

## Successful stream rehabilitation: first set the goals

Anthony Ladson<sup>1</sup>, John Tilleard<sup>1</sup>, Sarah Ewing<sup>1</sup>, Michael Stewardson<sup>1</sup>, Ian Rutherford<sup>2</sup>

**SUMMARY:** For river rehabilitation projects to be successful, they must proceed through several stages. These include setting goals, selecting strategies, implementing works or other activities and evaluating success. The main barriers to successful stream rehabilitation exist at the first of these stages - setting goals. If goals are unclear then a river rehabilitation project is likely to have a less than optimal outcome, even if all the other stages are completed successfully. In the simplest of terms, if we know what it is that we are trying to achieve then it is (comparatively) straightforward to get there. In Australia, currently there is much emphasis on techniques of stream rehabilitation (e.g. rock chutes or revegetation) but little consideration of goals. This makes it difficult to satisfy stakeholders and to evaluate success.

Developing catchment-wide, or regional, stream management goals is currently a barrier to progress. Achieving an acceptable balance between utilitarian and environmental objectives for rivers is a topic of debate. But even within the rehabilitation context, goals and objectives are usually unclear. Are we managing this river as a trout stream, for native fish, for naturalness or for recreation? The way forward is to develop participative and repeatable approaches to assessing the need for, and setting the goals of, stream rehabilitation.

### MAIN POINTS

- Goal setting is the first and most important stage in stream rehabilitation projects.
- Unless there are clear goals for stream rehabilitation, success is unlikely.
- Lack of clear goals is currently a barrier to progress in Australian stream rehabilitation.

### 1. INTRODUCTION

Why worry about setting goals for stream rehabilitation; why not just do it?

This paper argues that we will get better stream rehabilitation if goals are clearly stated. Skipping this first critical step is likely to result in an uncoordinated approach that is common in the documented examples of failed restoration projects (e.g. Beschta *et al.* 1994). The lack of clear objectives, inadequate problem definition, or incomplete needs assessment are important criticisms of stream rehabilitation projects.

When goals are not stated they are usually implied in the selection of techniques and the design of activities. But these implicit goals are likely to be vague or inconsistent and future evaluation will be difficult. Unless the objectives are specified, it is impossible to measure success. Goal setting is the first step in a series of activities that define a stream rehabilitation project.

### 2. STAGES IN THE PROCESS OF REHABILITATING STREAMS

For river rehabilitation to be successful, we must proceed through several stages (figure 1):

1. Set goals and develop measurable objectives, define problems and assess needs;

2. Understand constraints that prevent the goals and objectives from being achieved;

3. Select the most appropriate strategies to address goals and objectives;

4. Prepare detailed designs and specify techniques;

5. Implement works or activities;

6. Maintain works or undertake follow up activities; and

7. Evaluate performance against project objectives and review success at each of the stages.

It is also important to bear in mind the question of scale; at each stage, the perspective is different. Specifically:

1. The setting of goals and objectives is an activity that should, in the first instance, occur at catchment or regional scales;

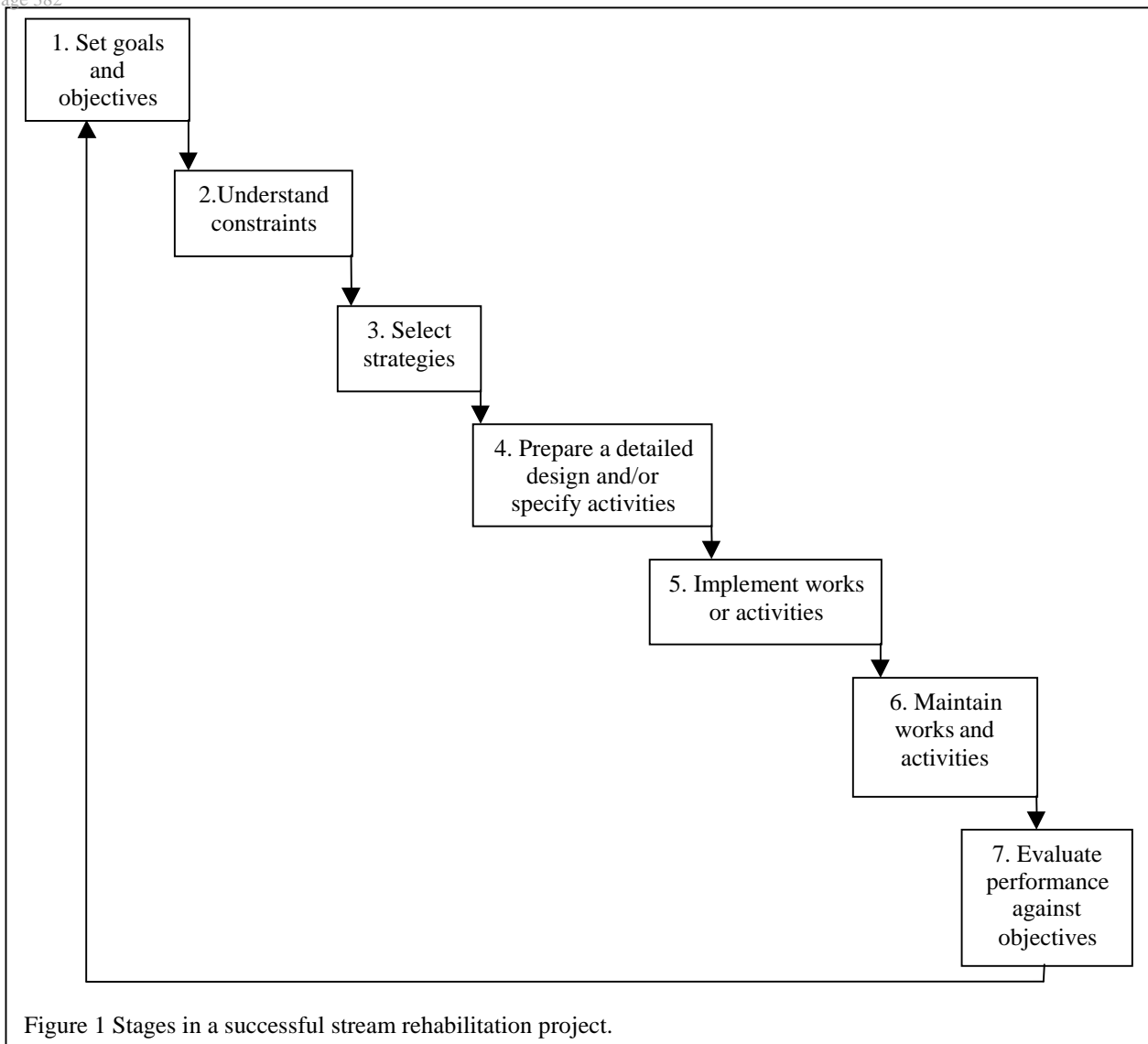
2. Understanding of constraints also needs to be identified at the catchment/regional scale;

