent to determining ecological value. For example, where measurable data are unavailable, an expert panel could be used to assess sites against each attribute (see later in this report for an example of such an approach). Dunn (2000) provides a list of attributes, identified through a survey of river experts as being important in determining ecological value. These attributes are similar to those identified by others as being important in defining ecological value for rivers (eg. Collier, 1993; QEPA, 1999). These attributes include the range of structural (eg. fauna/flora/habitat) and functional (eg. ecological processes) components of river systems. Examples of some attributes are given the Table 3.

Table 3. Examples of attributes used to determine ecological value

(a) From Dunn (2000)

Criterion	Measurable attribute	Potential data sources
Diversity	Range of in-stream habitats	AusRivAS, river habitat surveys
	Type of style of channel or floodplain	Remote sensing, air photos, maps
	Diversity of native species	AusRivAS, surveys, databases, records
	Diversity of endemic species	Databases, museum records, interest groups, survey

(b) From Collier (1993)[a]

Criterion	Measurable attribute
Rarity and unique features	Number of large waterfalls
	Number of unusual rock types
	Number of unusual vegetation types
	Number of unusual geological formations
	Number of known/endangered species

[a] No indication of potential data sources provided

(c) From QEPA (1999)

Criterion	Measurable attribute	Potential data sources
Naturalness	Overall catchment quality	Wild Rivers database, river survey
	Overall channel quality	Wild Rivers database, river survey
	Overall bank stability	State of the Rivers database, river survey
	Number of instream habitats	State of the Rivers database, river survey
	Presence of artificial barriers	Wild Rivers database
	Number of macroinvertebrate functional feeding groups	AusRivAS
	Proportion of exotic fish species	Local fish reports
	Percentage canopy cover (riparian vegetation)	State of the Rivers database, river survey
	Width of riparian vegetation	State of the Rivers database, river survey

3.1.2 Methods of assessing ecological value

3.1.2.1 Concepts

Once the criteria for defining ecological values of rivers have been determined, it is then necessary to determine the relative value of specific rivers/sections of rivers/sub-catchments/catchments using an appropriate methodology. There is no consistent methodology for determining the ecological value of rivers. The choice of methodology to use in any particular situation will be influenced by the proposed end-use of the assessment, the availability of information/data to address the criteria, the available time and resources to undertake the assessment and the skills of the people using the assessment method. It is important, however, to employ the most rigorous and scientifically valid method possible, within the limitations of both expertise and information.

3.1.2.2 Basic steps

Boon (1992) described three basic steps that need to be addressed in the assessment of ecological value:

1. description of species and habitats, to determine their distribution and abundance, and the features of rivers that are important in sustaining them;
2. classification of river types, to provide a context within which to compare species and habitats and therefore ecological values, as rivers vary inherently at a number of scales (eg. lowland and upland); and
3. assessment to establish relative ecological values.

Step 1 Describing species and habitats

In order to be able to classify river types and assess ecological value, an understanding of the essential elements of a river system is required. This includes a description of what species occur where, and how they interact with both biotic (eg. other species) and abiotic (eg. geomorphology and flow) features. There are numerous approaches to describing species and habitats, although detailed knowledge of many Australian rivers is lacking (Lake and Marchant, 1990). Biotic and abiotic features vary both spatially and temporally, and at a range of scales within these dimensions. It is therefore essential that rivers be classified into types in order to be able to meaningfully compare the relative values of biotic and abiotic features.

Step 2 Classifying river types

Classification of river types is required in order to be able to compare ecological values across river types, while taking into account the natural spatial variation which is inherent within river systems. Classification also allows for the establishment of reference conditions within the context of river type. Reference condition is needed for assessing a number of the criteria used to define ecological value.

There is no clear consensus on what constitutes a river classification system, or on what its primary use should be (Hart and Campbell, 1994; Snelder *et al*., 1998). This is not surprising given that classifications are developed for a range of reasons. Naiman *et al*.. (1992) reviewed the general principles of river classification, along with the array of classification schemes developed for rivers. Rivers have been classified using:

- macroinvertebrates eg. Wright *et al*. (1989);
- ecoregions eg. Omernik (1995);
- microhabitat features eg. Cupp (1989); Rosgen (1994);
- stream order eg. Strahler (1957);
- fish eg. Karr (1981);
- geomorphology eg. Brierley (1999);
- riparian vegetation eg. Harris (1988); and
- aquatic plants eg. Holmes *et al*. (1998).

The attributes ultimately used will depend on the use of the classification. For example, to produce an ecologically and geomorphologically relevant classification of river types, attributes should include measures of flora/fauna community structure, biological processes, habitat measures, water quality/quantity measures, geomorphological measures and catchment and regional features. Where data sets allow it, measures of temporal and spatial variation should be used. There are several ways of incorporating temporal variation into a classification:

- Use indicators which reflect temporal variation. This is not an easy task as in general data are not available for consistently long time periods.
- Accept that a value may change with time (especially if that value is not protected following an initial high assessment value) and therefore accept that we are producing a ‘snap-shot’ of the types of rivers and ecological values found in the catchment.
- Represent temporally varying data as ranges rather than average or mean values.
- Use coefficients of variation to represent temporal variation.

At least some of the data will be available only for limited time periods. It is likely that such limitations will need to be accepted in order to develop an ecologically meaningful classification (as the exclusion of such data may reduce the pool of attributes of direct ecological relevance).

Step 3 Assessing ecological value

As discussed above, classification of rivers provides the basis for comparison of ecological values, taking into account natural variation between river types. Assessing ecological value requires a different perspective from that of assessing the condition or health of a river, as it incorporates a range of attributes not generally covered by river health methodologies eg. rare and threatened species

(Dunn, 2000). While the methods for defining ecological value are relatively new, there has been considerable development in methods for assessing river health or condition. It is considered appropriate to include a discussion of methods for assessing condition, as they can be used to feed directly into the overall assessment of ecological value, specifically in relation to the naturalness/ condition criterion. Table 4 summarises a range of methods used to establish the condition of waterways. The methods are listed in alphabetical order and do not indicate any particular preference.

For each method, the following features are outlined in Table 4.

a) Outcome—what does the method produce?
b) Skill level—what expertise is required to use the method?
   – low = targeted at groups/individuals with limited specialist expertise (eg. schools, volunteer community groups without access to specialists)
   – moderate = targeted at groups/individuals with some expertise in river assessment, which can be augmented with minimal training (eg. community groups with scientific support)
   – high = targeted at individuals/groups with considerable expertise in river assessment (eg. scientific community)
c) useability—is the method transferable ie. has a standard method been used which can be used elsewhere? Can the method be applied at a range of spatial scales? Can it be applied where there are few data? Is the method repeatable ie. can the method be used again and again and give consistent results each time?
d) Source—where can the reader go for more information on the method (see Bibliography for full references).

As discussed above, methods for establishing ecological value have been developed relatively recently and consequently vary in their useability, as many are still in developmental phases. They range from qualitative assessments using 'expert panels' (eg. Burrows, 1998; Collier, 1993) to detailed assessments utilising desktop and field derived data sets and a numerical, automated assessment process (eg. Boon *et al*., 1997, 1998; QEPA, 1999, Phillips *et al*., 2000). The skills required to utilise these methods vary, although at least some methods (eg. QEPA, 1999) target a range of users. Table 5 summarises a range of methods that have been used for identifying the ecological values of waterways. An evaluation of the outcome of the assessment method, the required skill level and the useability of the method is undertaken, using the same criteria as for Table 4. Again the methods are listed in alphabetical order and do not indicate any particular preference. It is interesting to note that very few of these methods have been applied (eg. neither the South Africa or New Zealand methods have been applied).

Table 6 provides an example of how ecological value could be assessed where there is little information and where specialist expertise is lacking. This table is designed for use on a site-by-site basis, with the collective information within a catchment being used to build a picture of ecological value for a catchment. Table 7 provides an example of a more elaborate assessment method for one ecological value criterion—naturalness. Such a method would be useful in a 'panel of experts' situation, where little measured information is available but where experts used their knowledge to rate different indicators of the criterion. Different weightings could then be placed on different criteria, reflecting their relative importance in determining ecological value. Such an approach would allow for a prediction of values to be made. Both methods require the use of reference sites so that natural conditions such as poor water quality as a consequence of drought, can be taken into account in the assessment of ecological value. These two methods represent different points in a spectrum of approaches that could be used to assess ecological value. The simpler method can be used as a trigger for a more detailed assessment such as the one presented in Table 7. Both methods are only as useful as the information used to derive the outcomes and so could potentially produce different results. These limitations need to be considered in the interpretation of the outcomes. The use of geographic information systems (GIS) can greatly enhance the capacity to interrogate information collected, as well as providing a range of visualisations of the final product (eg. maps). Such a system also allows relatively simple updating when new information and/or methods become available.

3.1.2.3 Potential data sources

Dunn (2000) provides details of the kinds of data sources that could be used to derive ecological value. Existing data sets and information provide a good basis for determining additional data requirements. Such data sets have often not been collected for the specific purpose of deriving ecological value and may therefore require reassessment in order to provide information of direct use to the determination of ecological value. Phillips *et al*. (2000) undertook a trial of a method for determining ecological values of rivers in the Burnett catchment in central Queensland. These authors used a range of existing data sources, but there was limited time available for further interrogation of the data. This work will be described in a forthcoming report (Phillips *et al.*, 2000). They found that some criteria could not be adequately described. For example, there were very few data available which described measures of in-stream biotic diversity. The use of existing data in this study, however, did prove useful in identifying information gaps.

Table 4. Examples of methods for describing condition

Assessment method	Outcome	Skill level	Useability	Source
Foreshore assessment in the urban and semi-rural areas (Western Australia)	Assesses river condition based on bank stability, foreshore vegetation, river cover and habitat diversity.	Low–moderate	Repeatable, reach scale assessment, requires detailed information.	Water and Rivers Commission (1999)
Index of Stream Condition (Victoria)	Provides a summary of condition based on hydrology, physical form, riparian zone, water quality and biology.	Low–Moderate	Repeatable, reach scale assessment, requires detailed information.	DNRE (1997)
National Land and Water Resources Audit (Commonwealth)	Will provide an objective assessment of the extent of degradation arising from approximately 20 key land and water and vegetation problems. Also developing a national database. Aims at facilitating improved decision-making and land and water resources management.	High	Reach scale assessment reported at a catchment scale.	http://www.nlwra/gov.au/
National River Health Program (Commonwealth)	Site-based assessment of river health based on macroinvertebrate composition.	High	Repeatable, reach scale assessment, requires detailed information.	Simpson *et al*. (1999)
River Habitat Survey (UK)	Provides both a description of the nature and features of rivers and an analysis of condition.	Moderate	Repeatable, reach scale assessment, requires detailed information.	Raven *et al*. (1998)
State of the Rivers (Queensland)	Provides a summary of condition based on hydrology, physical form and riparian zone.	Low–Moderate	Repeatable, reach scale assessment, requires detailed information.	Anderson (1993)
State of the Rivers (Western Australia)	Involves mapping of the major forms of degradation to which rivers in the State are subject. Also incorporated information from the Wild Rivers Project.	Moderate	Repeatable, reach scale assessment, requires detailed information.	Water and Rivers Commission (1997)
Stream foreshore assessment in farming areas (Western Australia)	Standardised technique for assessing river condition.	Low–moderate	Repeatable, reach scale assessment, requires detailed information.	Pen and Scott (1995)
Urban Stream Habitat Assessment Method (USHA) (New Zealand)	Provides scores for value of physical habitat within rivers, identifying those features which are most important in limiting 'biological health'.	High	Repeatable, reach scale assessment, requires detailed information.	Suren *et al*. (1998)

Table 5. Examples of methods for establishing ecological value

Assessment method	Outcome	Skill level	Useability	Source
'Expert System' approach to the assessment of the conservation status of rivers (South Africa)	Developed method for assessing major conservation attributes of rivers and for communicating these in a conceptually simple manner.	Moderate–High	Repeatable, reach or catchment scale, qualitative assessment.	O'Keefe *et al*. (1987)
FNQ2010 Regional Environmental Strategy Key Waterways Report (Queensland)	Identifies important freshwater habitats within the Far North Queensland (FNQ) region.	Moderate–High	Not repeatable, reach or sub-catchment scale, qualitative assessment.	Burrows (1998)
Identifying and protecting rivers of high ecological value (Australia)	Reviews existing methods for determining ecological value and provides a framework for assessing high ecological value rivers.	Moderate–High	Repeatable, reach or catchment scale, qualitative assessment.	Dunn (2000)
Interim Guideline for Describing the Ecological value of Waterways (Queensland)	Quantitative or qualitative assessment of ecological value (depending on way method applied).	Low–High	Repeatable, reach scale assessment, can be applied at a range of spatial scales, can be used where little information.	QEPA (1999)
Stressed Rivers (NSW)	Determines hydrological and environmental stress, along with ecological value based on expert panel assessment of limited data sets.	Moderate–High	Repeatable, reach or catchment scale, qualitative assessment.	DLWC (1998)
System for Evaluating Rivers for Conservation SERCON (UK)	Broad-based technique for river evaluation. Applications include identifying important rivers for conservation and potentially for monitoring of river rehabilitation schemes.	Moderate–High	Repeatable, reach scale numerical assessment, requires detailed information	Boon *et al*. (1997, 1998)
Towards a protocol for assessing natural values of New Zealand rivers (New Zealand)	Provides a description of ecological values using a numerical, expert panel assessment method.	High	Repeatable, reach or catchment scale, qualitative assessment.	Collier (1993)
Victorian Heritage Rivers Program	Identifies natural, recreational and landscape values, resulting in declaration of "heritage rivers" and "natural catchments" under the *Heritage Rivers Act 1992* (Vic.). Provides derivation of "representative rivers".	Low (designations already identified and selected)	The river types where identified using a classification dependent essentially on hydrology and geomorphology. This method pre-dated the IBRA framework, and consequently needs revision.	Land Conservation Council (1989, 1991)

Table 5. (Cont'd) Examples of methods for establishing ecological value

Assessment method	Outcome	Skill level	Useability	Source
Wild and Scenic Rivers Act (USA)	Classifies rivers based on wildness or naturalness using established criteria.	Moderate	Repeatable, reach or catchment scale, requires detailed information.	Interagency Wild and Scenic Rivers Coordinating Council (1999)
Wild Rivers Project (Australia)	Provides an assessment of rivers throughout Australia that have not been significantly altered since European settlement.	Low (data available for all sites)	Repeatable, reach or catchment scale, requires detailed information.	Stein *et al*. (n.d.)

Table 6. Example of method for defining ecological value where little information is available and where minimal specialist skills are required

Criterion	Question	Yes (Y)/No (N)[a]
Naturalness	Is the area free from (or from signs of): • cattle disturbance (e.g. stirring up of river bed and banks)? • rubbish? • poor water quality (e.g. presence of scum or smell)? • clearing of native vegetation? • presence of weeds? • erosion (e.g. banks slumping)? • dams or weirs (e.g. reduction or loss of flows downstream, presence of weir pool)? • channel modification (e.g. channel straightening)?	
Special features	Using your local knowledge • are there any features present in the area which make it special? For example, does it contain a waterfall or other feature which is not common throughout the river system?	
Diversity	Using your local knowledge • does this area support a large number of native species? • does this area have a range of instream habitats (e.g. pool, riffle, run, waterfall etc.)? • is a variety of native birds commonly seen/heard in this area? • is variety of streamside plants found in this area?	
Rarity	Using your local knowledge • does this area support a rare, threatened or vulnerable species (under legislation) or those that are known locally or regionally as being significant? • does this site have unusual natural features?	
Cultural heritage	Using your local knowledge • does this area contain any features of cultural heritage significance (either indigenous or non-indigenous)?	

[a] If you answered 'yes' to any of these questions, then this site may have significant ecological value. A more detailed assessment of ecological values may be warranted.

Augmentation of existing data with field surveys or modelling to fill data gaps will most likely be required to produce comprehensive assessments of ecological value. Additionally, the use of expert panels in conjunction with existing data could be an effective compromise where resources to obtain new data are minimal.

Anecdotal evidence and local riverine information are particularly useful where the methods to be used rely on community participation and also provide a significant resource for assessing long term changes. Rixon *et al*. (1999), Starr (1999) and Shepheard *et al*. (1999) all describe ways in which such community information can be used. Some caution must, however, be exercised when utilising such information, as its reliability may be highly variable. Some form of validation is recommended in such cases.

Table 7. Example of method for defining ecological value where little information is available and where specialist skills are required (scoring table for naturalness)

For each of the following indicator measures, assign a rating between 1 and 5 based on your expert knowledge. Multiply each rating by its assigned weighting to produce a weighted score. Sum across all indicator measures to produce an overall score. Range standardise this score using the formula in the table to produce the final score. Assign a category based on the criteria indicated below. Complete tables for other criteria to develop an ecological value profile for your site.

Indicator measure	Naturalness rating					Rating (R) (1 - 5)	Weighting (W) (also equals minimum possible score)	Weighted rating (R * W)	Maximum possible score (W * 5)
	1	2	3	4	5				
Catchment quality									
	Extensively cleared				Uncleared				5
Channel quality:									
Banks	Highly eroded				Very stable		1		5
Bed	Highly aggraded/ degraded				Not aggraded/ degraded		1		5
Water quality, *variation* from reference condition *or non-compliance* with appropriate standards for:									
Turbidity	High				Low		0.7		3.5
pH	High				Low		0.7		3.5
Conductivity	High				Low		0.7		3.5
Artificial barriers — presence of dams or weirs, affecting ecological processes									
reach	1 dam or >3 weirs		1 weir		None		1.5		7.5
Macro-invertebrates, variation from reference condition for:									
observed/expected ratio	High				Low		1.7		8.5
SIGNAL	High				Low		1.7		8.5
Fish, variation from reference condition for:									
species richness	High				Low		1.3		6.5
composition of trophic status groups	High				Low		1.3		6.5
Other aquatic/riparian fauna, variation from reference condition for:									
species richness	High				Low		5		25
Riparian vegetation, variation from reference condition for:									
species richness (variation from reference condition)	High				Low		0.8		4
structural composition (variation from reference condition)	High				Low		0.8		4
width	<1 m				>100 m		0.8		4
continuity	Sporadic				Continuous		0.8		4

Table 7. (Cont'd) Example of method for defining ecological value where little information is available and where specialist skills are required (scoring table for naturalness)

Indicator measure	Naturalness rating					Rating (R) (1 - 5)	Weighting (W) (also equals minimum possible score)	Weighted rating (R * W)	Maximum possible score (W * 5)
	1	2	3	4	5				
Aquatic vegetation, variation from reference condition:									
species richness	High				Low		2		10
Carbon and nutrient cycling (variation of flux rates from reference condition)									
	High				Low		5		25
Ecological processes — degree of variation of process components for reference condition (eg. primary and secondary productivity, fish spawning, eutrophication, interspecies relationships)									
	High				Low		5		25
TOTALS							32.8 (C)	Sum of R*W (B)	164 (A)
Per cent of maximum score (range standardised) = (1– {B – C}/{A – C}) ×100%									
Naturalness value category[a]									

[a] % of maximum score: 0–25% = low, 26–50% = moderate, 51–75% = high, 76–100% = very high

3.1.3 Setting priorities for the protection of ecological values

3.1.3.1 Introduction

Setting priorities for the protection of ecological values involves four steps. These are:

1. establishing relative ecological values;
2. identifying threats to these values;
3. setting priorities based on a consideration of values and threats; and
4. identifying the appropriate actions to be taken to address these priorities.

Each of these steps is discussed in more detail below.

3.1.3.2 Establishing relative ecological values

The establishment of relative ecological values is largely discussed in the previous sections of this report, and also by Dunn (2000), who emphasises the need for consideration of context and scale when establishing such values.

Table 8 provides examples of the methods for determining ecological value use to identify priorities (through the identification of relative values).

The key methods used are:

- *panel assessment*—a panel (consisting of, for example, river experts or community members) is used to determine relative values;
- *numerical assessment*—a numerical, sometimes automated, process is used to calculate relative values. This often involves the calculation of numeric indices;
- *weightings*—criteria used to define ecological value may be weighted relative to their importance in defining ecological value, using either the expert or numerical assessment process; and
- *cut-off points/decision rules*—cut-off points or decision rules for categorisation need to be defined to assess relative value and again may be used with either the expert or numerical assessment process. Such decision rules may be, for example, that the presence of a rare or threatened species indicates a high value for that site for that criterion, while the absence indicates a low value.

Dunn (2000) discusses the use of numerical assessment processes. She suggests that such methods may result in a loss of information (as it combines various raw data) and can lead to a misinterpretation of ecological values. Boon *et al*. (1998) suggest that data produced from a numerical analysis (eg. indices) needs to be interrogated at the level

Table 8. Examples of methods used to establish relative ecological value

Methods	O'Keefe *et al.* (1987) (South Africa)	Collier (1993) (NZ)	Stein *et al.* (n.d.) (C'wealth)	SERCON (Boon *et al.*, 1997, 1998 – UK)	QEPA (1999) (Qld)	Burrows (1998) (Qld)	DLWC (1998) (NSW)
Expert assessment	✓[a]	✓	×	✓	✓	✓	✓
Numerical assessment	✓	✓	✓	✓	✓	✓	×
Weightings	✓	✓	✓	✓	✓	×	×
Cut-offs/decision rules (high to low categories)	×	×	✓	✓	✓	✓	×

[a] A tick indicates that the criterion was used, while a cross indicates that it was not used
[b] System for evaluating rivers for conservation

of individual attributes and raw data when assessing ecological value. However, numeric assessments are useful when large amounts of data and attributes need to be interpreted and presented in an easily understood manner. Numeric information can be presented in non-numeric formats (eg. maps). As highlighted previously, the use of geographic information systems (GIS) allows for the interrogation of raw data relatively easily, as well as allowing for the updating of information.

3.1.3.3 Identifying threats

Activities which may be threatening values need to be identified in order to formulate appropriate management actions. Examples of such threats include:

- clearing of vegetation;
- cattle access;
- point or diffuse source pollution;
- in-stream barriers;
- weed infestations (riparian and aquatic);
- exotic fauna species;
- overfishing;
- sand and gravel extraction;
- sedimentation; and
- changes in land use.

Such threats should be considered in terms of short and long term time frames, so that longer term sustainability issues can be accommodated.

3.1.3.4 Setting priorities

The major aim in setting priorities should be to maximise the ecological outcomes from the protection action(s) that are being planned. Section 2 and Appendix 2 provide examples of some ecological outcomes. In this context, priority setting is aimed at establishing conservation priorities (from consideration of ecological values and threats to those values) and does not directly incorporate other values eg. social, economic and cultural values. The following examples show processes which could be used to establish protection priorities for river management activities.

Example 1–Draft Waterway Protection Scoping Paper (QEPA, 2000)

Table 9 indicates that those rivers of high value and subject to moderate to high threats have highest priority for protection. For each priority, the right 'mix' of actions required to maintain values needs to be identified. The type and extent of actions will vary according to the scale at which the values have been defined. For example, at a State-wide level, such actions could include the development of a policy for a higher level of protection of Priority 1 rivers and for a minimum level of protection (ie. maintenance of existing values) for all rivers. At a local scale, individual landholders could use this process as a way of prioritising reach-scale actions required to maintain identified values, in cooperation with other landholders in the catchment.

Example 2–Mary River Rehabilitation Plan

The Mary River Catchment Coordinating Committee (MRCCC) is developing a rehabilitation plan for the Mary River (Stockwell, 2000). This plan identifies ecological values, along with threats to these values and actions to be taken to maintain the values. Table 10 provides an example of the criteria used to determine various priorities. Priority category 0 has the highest priority from the perspective of protecting high value river systems. It is intended that this prioritisation be reviewed in the context of social and cultural outcomes (Stockwell, 2000).

Table 9. Example of a priority setting process and examples of waterway management responses

Ecological value	***Threats***		
	High	**Moderate**	**Low**
Low	*Priority 5:* Consider remediation; Consider reducing existing impacts.	*Priority 6:* Consider remediation.	*Priority 6:* Consider remediation.
Moderate	*Priority 3:* Protect; Restore degraded components; Reduce existing impacts.	*Priority 4:* Protect; Rehabilitate degraded components.	*Priority 5:* Protect representative examples; Consider rehabilitating degraded components.
High	*Priority 1:* Protect; Reduce existing impacts.	*Priority 2:* Protect; Reduce existing impacts.	*Priority 3:* Protect representative examples.

Source: QEPA (2000)

Terminology used in the table:

- *Protect* — achieve the principles set out in this document
- *Representative examples* — waterways that have high representativeness value
- *Restore* — return structure and function to natural condition
- *Rehabilitate* — improve the important aspects of structure and function to near natural condition
- *Remediate* — improve selected aspects of structure and function to a better condition (where streams have been so modified that natural condition is no longer attainable)
- *Reduce existing impacts* — improve the buffering capacity of the natural system by removing any existing threats to long term sustainability

Table 10. Biophysical reach prioritisation categories

Priority category	**Criterion used to set priority**
0	Protected reaches of good condition throughout
1	Protecting and restoring reaches of regional conservation significance
2	Protecting and rehabilitating reaches of local conservation significance
3	Protecting deteriorating strategic reaches
4	Improving linking/close reaches and isolated islands
5	Improving moderately damaged reaches with moderate to high recovery potential
6	Highly degraded reaches with little chance of natural recovery

Source: Stockwell (2000)

The premise behind the approaches in Tables 9 and 10 is that it is better to protect the high value, highly threatened areas of rivers before the low value, relatively unthreatened areas. This premise is consistent with the approach recommended by Rutherfurd *et al*. (1999). Their approach recommends the protection of the good before the restoration of the bad. Of course, there will be a continuum of priorities, from high through to low, and the approach taken at any point along the continuum is likely to reflect broader priorities, such as social and economic priorities. The final priority given to a particular area of a river may be influenced by an array of social factors. It might be, for example, that a catchment group involved in river management choose, to restore

areas that give the most conspicuous outcome or which slow the rate at which things get worse (Pen, pers. comm., September 2000).

Example 3–Melbourne Water

Another example of a priority setting process is illustrated by the Environmental Risk Assessment and Priority Setting Model (ERAPSM), which has been developed by Melbourne Water (Heron *et al*., 1999). The model was developed in response to a need to determine waterway management activities in an environment of competing projects and limited resources (Heron *et al*., 1999). It is a computer-based model which interrogates information on waterway condition and calculates ratings for waterway threat, value, risk and benefit of waterway management activities according to specified rules. It utilises an environmental risk based approach to the management of waterways. Environmental risk is a function of the extent and severity of environmental threats to a waterway and the values of the waterway; the greater the risk, the greater the potential loss of values because of threatening processes. Figure 2 illustrates the contribution of ERAPSM to a priority setting framework (boxes in bold).

Rules are used to derive numerical value scores (ranging from 1 to 5) eg. a value score of 1 (very low) would be applied to a river reach where bank vegetation was largely exotic or had been cleared. Reach risk is calculated as the sum of all value scores multiplied by the sum of all threat scores. The higher the score the higher the risk of losing the river values and hence the higher priority for managing the threatening process. Because information is collected at the reach scale, risk can be calculated at various scales, by integration of scores.

ERAPSM provides many data sorting and selection tools that can be activity specific. For example, it has been used to assist in developing a weed management works program. Priority setting rules were established using a forum as part of an 'activity strategy' for weeds. The rules required that the:

- highest proportion of funding should be given to waterways that exhibited high value vegetation and moderate weed threat; and
- some funding should be provided to waterways that exhibited high value vegetation and low weed threat.

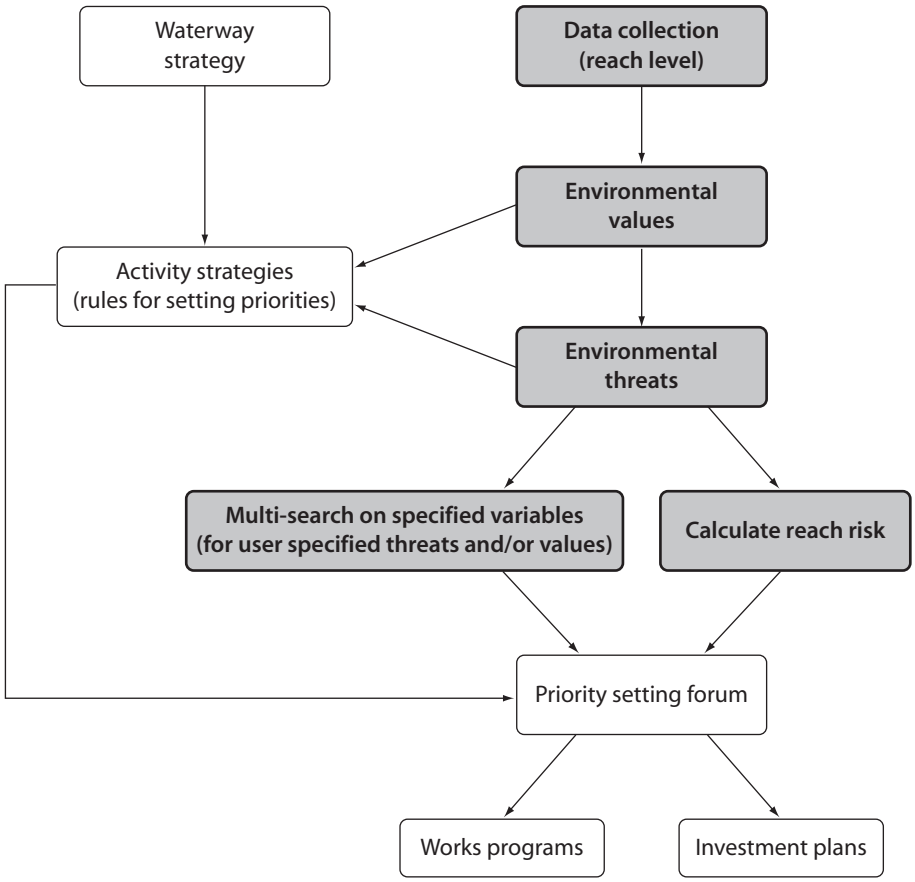

Figure 2 Contribution of ERAPSM to priority setting framework. Adapted from Heron *et al.* (1999)

Data deficiencies

Priority setting may be difficult where data are few or absent. In such situations the use of an expert panel can be an effective compromise

3.1.3.5 Determining the appropriate action(s)

Once relative ecological values, threats and priorities have been established, planning processes can be used to identify the right mix of actions required to protect these values, giving due consideration to identified threats, available resources, timing, etc. Such planning processes are used by the many catchment management groups and other planning groups throughout the country. For example, regional (natural resource management) strategies (Queensland) are planning tools to provide a regional framework to guide actions for achieving sustainable resource use and development and as such give consideration to ecological values. Catchment/river management authorities (Victoria) implement regional catchment strategies. They identify priority activities and work programs under these strategies. Catchment management boards and catchment management trusts in New South Wales are also charged with preparing catchment management plans. The challenge for these processes is to get the right balance of protection and restoration actions to maximise the ecological outcomes.

3.1.3.6 General discussion

QEPA is currently developing a guideline to assist with developing river protection plans. This guideline will also develop the priority setting process further and record and synthesise the range of river planning instruments currently utilised. Part of the planning process involves the identification of the most appropriate instruments for maintaining and/or enhancing the identified ecological values. Such instruments are discussed in the following section.

3.1.4 Protection instruments/processes

This section discusses the range of instruments and processes which are currently in place for the protection of the ecological values of rivers and other, non-riverine ecosystems. Examples of instruments used in other ecosystems are included because there are very few instruments specifically applicable to rivers. Further, non-river specific instruments could potentially provide for the protection of waterway ecological values. An assessment of the effectiveness of each example is beyond the scope of this document, but a comment on the likelihood of successful protection based on each instrument is presented.

Protection of rivers is likely to occur at a range of scales, from the catchment level (eg. through a catchment planning process), at the level of the river section (eg. designation of National Parks), through to individual properties. People throughout the community have direct responsibility for the management of species and ecosystems. It is recognition of community involvement that will ultimately lead to the development of the types of incentives and instruments that are most likely to succeed in promoting conservation and ecological sustainability. In addition, local communities interact with all three levels of government.

Conservation of rivers should be linked to conservation efforts on land, and the protection of rivers should focus on the protection and preservation of the land that rivers flow through. Additionally, the actions for conservation of rivers should be integrated at different geographic scales. The piecemeal application of conservation tools (land acquisition, riparian restoration, etc.) will not work if efforts are not coordinated across both geographical and political boundaries, as the scale of remediation activities is simply too small to have more than a local effect. Sapsford (1998) suggests that conservation is a decentralised activity; it is the outcome of a range of individual and collective actions. As a result it relies as much on motivation and shared goals as on rules and controls. Conservation requires an integrated approach because of the multi-faceted nature of the issue.

Dunn (2000) suggested that there was no single instrument that would effectively protect waterway values, and that a combination of instruments, applied on a case-by-case basis, would need to be considered. Such an approach is also recommended by Young *et al*. (1996). These authors suggest that a ‘single instrument’ or ‘single strategy’ approach is misguided, because all instruments have strengths and weaknesses and because none is sufficiently flexible and resilient to be able to successfully address all threats to ecological value in all ecological, social, economic and institutional contexts. Accordingly, in a large majority of circumstances, a mix of instruments is required. The mix should be tailored to specific policy goals. Combinations of instruments, appropriate to particular threats to ecological values at any location, will be the most effective response. The success in maintaining or enhancing values will be greatest if an understanding of the unique features of river systems underpins any goals for river protection or rehabilitation/restoration. These features include:

- the non-renewable nature of rivers—while the physical components of the river system may be replaceable (water, sediment etc.), the biotic components may not be, as many species are not even known; and
- the functioning of river ecosystems is poorly known, so the impacts of the loss of species and the way in which ecosystems respond to such losses remain largely unknown.

In addition, sustainability thresholds are frequently not known. As a consequence, for example, assessing the impacts of a development proposal on conservation values is difficult. Finally, other than water, few components of river systems have immediate economic value, so there may be tensions between public and private interests.

There is a range of instruments which could potentially be used to protect rivers. These instruments can broadly be described as:

- legislative mechanisms;
- non-legislative instruments such as agreements, policies, strategies, programs, codes of practice;
- planning mechanisms;
- voluntary property-based mechanisms;
- financial and other motivational mechanisms; and
- voluntary action groups.

Table 11 presents a summary of the types of instruments and their potential users, along with a description of what each instrument can potentially do (the overall outcome), some examples of specific actions leading to each outcome and examples of existing instruments. Appendix 3 provides a more comprehensive listing of available instruments and their specific outcomes, although this list is by no means exhaustive and is aimed at guiding the reader in the kinds of instruments and outcomes possible. The particular table in Appendix 3 relevant to each type of instrument is referred to in Table 11. A general discussion of each of the types of instruments is also presented below. The relevance of these instruments to users depends on the management framework under which the user operates. For example, government agencies would be the most likely to use legislative instruments for protection of rivers, water quality or water quantity. In contrast, individual landholders have an opportunity to protect ecological values through voluntary agreements such as conservation covenants. Doolan (2000) presented a summary of the management roles for those involved in river management. This summary is presented in Appendix 4.

Table 11. Potential instruments available for the protection of ecological values of rivers

Instrument	Who uses it?	What can it do?	Examples of outcomes	Examples of instrument [Relevant table in Appendix 3]
Legislation	Government	Protect rivers	• protection of land adjacent to rivers; restrictions on developments in catchments of such areas	*Heritage Rivers Act 1992* (Vic.) [Table A3.1]
		Protect flora/fauna	• declaration of protected areas (eg. Fish Habitat Areas, National Parks, Marine Parks, Nature Reserves) • protection of significant species, habitats, ecosystems	*Nature Conservation Act 1980* (ACT) *Fisheries Act 1982* (WA) [Table A3.2]
		Protect water quality	• establishment of ICM framework • retention and management of native vegetation • management of point and diffuse pollution sources • consideration of potential impacts of proposed developments	*Native Vegetation Act 1991* (WA) *Environmental Protection Act* (Qld) [Table A3.3]
		Protect quantity	• development of environmental flow allocations	*Water Act 1989* (Vic.) [Table A3.3]
Agreements	Government	Preserve habitats	• preservation and maintenance of wetlands	Ramsar Convention [Table A3.4]
		Preserve species	• protection of migratory species	JAMBA/CAMBA [Table A3.4]

Table 11. (cont'd) Potential instruments available for the protection of ecological values of rivers

Instrument	Who uses it?	What can it do?	Examples of outcomes	Examples of instrument [Relevant table in Appendix 3]
Agreements	Government	Promote adoption of environmental protection instruments	• provide assistance in adopting environmental protection instruments	Rio Declaration (Agenda 21) [Table A3.4]
		Promote cooperation in environmental matters	• promote inter-governmental cooperation on environmental matters	IGAE [Table A3.4]
Policies	Government	Establish environmental values/objectives of waterways	• aid planning for waterway and associated catchment use	State Policy of Water Quality Management (Tasmania) [Table A3.5]
Strategies/ Programs	Government	Establish guidelines	• national framework and guidelines for water quality	National Water Quality Management Strategy [Table A3.6]
		Establish principles	• biodiversity principles	National Local Government Biodiversity Strategy [Table A3.6]
		Manage off-reserve values	• identification of management needs of off-reserve values	National Endangered Species Program [Table A3.6]
Codes of practice	Government Industry	Provide guidance on management of activities to prevent/ minimise environmental impacts	• preparation of an erosion and sediment control plan	Erosion and Sediment Control Code of Practice 1998 (Tas.) [Table A3.7]
Planning instruments	Government, Catchment Authorities, Community/ Non-Government Organisations, Individual landholders	Catchment planning activities to manage/enhance ecological values	• planning activities to manage the catchment to maintain/ enhance ecological processes and biodiversity	River Management Plans [Table A3.8]
Voluntary property-based instruments	Individual landholders	Voluntary agreements to set aside significant land/vegetation/ river section	• establishment of conservation covenant	Conservation Covenant (Tasmania) [Table A3.9]

Table 11. (cont'd) Potential instruments available for the protection of ecological values of rivers

Instrument	Who uses it?	What can it do?	Examples of outcomes	Examples of instrument [Relevant table in Appendix 3]
Financial and other motivational instruments	Catchment Authorities, Community/ Non-Government Organisations, Individual landholders	Provides incentives and disincentives	• National park fees	[Table A3.10]
		Increases awareness	• environmental education programs	
		Provides funding	• Riverbank replanting programs	• Natural Heritage Trust
Voluntary action groups	Government, Catchment authorities, Community/ non-government organisations, Individual landholders	Various activities undertaken in relation to river management eg. lobbying, surveys, monitoring, rehabilitation, education, awareness campaigns, local management of waterways	• National Rivercare Program	[Table A3.11]

3.1.4.1 Legislation

Legislation is largely administered by governments (all levels).

Direct protection of rivers

There is a considerable range of legislation which could potentially influence conservation outcomes for rivers. However, there is very little direct legislative protection of rivers in Australia, with the *Heritage Rivers Act 1992* (Vic.) and the *National Parks and Wildlife Services Act 1974* (NSW) being the only examples to date. Legislation which results in the establishment of national parks or other conservation areas may result in the protection of rivers, but such legislation does not specifically identify the importance of rivers in their own right. Some rivers may receive protection if they flow through a national park or other protected area, although protection of river values is not guaranteed unless upstream and downstream activities are also managed to maintain these values. Table 1a of Appendix 3 provides examples of such legislation from Australia and overseas.

Protection of species/communities

While there appears to be considerable opportunity for the protection of species through legislation, few aquatic species are actually included, generally as a consequence of lack of information on relative significance, which stems from a lack of knowledge about relative distribution, abundance and ecology, as well as poor taxonomic resolution of many aquatic fauna and flora groups. In addition, much of the fisheries legislation is targeted at preserving recreational and commercial fisheries and is not directly relevant to conservation. There is also much merit in considering the legislative protection of aquatic communities/ecosystems rather than simply concentrating on individual species, given the complexities of aquatic environments. Such an approach is used in some legislation eg. *Environment Protection and Biodiversity Conservation Act 1999*. Table A3.2 of Appendix 3 provides examples of this type of legislation.

Protection of water quality/quantity

Protection of water quality/quantity is a potentially powerful instrument for protecting the values of waterways, as both are key features of sustainable river systems. Legislation relating to water quality and quantity can be found in all States and Territories, although the recognition of the need to maintain and protect ecological values varies considerably under such legislation. Table A3.3 of Appendix 3 provides examples of such legislation.

3.1.4.2 Agreements/policies/strategies/programs/ codes of practice

Australia's National Strategy for Ecologically Sustainable Development (NSESD) acknowledges the national and international dimensions of sustainable development. The NSESD calls for the provision of a policy framework which supports the efficient and environmentally responsible development of the nation's resources. Within the framework of the NSESD, several strategies and plans provide a focus for particular

resource issues, including the National Strategy for the Conservation of Australia's Biological Diversity, the National Water Quality Management Strategy and the Council of Australian Governments' (COAG) Water Reform Framework. There are various agreements and policies which address protection of rivers and which are of national or international relevance eg. the Ramsar Convention. Tables 1d and 1e of Appendix 3 provide examples from throughout Australia.

There is also a range of strategies/programs currently in place which broadly aim to protect values of relevance to rivers eg. the National Local Government Biodiversity Strategy. They are found at all levels of government, as well as at international levels. Table 1f of Appendix 3 provides examples from throughout Australia.

There are many activities which potentially impact on waterway values. Codes of practice are designed to minimise such impacts and therefore provide a potential instrument for maintenance of existing waterway values. One example is the Erosion and Sediment Control Code of Practice (1998) for Tasmania. Table 1g of Appendix 3 provides examples from throughout Australia.

3.1.4.3 Planning instruments

While waterway protection is likely to occur largely at a reach level, a catchment level strategy allows for a more holistic approach to identification and management of values, and threats to these values. There are many examples of catchment level planning processes which address waterway values, although many of these relate to maintaining condition rather than ecological value per se (ie. they do not consider other aspects of relevance to conservation, such as diversity and rarity). Better planning can lead to better river management. An example of a planning instrument is the River Management Plan (NSW). Table 1h of Appendix 3 provides examples from throughout Australia.

3.1.4.4 Voluntary property-based instruments

Voluntary programs are often favoured over binding contractual arrangements or compensatory measures as an instrument for conservation on private property. Contractually binding management agreements are not as prevalent in Australia as voluntary agreements. Most States and Territories operate voluntary schemes to protect specific habitats or to restrict farming practices. Regulatory agreements operate in some States. Even voluntary management agreements that offer financial incentives are not widespread, probably because of the ongoing funding requirements of such agreements. The financial assistance applicable as part of many of the voluntary management schemes offered by States and Territories is sometimes provided on the costs of material associated with the work required. A conservation covenant is a legally binding agreement between two or more parties to protect an area, either for a specified amount of time, or in perpetuity. They can be achieved without acquiring ownership of the land. Table A3.9 of Appendix 3 provides examples from throughout Australia.

3.1.4.5 Financial and other motivational instruments

Financial instruments can include both incentives (eg. grants, compensation, payouts, etc.) and disincentives (eg. charges for activities, etc.). The use of financial instruments varies considerably throughout the country. Motivational instruments largely revolve around the provision of information and education. Information provision is essential, for only with adequate information can decision-makers arrive at determinations that do not lead to unintended consequences (Young *et al*., 1996). One example of a disincentive is national park fees. Some examples of such instruments are presented in Table 1j of Appendix 3.

3.1.4.6 Voluntary action groups

Programs such as Landcare are essential for ensuring practical, relevant decision-making for natural resource management in rural Australia. By involving community members who naturally link social, economic and environmental aspects of their lives and who have a vested interest in change, an integrated and sustainable approach to natural resource management and rural development can be achieved. There are also many groups dedicated to the maintenance and enhancement of natural resources and who represent a significant resource for use in enhancing the conservation planning process. One example of such a group is the National Rivercare Program. Table 1k of Appendix 3 lists some of the existing programs that directly involve the community.

3.1.4.7 Which instrument is best?

Processes for protecting rivers must consider the needs of all users. This includes future generations, the wider community and the environment, as well as those people currently in the local area. Effective protection will be implemented using a 'package' of instruments which share a number of characteristics reflecting these diverse needs. Sapsford (1998) summarises the key features of such a 'package'. The package of instruments should be:

- *robust*—deliver relatively predictable results in situations of uncertainty about ecological value;
- *precautionary*—minimise the chance of serious or irreversible consequences due to uncertainty;
- *flexible*—be able to be adapted to changing knowledge;
- *equitable*—operate without advantage or favour across all groups and generations;
- *cost-effective*—achieve their outcomes in ways that minimise the overall costs of doing so;

- *acceptable*—be seen by the community as legitimate means of promoting conservation, be incorporated into everyday life, assist in motivating people and have social and political support;
- *durable*—create ongoing incentives for innovation towards improving ecological value; and
- *informative*—encourage active self-monitoring and the dissemination of information.

No single instrument demonstrates all of these features. These features can best be thought of as a checklist of criteria against which a package can be evaluated. The exact mix of instruments will often depend on local circumstances. All instruments have strengths and weaknesses. The key is to find the optimal mix of instruments to meet both national and State goals and local circumstances. Finding this optimal mix is aided by all stakeholders having a good understanding of the strengths and weaknesses of the various types of instruments. With any type of instrument, widespread acceptance and understanding improve effectiveness and reduce monitoring and compliance costs.

3.2 Barriers/constraints to effective river protection

Barriers to effective river protection are many and varied and are likely to be met at all stages of the process of planning for and undertaking actions to address river protection. Various authors describe barriers to effective protection of ecological values (eg. Young *et al*., 1996; Dunn, 2000; Stockwell, 2000). Such barriers include the following:

- *Accommodating multiple users*—this may be an issue when establishing the vision of what is desired from the planning process, as expectations are likely to differ. For example, an irrigator may have a substantially different view from that of a recreational fisher of what a river should be like. Conflicting interests often relate to economic realities.
- *Lack of information*—it is essential that adequate information be available at all stages of the planning process, so that informed decisions can be made. Such information should be relevant to the end-user (eg. locally relevant).
- *Multiple and potentially conflicting legislative instruments*—in the event that a planning process incorporates a legislative element, establishing a vision based on one piece of legislation may not be achievable when the wider context of legislation relating to river management is considered.
- *Cross-border issues*—these are complex issues and can make planning at a catchment level difficult. They may include differences in legislation, political imperatives, policies etc.
- *Harmonising river protection and land-use activities*—land adjacent to rivers needs to be managed in harmony with the values of the rivers. For example, protection of a section of river using national park establishment legislation may not maintain the ecological values in the long run if, for example, an upstream activity results in degradation in water quality.
- *Funding*—there is a tendency for funding to be provided on a site-by-site basis, allowing little chance of a more holistic approach to river management. Also, there is seldom sufficient funding to implement a given plan, with funding being provided incrementally (eg. funding for development of a plan is provided without additional funding for implementation and monitoring).
- *Establishment of roles and responsibilities*—good planning should identify who does what, so that actions are implemented. Such planning requires good leadership and direction. All participants need to be involved at all stages (establishing a vision, planning, implementation and monitoring/review) of the process.
- *Communication*—there are often inadequacies in the way information is made available. For example, written information may be less valuable than learning by extension, best practice and participation in conservation programs.
- *Understanding the value of rivers*—there is a need to increase understanding of the values, including the inter-relationship between environmental, economic and social values.

4 Case Studies Illustrating the Application of Protection Principles and Tools

Here we present examples of river planning processes that have incorporated the principles and tools identified in this document. A review of a number of cases, indicates that many of these processes *are targeted almost solely at the restoration of degraded systems, and not at the protection of significant assets (values)*. Nevertheless, it is anticipated that the case studies here will guide readers in the additional steps that need to be undertaken to address river protection and it is not intended to imply any criticism of the plans used. In addition to a discussion on the extent of incorporation of protection principles and tools, how each case study addresses the key planning process elements (as discussed in section 1.4 of this document) is examined. Thus the discussion of each case study is presented in the following format:

- introduction to the case study;
- establishing the vision;
- developing the plan
  - criteria and methods used to identify ecological values,
  - priority setting,
  - instruments used;
- implementation; and
- monitoring and review.

Specific comments relating to those elements relevant to this document (ie. developing the plan and components thereof) are highlighted in italics.

4.1 Draft Mary River Rehabilitation Plan (Queensland)

4.1.1 Introduction to the case study

The Mary River is a large south-east Queensland catchment that has had several decades of rural and urban settlement and development and as a consequence has a river system that in general is significantly degraded but retains some values and sub-catchments of regional conservation significance (Stockwell, 2000). It is the last known remaining habitat for the Mary River cod and the Mary River turtle. The Mary River Catchment Coordinating Committee (MRCCC) (a non-statutory body) is developing a rehabilitation plan for the Mary River using the process outlined in the *Rehabilitation Manual for Australian Streams* (Rutherfurd *et al*., 1999, 2000). Table 12 summarises the key elements in the process used in developing the Mary River Rehabilitation Plan (MRRP).

It must be noted that this plan is non-statutory. The implementation of the plan will be dependent on the extent to which State agencies, local governments and community groups incorporate its findings in their activities.

The purpose of the plan is to prioritise rehabilitation effort on a reach-by-reach basis. The long term objective of the plan is to protect waterways of conservation value, while rehabilitating and restoring degraded reaches in a more strategic and cost-effective manner than has occurred in the past, to achieve the shared vision for the future. The key principle behind the process used in the development of the plan is that protection of natural assets (values) is more cost effective than rehabilitating highly degraded reaches. A biophysical approach is advocated for the prioritisation of rehabilitation/ protection effort, based on river reaches/styles, geomorphic assessment of the recovery potential of rivers and conservation status. A consultation process will then be used to balance these priorities against those driven by the social, economic and cultural values of the river system. A discussion follows of how the draft MRRP addresses each aspect of the process outlined in this document for river protection.

4.1.2 Establishing a vision

There has been considerable local effort in restoration and management of waterways and riparian zones in the Mary River catchment, through the involvement of individuals, groups and councils. A review of previously stated goals and objectives of river rehabilitation in the Mary River catchment was therefore undertaken by reviewing existing documentation. The outcomes of this review were presented at a ‘vision workshop’. A draft vision for the MRRP has been developed and sets out a

50-year vision, along with 10-year goals. The MRRP emphasises the importance of establishing a realistic (ie. achievable) vision, which is based on lessons learnt from past mistakes. The MRRP aims to get broad acceptance of an agreed vision and a commitment to its achievement. In doing this, it is acknowledged that this is an ongoing, iterative process.

4.1.3 Developing a plan

4.1.3.1 Criteria and methods used to identify ecological values

As indicated in Table 12, the development of the MRRP involved several steps which identified its current assets (values) and threats to these assets (values). A review of existing information was undertaken and included:

Table 12. Summary of elements of rehabilitation frameworks used in developing the MRRP

Recommended elements/steps in models	Brierley (1999)	Rutherfurd *et al.* (1999)
Set goals and vision for rehabilitating of your stream		×
Do other people share your vision of an ecologically rehabilitated stream?		×
Baseline survey of catchment boundaries, topographic and geological maps, sketch long profiles, identify discontinuities	×	
Baseline survey of river character and behaviour: Classification of (geomorphologically homogeneous) reaches	×	×
Assessment of river condition, framed in terms of river evolution and recovery potential following disturbance	×	×
Catchment audit—What are your stream's main assets and problems?—biophysical and cultural characteristics to evaluate linkages between catchment processes and river instability	×	×
Historical analysis—to establish and understand links between catchment controls, local factors and river channel changes and to determine whether the pre-disturbance channel form can be reinstated or a different morphology designed because of altered catchment conditions.		×
Identify relevant utilities that are affected by the problems.		
Setting priority reaches—which reaches and problems should you work on first, considering conservation, ecological and recovery trends in selecting reaches (as opposed to focusing on erosion control and stabilisation).	×	×
Identification of reference reaches (relatively natural channel that is to provide a rehabilitation template)	×	×
Create detailed, specific and measurable objectives that will be the core of your stream rehabilitation plan.		×
Develop strategies to protect natural assets and improve your stream—identify and list the things that you can do to protect and improve the important natural assets in the reaches that you identified as a high priority in the last step.		×
Integrate hydraulics, hydrology, geomorphology and ecology—create a multi-functional team; community consultation and ownership is essential.		×
Test feasibility of objectives—many factors, such as cost, politics, and undesirable consequences for other users of the stream, may require alteration of priorities.		×
Develop assessment criteria to evaluate project—measurable becomes the basis for evaluating the project.		×
Monitoring and auditing		×

Source: Stockwell (2000)

- a review of existing information on Australian river processes, fluvial geomorphology and aquatic ecology and their application to river restoration; and
- a review of previous research and surveys in the Mary River catchment dealing with hydrology, geology, history, ecology, condition and use of streams and their resources.

Preparation of the MRRP brought together scientific, management and community aspects of rehabilitation planning. It is suggested in the MRRP that an appreciation of the physical, biological and cultural (social) attributes of the catchment is an essential element of a strategic framework for river rehabilitation.

In identifying assets (values) and threats, current condition was compared with that of reference reaches. Known reaches/localities of conservation significance were identified by compiling:

- distribution data on rare, endangered, threatened or listed species within aquatic, riparian and floodplain habitats;
- existing and proposed (under Regional Forestry Agreement) protected areas;
- 'of concern' regional ecosystems that have a linkage with riverine ecosystems;
- known remnants of high integrity on private lands; and
- valuable features within the riverine system.

In addition, an analysis of data collected from stream surveys, including data on geomorphology, water quality and macroinvertebrates, was undertaken.

The methods used in this case study are clearly aiming to recognise wider ecological values and not just condition/ naturalness. Although not explicitly stated, it is evident from consideration of the information used in the draft MRRP that the criteria of naturalness, rarity, diversity and representativeness (at a regional level) are used to determine the conservation value of reaches in the Mary River. These criteria are consistent with those identified in this document as being important in determining the ecological value of rivers.

4.1.3.2 Priority setting

A regional workshop of 50 river professionals, technical officers, environmental scientists, aquatic ecologists, fish biologists and catchment management representatives was facilitated to develop a draft set of regional 'Rivercare' priorities. This process involved identification of the assets, their relative values and the threatening or degrading processes that impact upon them. Homogeneous reaches and isolated 'island' segments were assigned to one of seven categories. Table 13 details the categories used. The priorities take into account were:

- rarity (rare before common);
- condition (good before bad);
- trajectory (degrading versus recovering); and
- ease to fix (easy before hard).

The use of geomorphic recovery potential as a template against which ecological values are assessed addresses some issues relating to the sustainability of the ecological values.

Generic strategies were developed for each category of reach. Objectives were established which set the level of change in stream condition and the length of time for the desired response to be obtained. It is proposed to analyse the feasibility of the objectives as part of the community consultation process.

4.1.3.3 Instruments proposed for use

Instruments for use in both protection and rehabilitation were recommended as strategies in the draft MRRP. Examples of protection instruments recommended include:

- financial and other motivational instruments

Table 13. Biophysical reach prioritisation categories

Priority category	Criterion used to set priority
0	Protected reaches of good condition throughout
1	Protecting and restoring reaches of regional conservation significance
2	Protecting and rehabilitating reaches of local conservation significance
3	Protecting deteriorating strategic reaches
4	Improving linking/close reaches and isolated islands
5	Improving moderately damaged reaches with moderate to high recovery potential
6	Highly degraded reaches with little chance of natural recovery

Source: Stockwell (2000)

  - provision of incentives, advice and encouragement to riparian landholders to retain and manage all existing native vegetation within riparian buffers, actively conserve key areas and ensure that all development permits restrict clearing within riparian areas;
- planning instruments
  - erection of riparian fencing and exclusion or active management of stock access to streams,
  - requirement for all infrastructure construction authorities to ensure appropriate sediment and erosion control regimes are incorporated into contracts for stream crossings,
  - minimisation of inter-basin transfers of water by taking a long-term approach of facilitating good local government planning which acknowledges the goal of the MRRP, and
  - minimisation of demands for, and defer construction of, new major in-stream impoundments by introducing urban and rural water re-use and water use efficiency, and encouraging sustainable water harvesting and off-stream storage; and
- codes of practice
  - review of the native forest management code to ensure it meets best practice with respect to riparian buffer widths, forestry track construction and harvesting in steep unstable areas.

These instruments are consistent with those discussed in previous sections of this report and include incentives, codes of practice and planning strategies. Management of water quality and forestry activities are at least partly covered by legislation. The recommended development of detailed reach-by-reach 'Rivercare' plans is considered an essential next step in the planning process.

4.1.2 Implementation

The strategies detailed in the plan clearly identify tasks that need to be undertaken. It is envisaged that implementation would require further case-by-case assessment of specific values, as well as roles and responsibilities. Funding is being sought for the finalisation and implementation of the plan (Stockwell, pers. comm., October 2000).

4.1.3 Monitoring and review

The MRRP stresses the importance of monitoring the effectiveness of any actions undertaken as part of the plan. It suggests that information collected as part of the development of the plan could provide a baseline against which to monitor change.

4.1.4 Conclusion

The MRRP was not written specifically as a river protection plan. However, the plan covers many of the aspects identified in this report as being necessary for its development. It is clear that the MRRP encompasses more than rehabilitation activities and highlights the continuum of activities that can be undertaken as part of the management of a river. Section 5 discusses this concept further. The MRRP has not as yet been finalised and awaits implementation. The plan has no statutory basis and so its implementation will depend on the extent to which its findings are incorporated in the activities of agencies and adapted by the community.

4.2 Capel River Action Plan (Western Australia)

4.2.1 Introduction to the case study

The Capel River is the largest river in the Geographe Bay catchment. Growing concern about the health of the river by residents, particularly in relation to water quality and riverbank stability, prompted the development of the Capel River Action Plan (White and Comer, 1999). This plan reports on the state of the river, and provides a prioritised plan of action to address degradation of the Capel River.

4.2.2 Establishing a vision

The primary aims of the plan are to:

- provide a benchmark against which the local community's future work to protect and rehabilitate the river can be gauged;
- provide a tool to better guide the limited resources available for weed control, erosion control, tree planting and rehabilitation;
- provide a sound technical basis for future funding or project submissions; and
- produce a description of the state of the Capel River and a river action plan which provides a prioritised plan of action through which riverine degradation can be addressed.

A specific vision for the river is not enunciated in the plan.

4.2.3 Developing the plan

4.2.3.1 Criteria and methods used to identify ecological values

The Capel River Action Plan was developed by walking the entire foreshore of the river to systematically assess and map foreshore condition, erosion and weed infestation, existence of and requirements for fencing; and the type and cover of vegetation present. Individual landholders were involved in this assessment. Several foreshore reserves are situated on the river and some have previously been found to have significant conservation value. Degradation of the original values of some of these reserves may have resulted from weed infestations. Most are considered to have high recreational value. The

foreshore assessment method (Pen and Scott, 1995) was used to assess the condition of the riparian zone and channel. Management issues were also identified as part of this process. Principles for revegetation, erosion control and fencing are included in the plan.

The methods used to define values are targeted more at condition/naturalness assessment and do not include other aspects of ecological value. The criteria of representativeness, naturalness and special features appear to have been used to determine the significance of the foreshore reserves.

4.2.3.2 Priority setting

This was achieved by undertaking a series of public meetings to inform the local community of the action plan; to report results of field assessments; and to obtain local contribution to the prioritisation of the recommendations presented within the plan. Major issues (threats to values) were also canvassed at these meetings.

The specific process for determining priorities was not discussed in the plan.

4.2.3.3 Instruments used

Priorities were largely centred around the actions (instruments) of fencing, rehabilitation, weed and erosion control (codes of practice).

These instruments are targeted more at rehabilitation of degraded sites, rather than protection of good quality sites, although fencing off cattle can be viewed as a protection instrument.

4.2.4 Implementation

The resultant river action plan includes recommendations on priorities and approaches to restorative work, accompanied by detailed maps of the river foreshore which identify the location of sites which require restorative work. There is no discussion on potential implementation of the plan.

4.2.5 Monitoring and Review

The report is seen as providing a benchmark against which to monitor future works. Monitoring *per se* is discussed only in terms of the spread of weeds. Monitoring the effectiveness of the plan is not discussed.

4.2.6 Conclusion

This plan includes some of the elements relevant to the protection of waterways discussed in this report. However, it is aimed largely at restoration, partly because of the generally poor condition of the catchment. In addition, the values of the catchment are largely captured in foreshore reserves, although the effectiveness of these reserves in maintaining values is clearly in need of review, given the extensive weed invasion in some areas. As there was no consideration given to in-stream values, the process uses a subset of the principles and tools required for protection of the ecological values of rivers.

4.3 Murrumbidgee Catchment Action Plan (New South Wales)

4.3.1 Introduction to the case study

The Murrumbidgee Catchment Management Committee (MCMC) and associated subcommittees have developed an action plan for the Murrumbidgee catchment, to set priorities and direction for the future management of the catchment's natural resources (MCMC, 1998). The Murrumbidgee Catchment Action Plan for Integrated Natural Resources Management (MCAP) has been developed to provide a coordinated, strategic action plan, which translates the MCMC's statement of intent (the Natural Resource Management Strategy for the Murrumbidgee Catchment), community initiatives and government strategies into a plan of action to be carried out by the catchment community.

4.3.2 Establishing a vision

The MCMC's vision for the future is:

> 'a productive Murrumbidgee Catchment with healthy ecological processes and enhanced biodiversity'.

4.3.3 Developing the plan

4.3.3.1 Criteria and methods used to identify ecological values

To achieve this vision, the MCMC's Natural Resource Management Strategy has promoted four key initiatives:

1. the development and implementation of land and water management plans;
2. the development and implementation of specific issue plans and programs;
3. community awareness and education programs; and
4. complementary and coordinated government policies.

Assessment of the values of the catchment included a review of existing information.

Conservation values were identified using many of the criteria defined in this report (rarity, diversity, representativeness, special features, naturalness), although a systematic assessment process was not documented within the plan. Nevertheless, identification of significant areas, both terrestrial and aquatic, is presented in the plan.

4.3.3.2 Priority setting

Prioritisation of the issues for each of the catchment segments (upper, mid and lower) was carried out as part of a three-step process:

- review of literature and previous consultation processes involving the community and other groups, which provided the initial guide to issues and priorities within catchment areas;
- issues identified were then presented at four stakeholder workshops, within the catchment in July and August 1997. Participants in these workshops represented a broad cross-section of stakeholders. Issues were discussed and prioritised and a first draft of issues was established for each area;
- once this process was completed, members of the MCMC worked through the outcomes of the workshops and fine-tuned the ranking of the issues, applying their experience as catchment managers and involvement in previous prioritisation processes.

Criteria were established for consideration during the prioritisation of issues. The purpose of using these criteria was to encourage the individual to think on a catchment basis when ranking issues.

The criteria used by participants were:

- *extent of damage*—to what extent is damage to the overall environment (social, environmental and economic) caused by the issue?
- *synergistic nature*—to what extent does the issue have links to other issues?
- *scale of effec*t—how far-reaching is this issue?
- *level of community support and motivation*—what is the level of community support for addressing the issue?
- *level of community conflict*—what is the level of conflict within the community regarding the issue?
- *political exposure*—what level of political attention is the issue receiving?
- *urgency of action*—what is the rate of degradation related to the issue?
- *investment value*—what is the level of return for investing time, money and energy in addressing the issue?
- *existing management*—what level of existing management activities are already addressing the issue?
- *effectiveness of existing management activities*—how effective are the current management activities in addressing the issue?
- *availability of solutions*—what is the level of information available regarding the issue?
- *education/demonstration value*—what is the value of addressing the issue in terms of demonstration and/or education?

The MCAP notes that the priorities that have been determined are dynamic and are unlikely to remain the same for the entire life of the plan. An integral part of the MCMC's regular review of the plan will be reassessment of priorities to ensure that they continue to reflect the issues facing the catchment community. Reform processes, on-ground management works, increased awareness and seasonal variability may alter the importance of individual issues.

The priorities in the MCAP are intended to direct the allocation of funds from the wide range of State, Territory and Commonwealth natural resource and environment management programs. However, the priorities do not preclude consideration of project proposals addressing issues of low priority or issues outside the broad framework of the MCAP.

The priority setting process aims to come to a compromise on the management of ecological values within the social, economic and political climates. The criteria used to identify priorities cover a broad range of issues.

4.3.3.3 Instruments used

A range of actions (instruments) was recommended for each issue, along with performance indicators (eg. weed management). Voluntary conservation agreements were recommended as an instrument for the protection of remnant vegetation.

4.3.4 Implementation

The most effective way of implementing the MCAP has been to establish catchment management arrangements which:

- ensure that resources are targeted to the key priorities of the MCAP so that on-ground outcomes are delivered;
- properly integrate service delivery on interrelated issues;
- strengthen links between strategic planning and implementation of on-ground works; and
- have clearly defined roles, responsibilities and accountability.

In many situations, the MCAP will be implemented through the numerous locally based or issue-specific plans that are in place or are being developed by local communities. The MCMC will support these plans.

4.3.5 Monitoring and review

Monitoring and evaluation will:

- report on implementation of the actions outlined within the plan;
- assess the effectiveness of the actions addressing objectives; and
- provide feedback on new priorities.

The MCMC has a role in monitoring the condition of the natural resources of the Murrumbidgee catchment, and will coordinate monitoring of the MCAP's implementation.

4.3.6 Conclusion

This is a comprehensive plan which identifies a broad range of issues. The whole planning process is consistent with the concepts discussed in this document. However, the extent of assessment of riverine values per se *is not clear although there is acknowledgment of ecologically significant areas.*

4.4 Barron River Management Action Plan (Queensland)

4.4.1 Introduction to the case study

The Barron River is located in northern Queensland and is one of the largest easterly-flowing waterways in the region. The plan's purpose is to identify and prioritise stream rehabilitation works and management actions for the Barron River that address multiple uses while ensuring ecological sustainability. These uses include drainage and flood mitigation, ecological, recreational, economic and cultural/social uses. The authors used the conceptual framework developed by Kapitze *et al*. (1998) for stream rehabilitation planning at a catchment scale, along with the framework of Rutherfurd *et al*. (1999) which provides for multiple stream management objectives.

4.4.2 Establishing a vision

Aspirations for the catchment were canvassed as part of a five-year effort to prepare the Barron River Catchment Management Study. The vision adopted for the catchment (NRA, 2000) provides a context for the Barron River Management Action Plan:

> "For the community to develop and implement equitable and sustainable resource management practices, so that the economic, ecological and cultural values of the Barron Catchment are maintained and enhanced."

4.4.3 Developing a plan

4.4.3.1 Criteria and methods used to identify ecological values

There is considerable existing knowledge of the river. Initial investigations aimed to produce outputs which reflected both regional and site-specific issues. A description of the biophysical setting, values and threats, along with management needs was developed for the catchment. This broad sweep of values and threats will be reassessed on a case-by-case basis for different river segments in the next stage of the study. The criteria used to define values are only loosely referred to in the plan and include aspects such as condition (naturalness), biodiversity, special features (eg. fauna corridor) and rarity. Field work undertaken as part of the study concentrated largely on identifying threats to values.

The criteria used to define ecological value are consistent with those recommended in this document.

4.4.3.2 Priority setting

Priority setting was undertaken using a multi-criteria analysis which incorporated economic, environmental and social information, public opinion and management goals. It involved the development of an evaluation matrix that utilises qualitative information about the suitability and ranking of various options by rating them against a range of objectives. Values were considered in relation to identified threats. The overall relative value of each option is determining by aggregating the information.

The priority setting process aims to come to a compromise on the management of ecological values within the social, economic and political climates. The criteria used to identify priorities cover a broad range of issues.

4.4.3.3 Instruments used

The instruments recommended are largely targeted towards rehabilitation of degraded areas rather than specific protection of high value areas, but some of the catchment is in a World Heritage Area and is therefore protected.

Instruments such as fencing-out cattle may be seen as a step towards protection, but no consideration was given to the protection of river sections other than those already protected.

4.4.4 Implementing the plan

The plan identifies strategic and operational components to its implementation. It promotes integration with other planning processes at a strategic level and identifies roles and responsibilities at an operational level. The operational level is assigned to existing organisations/ groups in the catchment. Costings for work to be undertaken are also presented in the plan.

4.4.5 Monitoring and review

This aspect of the planning process is not discussed in the plan.

4.4.6 Conclusions

This plan is targeted at rehabilitating a degraded river system using a multiple objective approach, taking into account social, environmental and economic considerations. As such it uses a subset of principles and tools necessary for the protection of rivers.

5 How Does It All Fit Together?

This report has presented protection principles and an overview of current protection tools (ie. methods for assessing the ecological values of rivers, and existing and potential instruments for protection of these values). It therefore provides the basis for developing the components of river management plans that specifically target river protection.

The Planning Guideline being developed by QEPA (see Section 1.1) will build on this report to produce a guideline to assist in the planning process. The Planning Guideline, along with the guidelines for determining ecological values, ecological sustainability and for evaluating development options, will add to the 'tool kit' for river protection and management. This work also complements other 'tool kits' such as Koehn *et al*.'s (1999) *National River Restoration Framework* and Rutherfurd *et al*.'s (1999, 2000) *Rehabilitation Manual for Australian Streams*, which both focus of river rehabilitation.

Protection and rehabilitation of rivers are simply points along the continuum that river management activities can be applied (Figure 3). This figure also demonstrates that protection need not only apply to rivers of high ecological value. In addition, consideration of the ecological sustainability of a river will assist with an assessment of the priority for, and the likelihood of success of, any management activity, be it protection or restoration. Such an assessment would reflect not only its current condition and threats, but also its ability to sustain values when subject to further disturbance.

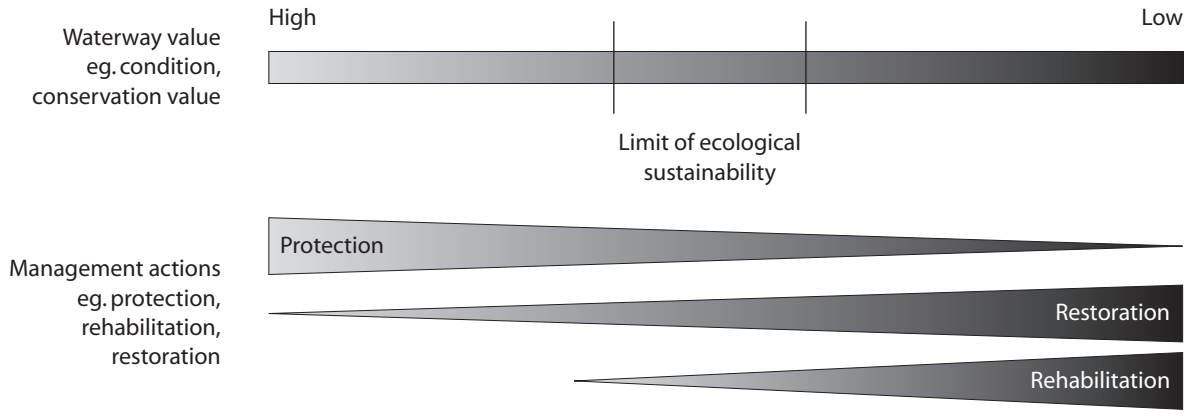

Figure 3. Continuum of river management activities

6 Where to Go for More Information

Australia Capital Territory	
General government contacts	http://www.act.gov.au
National Rivercare Program	http://www.affa.gov.au/docs/nrm/rivercare/about.html
Commonwealth	
Agriculture, Fisheries and Forestry – Australia	http://www.affa.gov.au
Environment Australia	http://www.ea.gov.au
New South Wales	
Department of Land and Water Conservation	http://www.dlwc.nsw.gov.au
General government contacts	http://www.nsw.gov.au
Northern Territory	
General government contacts	http://www.nt.gov.au
Queensland	
Environmental Protection Agency	http://wwwhost.env.qld.gov.au
Department of Primary Industries Fisheries	http://www.dpi.qld.gov.au
Department of Natural Resources	http://www.dnr.qld.gov.au
General government contacts	http://www.qld.gov.au
South Australia	
General government contacts	http://www.sacentral.sa.gov.au
Tasmania	
General government contacts	http://www.tas.gov.au
Western Australia	
General government contacts	http://www.wa.gov.au/home.html
Victoria	
Department of Natural Resources and Environment	http://www.nre.vic.gov.au
Catchment management authorities	http://www.nre.vic.gov.au/catcment/palmer/cma/index.htm
General government contacts	http://www.vic.gov.au
Other	
Australian Local Government Association	http://www.alga.com.au
Inland Rivers Network	http:/www.irnnsw.org.au
Bushcare	http:/www.envt.gov.au/bg/bushcare/index.htm

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Appendix 1
Examples of planning processes for rivers

Figures A1.1 to A1.3 provide examples of different planning processes, showing the common elements that should be used in the development of a river protection plan. For example, Figure A1.1 shows the basic steps for developing and implementing a plan for restoring a river as defined by Koehn *et al*. (2001) in their National River Restoration Framework. Figure A1.2 illustrates Queensland's activities in implementing the National Water Quality Management Strategy. Figure A1.3 illustrates the 12-step procedure Rutherfurd *et al*. (2000) propose for stream rehabilitation.

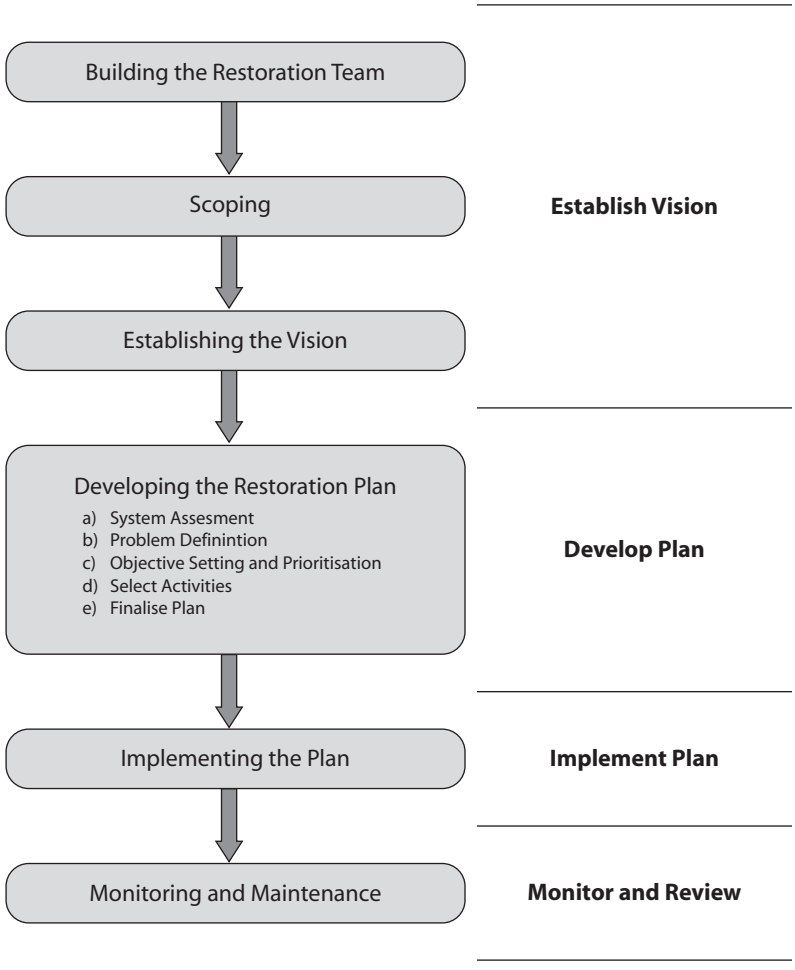

Figure A1.1. Basic steps in the river restoration framework
Source: Koehn *et al*. (2001)

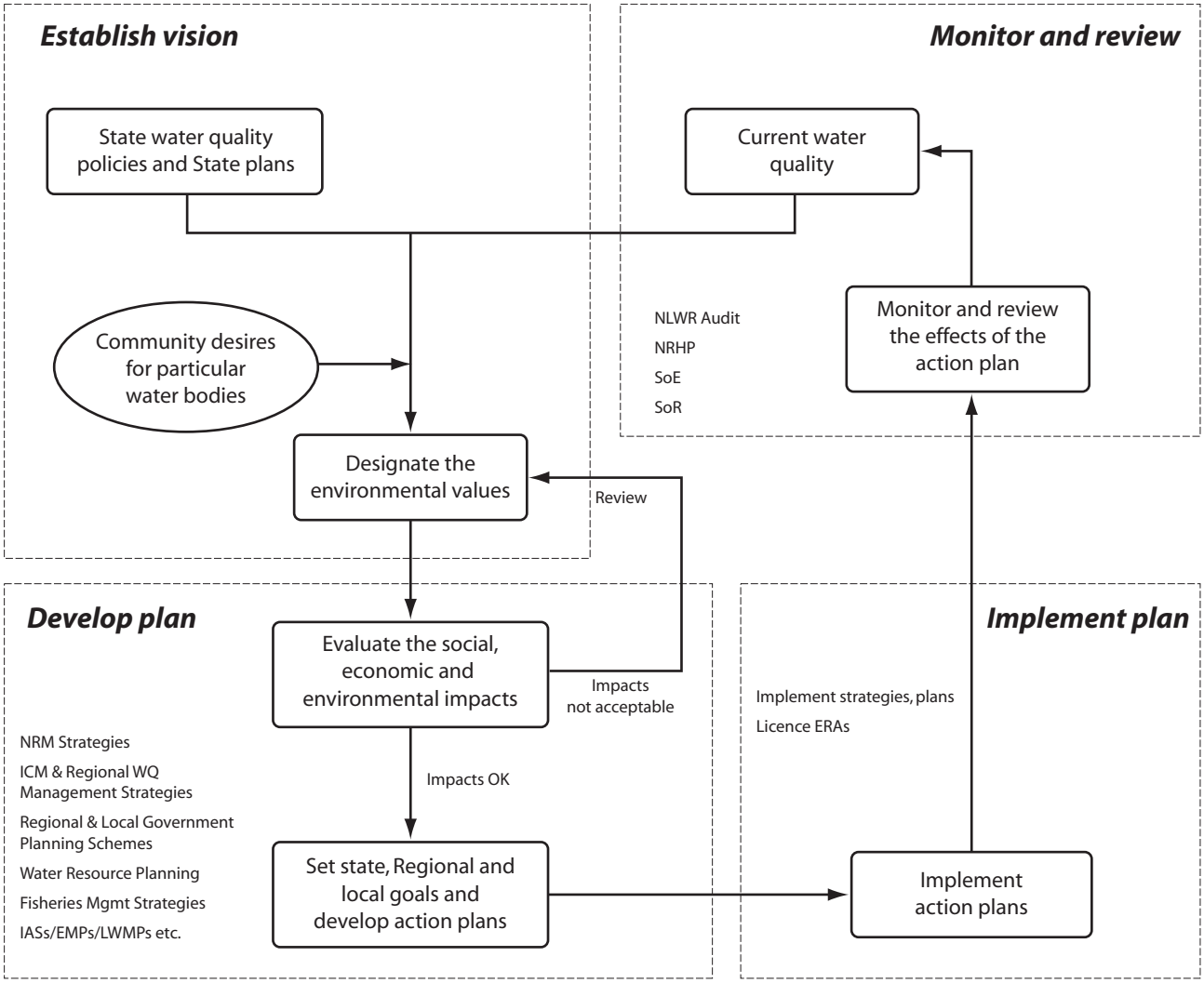

Figure A1.2. Queensland implementation of the National Water Quality Management Strategy

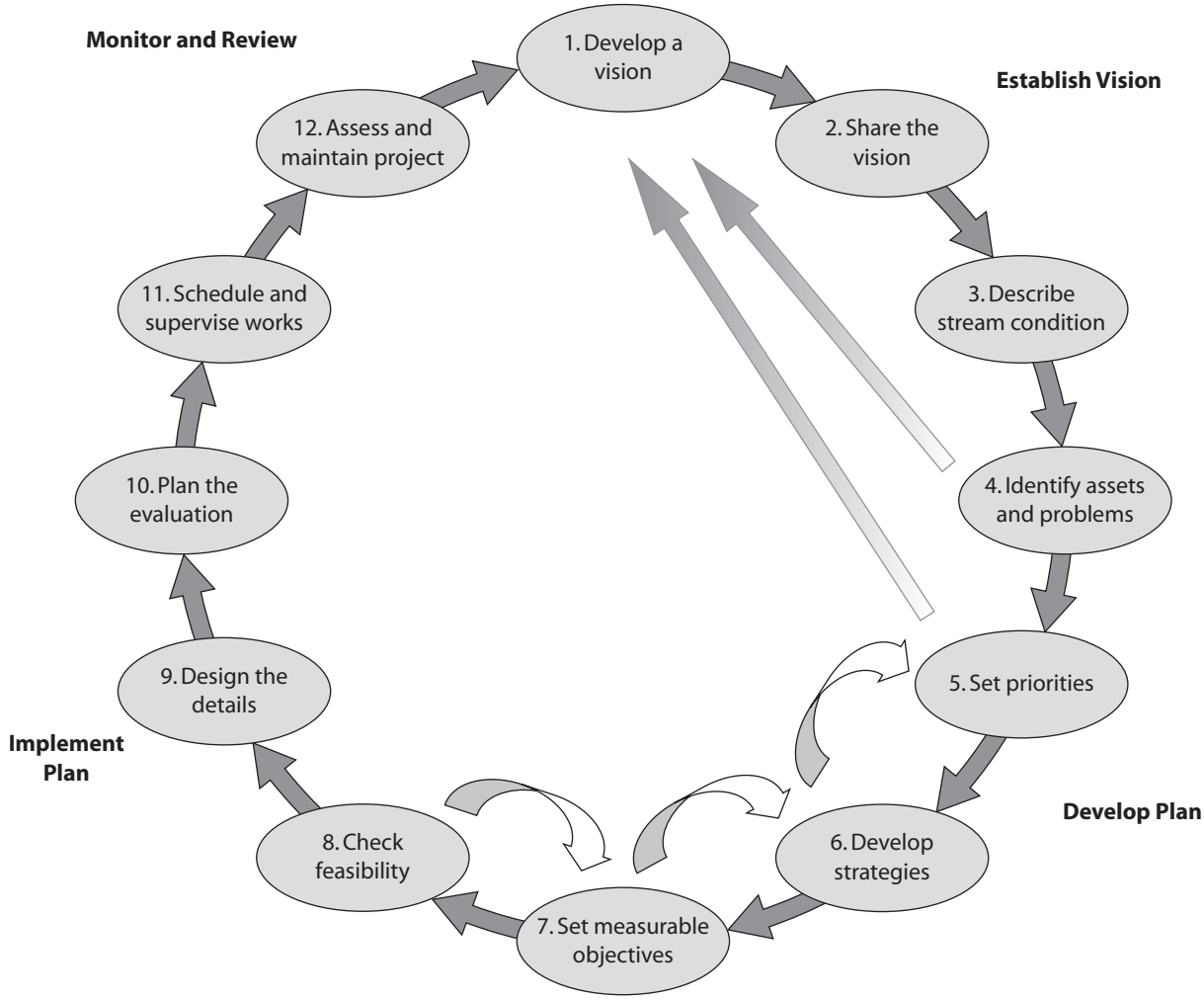

Figure A1.3. Flow-chart summarising the 12-step rehabilitation strategy of Rutherfurd *et al*. (2000)

Appendix 2
Examples of principles relevant to river protection

Tables A2.1–A2.6 present principles which target each of the criteria identified in section 1.3.3 of the main report as being relevant to the protection of rivers. In addition, general principles for the maintenance and/or enhancement of ecological values are presented. For each principle the ecological outcome is presented. This outcome reflects the consequences to the environment of adopting a principle and allows for commonalities across principles to be determined.

There is a plethora of principles which relate to the maintenance of ecological values and which will be common to any natural resource management strategy or plan. Some examples of these are listed in Table A2.1.

Table A2.1. Examples of general principles of resource management

Principle	Source	Ecological outcome
Consideration be given to establishment of landcare practices that protect areas of river with high environmental value or are sensitive	COAG Water Resource Policy	Protection of ecological value
Management and use (of wetlands) based on ecologically sustainable management	Qld Wetlands Strategy (1998)	Ecologically sustainable rivers/wetlands
Promote ESD through conservation and ecologically sustainable use of natural resources	*Environmental Protection and Biodiversity Conservation Act 1999* (Cwlth)	Ecologically sustainable rivers
That the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations	Australian Natural Heritage Charter (ANC, 1996)	Maintenance of ecological values for future generations
The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations	InterGovernmental Agreement on the Environment (1992)	Maintenance of ecological values for future generations
Public and private decisions guided by careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment	InterGovernmental Agreement on the Environment (1992)	Maintenance of ecological values
Our knowledge of natural heritage and the processes affecting it is incomplete, and that the full potential significance or value of natural heritage remains unknown because of this uncertain state of knowledge	Australian Natural Heritage Charter (AHC, 1996)	Maintenance of ecological values
That where there are threats or potential threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation	Australian Natural Heritage Charter (AHC, 1996)	Maintenance of rivers for future generations
Precautionary principle	National Strategy for ESD (1992)	Maintenance of rivers for future generations

Table A2.1. (cont'd) Examples of general principles of resource management

Principle	Source	Ecological outcome
Achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development	National Water Quality Management Strategy	Ecologically sustainable rivers
Protect, conserve, rehabilitate and manage the coast, including its resources and biological diversity	*Coastal Protection and Management Act 1995* (Qld)	Protection of ecological values
Provide for the protection of the environment	*Environmental Protection and Biodiversity Conservation Act 1999* (Cwlth)	Protection of ecological values
That conservation be recognised as a valid resource use	This document	Protection of ecological values

Table A2.2. Examples of principles aimed at maintaining rare features

Principle	Source	Ecological outcome
Manage habitats for optimum conditions for survival of rare or threatened wildlife	Qld Wetlands Strategy (1998)	Protection of significant features
That rare ecological, geomorphological and hydrological features be protected	Dunn (2000)	Protection of rare features
Protect native wildlife and its habitat	*Nature Conservation Act 1992* (Qld)	Protection of significant species

Table A2.3 Examples of principles aimed at maintaining naturalness

Principle	Source	Ecological outcome
Protect the environment in a way that maintains the ecological processes on which life depends	*Environmental Protection Act 1994* (Qld)	Maintain ecological processes
Maintain essential ecological processes and life support systems	National Strategy for ESD (1992)	Maintain ecological processes
Mimic natural streamflow characteristics to maintain ecological function	Fitzroy Basin Water Allocation and Management Plan (1999)	Mimic natural streamflow characteristics
Prevent environmental degradation where there are threats of serious or irreversible damage	National Strategy for ESD (1992)	Minimisation of ecological damage
Provide water to maintain the health and viability of river systems and groundwater basins	National Principles for Provision of Water for Ecosystems	Maintenance of natural streamflow characteristics
Provide (as far as possible) the water regime necessary to sustain the ecological values	National Principles for Provision of Water for Ecosystems	Maintenance of natural streamflow characteristics
Manage water allocation to maintain natural values and functions	Qld Wetlands Strategy (1998)	Maintenance of natural values and functions
That the inter-connectedness between upstream and downstream activities be recognised	Dunn (2000)	Protection of the natural features of rivers
That the non-uniformity of rivers be acknowledged	Dunn (2000)	Protection of the natural features of rivers
That the non-substitutable nature of rivers be acknowledged	Dunn (2000)	Protection of the natural features of rivers

Table A2.4. Examples of principles aimed at maintaining representative river types

Principle	Source	Ecological outcome
That some rivers be managed with conservation as a priority	This document	Protection of ecological values
Provide for the permanent preservation of natural condition and protection of the area's cultural resources and values	*Nature Conservation Act Amendment 1994* (Qld)	Protection of ecological values
That a comprehensive, adequate and representative reserve system specifically for rivers be established	ANZECC (1996)	Protection of significant features

Table A2.5. Examples of principles aimed at maintaining biodiversity

Principle	Source	Ecological outcome
Protect biodiversity by dedicating protected areas, protecting and managing wildlife	*Nature Conservation Act 1992* (Qld)	Protection of biodiversity
Promote conservation of biodiversity	*Environmental Protection and Biodiversity Conservation Act 1999* (Cwlth)	Protection of biodiversity
Protect biological diversity and maintain ecological processes and systems.	National Strategy for the Conservation of Australia's Biological Diversity (1996)	Protection of biodiversity and ecological processes
Protect biological diversity	National Strategy for ESD (1992)	Protection of biodiversity
Conserve biological diversity and ecological integrity	InterGovernmental Agreement on the Environment (1992)	Protection of biodiversity and ecological processes
That biological, hydrological and geomorphological diversity and richness be maintained	QEPA (2000)	Protection of biodiversity and ecological processes

Table A2.6. Examples of principles aimed at maintaining special features

Principle	Source	Ecological outcome
Maintain the importance of (international agreement areas) to conservation of nature and conserve native wildlife habitat	*Nature Conservation Act 1992* (Qld)	protection of internationally significant species/taxa/ecosystems

Appendix 3
Examples of instruments of relevance to the protection of rivers

Table A3.1. Examples of legislative protection of rivers

Instrument	Jurisdiction	How does it work?
Heritage Rivers Act 1992	Victoria	Provides for the protection of public land in particular parts of rivers and river catchment areas in Victoria which have significant nature conservation, recreation, scenic or cultural heritage attributes. Requires that a management plan be prepared. Restrictions on developments.
Wild and Scenic Rivers Act 1968	USA	Establishes the national system. Declares a national policy to preserve certain rivers and their immediate environments, maintain free-flowing conditions, protect water quality and fulfil other vital national conservation purposes.
National Parks and Wildlife Service Act 1974	New South Wales	Can declare wild and scenic rivers, as well as national parks.
Resource Management Act 1991	New Zealand	Establishes process for managing natural resources. Can establish a 'heritage order' to protect the heritage characteristics of a particular place. May include special cultural, architectural, historical, scientific, ecological or other interests. May include part of the land surrounding a protected place.

Table A3.2. Examples of legislative protection of flora and fauna

Instrument	**Jurisdiction**	**How does it work?**
Fisheries Act 1982	Western Australia	Can declare 'fish habitat protection areas'.
Fisheries Act 1968	Victoria	Provides basic powers to protect threatened fish species listed under the *Flora Guarantee Act*.
Tasmanian Fisheries Act 1959	Tasmania	All freshwater species are protected.
Fisheries Act 1982	South Australia	Freshwater fish can be protected. Aquatic reserves can also be declared.
Australian Capital Territory Fishing Act 1967	Australian Capital Territory	Provides a range of controls and regulations for freshwater and marine fish species. Contains limited protection for habitat of endangered aquatic species.
Fisheries Act 1999	Northern Territory	Can declare fisheries management areas.

Table A3.2. (cont'd) Examples of legislative protection of flora and fauna

Instrument	Jurisdiction	How does it work?
Fisheries Act 1994 and Regulations 1995	Queensland	Aims to conserve fish stocks, key fish habitat, threatened species, populations and ecological communities of fish and promote viable commercial and recreational fishing. Can declare 'fish habitat areas', which can be used to protect specific fisheries values.
Marine Parks Act 1982	Queensland	Establishes marine parks
New South Wales Fisheries Management Act 1994	New South Wales	Aims to conserve fish stocks, key fish habitat, threatened species, populations and ecological communities of fish and promote viable commercial and recreational fishing.
Nature Conservation Act 1980	Australian Capital Territory	Threatened species of fish an invertebrates can be listed.
Nature Reserves	Australian Capital Territory	The entire length of the Murrumbidgee River in the ACT is managed as a series of nature reserves and offers a degree of protection to the surrounding riverine environment.
Environmental Protection and Biodiversity Conservation Act 1999	Commonwealth	Provides improved protection for nationally threatened species and ecological communities and for Ramsar wetlands.
Wilderness Protection Act 1992	South Australia	Allows for the identification and establishment of wilderness areas.
National Parks and Wildlife Act 1970	Tasmania	Includes all threatened wildlife across all land tenures.
National Parks and Wildlife Conservation Act 1975	Commonwealth	Establishes national parks
Victorian National Parks Act 1975	Victoria	Establishes national parks
National Parks and Wildlife Act 1972	South Australia	Allows for the protection of habitat and wildlife through the establishment and reserves (both on land and in State waters).
Territory Parks and Wildlife Act 1977	Northern Territory	Provides protection for non-fish species of freshwater aquatic life.
Environmental Protection Act 1986	Western Australia	Can declare threatened species.
Threatened Species Protection Act 1995	Tasmania	Includes all threatened species of flora and fauna on any land tenure
Wildlife Act 1975	Victoria	Aims for the protection and conservation of wildlife, sustainable use of and access to wildlife.
Nature Conservation Act 1992	Queensland	Allows for the listing of threatened species, communities and habitats.
Flora and Fauna Guarantee Act 1988	Victoria	Aims to guarantee that all taxa of flora and fauna and ecological communities in Victoria can survive and flourish and retain their potential for evolutionary development in the wild. Can list species, communities and threatening process which conveys specific management actions.

Table A3.2. (cont'd) Examples of legislative protection of flora and fauna

Instrument	Jurisdiction	How does it work?
World Heritage Properties Conservation Act 1983	Commonwealth	Authorises the Commonwealth to prevent the damage or destruction of a property by regulation through prohibition.
IUCN Threatened Species	Commonwealth	The IUCN 'Red Lists of Threatened Species' are compilations of plant or animal species categorised as critically endangered, endangered or vulnerable according to IUCN categories of threat.

Table A3.3. Examples of legislative protection of water quality/quantity

Instrument	Jurisdiction	How does it work?
Catchment and Land Protection Act 1994	Victoria	Sets up a framework for integrated management and protection of catchments. Encourages community participation.
Conservation and Land Management Act 1984	Western Australia	Can declare inland waters as parks.
Native Vegetation Act 1991	South Australia	Aims to retain and encourage management of native vegetation.
Environmental Protection Act 1994	Queensland	Contains provisions for the management of both point and diffuse pollution sources to water.
Environment Protection Act 1970	Victoria	Regulates environmental management activities.
Water Act 2000	Queensland	Establishes a framework for allocating water for environmental needs and for developing land and water management plans.
Water Management Act 1999	Tasmania	Provides for the development of water management plans, which address environmental flow requirements
Water Resources Act 1997	South Australia	Catchment water management boards and water resources planning committees must prepare a water allocation plan, which must include an assessment of the quantity and quality of water required by the ecosystems that depend on the water resources. Must also include an assessment of any detrimental effects of taking water.
Water Act 1992	Northern Territory	Includes issue of permits for water use and management of water quality.
Water Act 1989	Victoria	Aims to provide formal means for the protection and enhancement of the environmental qualities of waterways and their in-stream uses and to provide for the protection of catchment conditions.
Water Pollution Act 1984	Australian Capital Territory	Relates to the control of pollution.
Planning and Environment Act 1987	Victoria	Ensures consideration of potential environmental impacts of proposed developments.
Integrated Planning Act 1999	Queensland	Ensures consideration of potential environmental impacts of proposed developments.
Environmental Protection Act 1997	Australian Capital Territory	Ensures consideration of potential environmental impacts of proposed developments.

Table A3.4. Examples of agreements relevant to the protection of waterways

Instrument	Jurisdiction	How does it work?
The Convention on Wetlands of International Importance (Ramsar Convention)	All	Entered into force in Australia in 1973. Originally targeted at preserving important habitat for migratory species. Widened and renamed in 1990 to reflect the preservation and maintenance of all wetlands.
Bilateral agreements with both Japan (JAMBA) and China (CAMBA)	All	Protect species of migratory birds between signatory countries.
World Heritage Convention 1972	All	Provides a listing of sites which contain the most important and significant natural habitats where threatened species of outstanding value from the point of view of science or conservation still survive.
Agenda 21	All	Action plan to assist nations in the adoption of environmental protection instruments.
International Agreement on the Environment (IGAE) 1992	All	Attempts to facilitate a significant cooperation between the Commonwealth Government, State Governments and local governments on matters of environmental importance.
International Convention of Biological Diversity (signed 1992, ratified 1993)	All	Provides a framework for global action to conserve and sustainably use biological diversity, taking as its primary aim the conservation of the maximum possible biodiversity for the benefit of present and future generations and for its intrinsic value.
Regional Forestry Agreements (RFA)	All	Seek to conserve the full suite of environmental and heritage values that forests can provide for current and future generations by ensuring the forest conservation reserve system is comprehensive, adequate and representative, and through complimentary ecological sustainable management of forests outside reserves in regions to which RFAs apply.

Table A3.5. Examples of policies of relevant the protection of waterways

Instrument	Jurisdiction	How does it work?
Water Quality Management Policy 1997	Tasmania	In part establishes water-based environmental values.
Water Environment Protection Policy	Australian Capital Territory	Establishes environmental values for waterways.
Environmental Protection (Water) Policy 1997	Queensland	Provides a framework to prevent or reduce harm to waterways. Includes a process for identifying environmental values.
State Policy of Water Quality Management	Tasmania	Establishes water quality objectives including protected environmental values (values or uses of the environment for which it is determined that a given area of environment should be protected).

Table A3.6. Examples of strategies/programs relevant to the protection of waterways

Instrument	Jurisdiction	How does it work?
National Water Quality Management Strategy (ARMCANZ/ANZECC)	All	Adopts a consistent approach to the whole of the water cycle. Sets out the national framework within which States and Territories will develop appropriate action plans for the water in their region. Has established water quality guidelines for fresh and marine waters.
National Biodiversity Conservation Strategy	All	Developed in parallel with the Convention on Biological Diversity. Aims to bridge the gap between current effort and effective identification, conservation and management of Australia's biodiversity.
National Local Government Biodiversity Strategy	All local governments	Sets out a national plan to enable biodiversity conservation to become a mainstream function of local government. Local government is generally responsible for planning and developing control. It focuses on 'off-reserve' biodiversity management.
National Strategy for Ecologically Sustainable Development	All	Has protection of biodiversity and maintenance of essential ecological processes and life support systems as one of its three core objectives. A key element is management of biological diversity on a regional basis.
Canadian Heritage Rivers System	Canada	River must have outstanding natural, cultural and/or recreational values, a high level of public support and it must be demonstrated that sufficient measures will be put in place to maintain values. The goal is to establish a system that reflects the diversity of Canada's river environments.
Biosphere Reserves program (UNESCO)	All	Establishes reserves servicing three complementary functions — conservation, development and logistic support. Conserves natural resources and special natural qualities.
Cape York Peninsula Land Use Strategy	Queensland	Multi-partner project to provide a sound basis for decisions about future land use on the Peninsula.
Draft Strategy for Conservation of Australian Species and Ecological Communities Threatened with Extinction (DEST)	All	National approach to the protection of rare, vulnerable and endangered species.
National Endangered Species Program	All	Contributes to the off-reserve management of biological diversity.
National Reserve System Program	All	Includes development and refinement of methods for identification of protective areas and incentives for State and Territory cooperation and development nationally of consistent management principles for protected areas. Will help to achieve a national representative system of protected areas.
National Wetlands Program (Environment Australia)	All	Aims to promote the conservation of Australia's wetlands through a variety of actions, such as management planning for wetlands listed under the Ramsar convention, management oriented research, surveys, training programs and awareness training.

Table A3.6. (cont'd) Examples of strategies/programs relevant to the protection of waterways

Instrument	Jurisdiction	How does it work?
State Revegetation Strategy	South Australia	Aims to establish regional plans to incorporate revegetation and management of existing vegetation into land management plans.
ACT Nature Conservation Strategy	Australian Capital Territory	Includes management of degradation of aquatic systems through development and implementation of environmental flows, management of urban and industrial sources of pollution, through protection of riparian vegetation and through controls on exploitation of fauna/ flora and minimisation of risks of introduced species.

Table A3.7. Examples of codes of practice relevant to the protection of waterways

Instrument	Jurisdiction	How does it work?
Mineral Exploration Code of Practice (1999)	Tasmania	Provides an outline of current procedures which must be followed to obtain an approval, including controls and monitoring procedures.
National Code of Practice for Recreational and Sport Fishers	All	Voluntary agreement addressing four main areas of fishing responsibility – looking after fisheries, protecting the environment, treating fish humanely and respecting the rights of others.
Erosion and Sediment Control Code of Practice 1998	New South Wales	Requires preparation of an erosion and sediment control plan, including management of vegetation removal.
Code of Practice for Sustainable Cane Growing 1998	Queensland	Voluntary code which includes provision of advice about protection of remnant and riparian vegetation.
Code of Practice for Ecotourism Operators	All	Relates to encouraging sustainable and ecologically sensitive use of resources.
Forest Practices Code	Tasmania	Provides guidance on actions to be taken to minimise impacts on aquatic environments during forestry activities.

Table A3.8 Examples of planning instruments of relevance to river protection

Instrument	Jurisdiction	How does it work?
River Management Plans (Water Management Committees)	New South Wales	Undertake planning activities to manage the catchment to maintain/enhance ecological processes and biodiversity.
Water Allocation Management and Planning process	Queensland	Identifies environmental flow provisions.
Investigations (Environment Conservation Council)	Victoria	Carries out investigations into balanced use/development of land, water, flora or fauna resources on public land. Must take account of the need to conserved and protect.
Investigations/Inquiries (Healthy Rivers Commission)	NSW	Independent commission set up in 1996 to make public inquiries into selected NSW river systems. Helps community make informed choices about how to protect and use rivers.

Table A3.9. Examples of voluntary property-based instruments

Instrument	Jurisdiction	How does it work?
Joint Management Areas, Protected Areas Management Scheme Agreement	Northern Territory	Established to encourage conservation of wildlife on Aboriginal land. Duration fixed or definite. Provisions for financial assistance, advice and signs.
Land for Wildlife	Victoria	Provides a framework for the support of voluntary management of wildlife habitat on private land. Doesn't involve landholders entering into agreements with government.
Land for Wildlife	Queensland	Voluntary, non-binding scheme which encourages and assists landholders to provide for wildlife on their property.
Conservation Agreements	NSW	Initiated by the NSW National Parks and Wildlife Service after identification and assessment of values, but are entered into with the consent of the landholder. The agreements are in effect covenants as they run with the land title and bind subsequent owners. There may be restrictions on land use, access or management.
Conservation Covenant	Tasmania	Private landholder consents to private wildlife sanctuary being proclaimed (*National Parks and Wildlife Act 1970*). Voluntary agreement to implement management plan. Conservation covenant permanently binding.
Conservation Covenant Program	Victoria	Aims to conserve areas on private land which are ecologically significant, of natural beauty or of historical interest. Also aims to conserve wildlife and native plants. Statutory. Voluntary agreement. Registered on title and binds all future owners.
Heritage Agreements	South Australia	Apply to vegetation and coastal waters. Conservation areas are leased to the State.
Nature Refuge and Conservation Agreement Schemes	Queensland	Landholder can declare part of all of property as a nature refuge. Voluntary agreement tailored to suit management needs of a particular area and needs of landholder to maintain production and economic land uses.
Private Sanctuary	South Australia	Landholders may nominate land as a Private Sanctuary. Can retract from nomination. No financial gain.
Wildlife Refuges, Wildlife Management Areas	New South Wales	Can be proclaimed if considered suitable by NSW NPWS and voluntarily accepted by landholder. Technical assistance sometimes provided in return.

Table A3.10. Examples of financial and other motivational instruments

Instrument	**Examples**
Charges and levies	National park fees
Grants	Landcare (Commonwealth) Land Protection Incentive Scheme (Victoria) National Estate (Commonwealth) Community Salinity Grants (Victoria) Save the Bush (Commonwealth) Natural Heritage Trust (Commonwealth)

Table A3.10. (cont'd) Examples of financial and other motivational instruments

Instrument	Examples
Removal of perverse incentives (ones which induce behaviour that results in a loss of or threat to ecological value)	Taxation advantages for clearing of native vegetation Below cost irrigation water pricing
Tax policy	Donations, rate relief
Education	Environmental education programs
Information supply	Revegetation guidelines

Table A3.11. Examples of voluntary action groups and programs

Voluntary action group	Jurisdiction	How does it work?
Australian Conservation Foundation	All	Objective is to work towards a society which protects, sustains and restores the environment.
Bushcare	Queensland	Supports community, local government and industry projects on private or public land which take action to conserve remnant native vegetation, to improve the management of native vegetation, and to enhance revegetation efforts. Emphasis is placed on biodiversity conservation as an integrated component of sustainable land use.
Conservation Council of South Australia	South Australia	Umbrella organisation for approximately 60 member groups whose purpose is conservation and protection of the environment.
Inland Rivers Network	NSW	Coalition of environment groups and individuals committed to conserving the biological diversity, natural functioning and health of the inland rivers, wetlands and groundwater of the Murray–Darling Basin.
Murray–Darling 2001	Murray–Darling Basin	This program aims to reduce, or where possible reverse, the underlying rates of natural resource degradation in the Murray–Darling Basin through an integrated catchment management (ICM) approach.
National Landcare Program	All	Provides support for natural resource management projects with a production-oriented or nature conservation focus. Aims to increase knowledge about resource degradation and assist in developing economically viable and ecologically sustainable land use.
National Rivercare Initiative	All	The aim of this program is to ensure progress towards the sustainable management, rehabilitation and conservation of rivers outside the Murray–Darling Basin and to improve the health of these river systems, through the provision of funding.
Queensland Conservation Council	Queensland	Umbrella organisation for conservation groups in Queensland working for the protection and promotion of Australia's natural environmental and biodiversity.
Ribbons of Blue	WA	Environmental education program aimed at increasing community awareness about local water quality and taking action. Part of the Waterwatch Program.
Rivercare New South Wales	New South Wales	Offers funding, technical advice and support and information and educational material promoting best management practices for the riverine environment.
Threatened Species Network	All	Community based network that aims to increase public awareness and involvement in the protection and recovery of threatened species.

Table A3.11. (cont'd) Examples of voluntary action groups and programs

Voluntary action group	Jurisdiction	How does it work?
Waterwatch	All	Raises community awareness of the natural environment, the wise use of natural resources ethic in communities, and encourages on-ground community based activities and networking.
Wilderness Society	All	National, community-based environmental advocacy organisation whose mission is to protect, promote and secure the future of wilderness and other high conservation areas.
Wildlife Preservation Society	All	Interested in the conservation of flora and fauna and habitats.
World Wide Fund for Nature	All	Mission is to preserve biodiversity by promoting the sustainable use of natural resources.

Appendix 4
Management roles for waterways

Doolan (2000) discussed the management framework for waterways (from the national to local level) in the context of the development of a Victorian River Health Strategy. Consideration of the roles at different levels of management is important in the context of the scale of planning for waterway protection and achieving the right 'mix' of planning for waterway protection. Appendix 3 provides examples of a range of planning instruments which could potentially be used to protect rivers.

Doolan (2000) outlined the following roles at different levels of waterway management:

National role:
- funding to States, groups and individuals to achieve national objectives;
- facilitates interstate coordination;
- invests in development of national principles, best management practices, tools, research and development to facilitate improved management; and
- ensures Australia meets its international obligations.

State role:
- sets statewide policy and strategic directions;
- establishes legislative and regulatory frameworks;
- establishes institutional arrangements;
- invests in provision of advice, research and monitoring, planning, extension, on-ground works and enforcement functions;
- implements State responsibilities under nationally agreed strategies; and
- provides funding to groups and individuals to achieve State and regional priorities.

Regional role:
- develops regional strategies and action plans;
- provides advice to State on regional resourcing priorities;
- coordinates and implements work programs;
- provides incentives and support for groups and individuals; and
- provides mechanisms for community involvement in natural resource management.

Local government role:
- incorporates waterway management objectives, priorities and actions into statutory planning processes; and
- provides local support for local action groups.
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- Landcare (community) groups' role:
- smaller scale waterway and catchment management projects.

Landholders' role:
- land stewardship.