3. Strategies will relate to rehabilitation programs for whole streams or to substantial stream reach or community scales;

4. Detailed design will have a reach or project focus or relate to small communities of stakeholders;

<sup>1</sup> Centre for Environmental Applied Hydrology, University of Melbourne, Parkville, Vic 3052.

<sup>2</sup> Cooperative Research Centre for Catchment Hydrology, Monash University, Vic 3068.



5. Implementation is at the site by site level involving individuals or small groups of stakeholders;

6. Maintenance and follow up is more likely to apply within a site or to individuals; and

7. Evaluation should occur at a variety of scales from site to catchment.

If there is failure at *any* of these stages then the success of the whole project is at risk even if all the other stages are completed successfully.

For example, consider the (frequent) case where stage 1 has been ignored or is unsuccessful; that is, the goals for rehabilitation are unclear. In that case, even if we understand the problem, select the appropriate technique, design, implement and maintain any works or activities correctly, the project is likely to be considered a failure, at least by some stakeholders, because of disagreement about goals. Similarly, being clear about goals, having adequate understanding of a problem and selecting appropriate activities may still result in project failure if there is not correct implementation. Further examples of failures at each of these levels, are provided in table 1.

### 2.1. Existing state of play in Australian stream rehabilitation - identifying barriers to progress

Where do the main barriers exist to successful stream management in Australia?

Adequate professional advice is already available at stages 4, 5 and 6 to assist with design, implementation and maintenance of stream rehabilitation activities. That is not to say that advances cannot be made in these areas; but, in general, we believe that practice lags well behind knowledge. The main need is to communicate existing results and best practice.

- Stage 4 - Design and specification of stream rehabilitation works is not a major barrier to stream rehabilitation success although the sources of sound, well-balanced advice are relatively scarce and not well spread geographically. The key issue is to obtain appropriate advice.
- At the implementation stage (stage 5) it may be necessary to provide training or employ skilled workers. The key issue here is communication of best practice through courses or guidelines, for example the Australian Manual for Stream Rehabilitation (Rutherford *et al.* in prep).

**Table 1. Steps to ensure that stream rehabilitation projects are successful and effectively targeted.**

Stage of stream rehabilitation project	Possible reasons for project being unsuccessful or ineffectively targeted	To ensure the rehabilitation project is successful
1. Set goals, develop objectives, define problems, assess needs.	Disagreement about vision or objectives for the river system or conflict between goals.	Develop participative techniques for setting goals and objectives about rivers Seek community input in articulating overall goals for rivers.
2. Understand constraints that prevent the goals and objectives from being achieved.	Wrong problem is addressed.	Thoroughly investigate and understand the problem to be addressed. Use professional advice and scientific input.
3. Select the most appropriate strategy to address goals and objectives.	Inappropriate technique selected. Appropriate technique not available.	Use guidelines and professional advice to select appropriate techniques.
4. Prepare a detailed design and/or specify techniques to implement the strategy.	Inappropriate design or specification.	Seek specialist advice when designing and specifying works or programs.
5. Implement works or activities.	Poor construction/ Implementation. Appropriate materials are not available.	Use trained staff or contractors to implement works on the ground.
6. Maintain works or undertake follow up activities.	Inappropriate maintenance or no maintenance.	Plan and budget for regular and emergency maintenance.
7. Evaluate performance against project objectives.	Initial works are not successful but there is no evaluation so future works also miss their target.	Plan and budget for evaluation early to measure success against objectives for rehabilitation.

- Recognition of the need for a maintenance stage (stage 6) is sometimes lacking. The key is to plan for maintenance early in the project to make sure that there are sufficient funds available for it to be carried out when necessary.

While stages 4, 5 and 6 tend to attract the most interest in stream rehabilitation, the emphasis should be on trials, monitoring and sharing of experience rather than research and development. It is the early stages of the hierarchy that present the greatest barriers to progress. In the simplest of terms, if we know what it is that we are trying to achieve, it is (comparatively) straightforward to get there. Stages 1, 2 and 3 are the hard ones: stages 4, 5 and 6 are (relatively) mechanistic. Stage 7, evaluation, depends on documented objectives specified in stage 1.

Consider the problems at stage 1 - goal setting. Developing catchment wide or regional stream management goals is currently a barrier to progress. Achieving an acceptable balance between utilitarian and environmental objectives for rivers is a topic of current debate (e.g. Snowy Water Inquiry 1998). But even within the rehabilitation context, goals and objectives are usually unclear: are we, for example, managing this river as a trout stream, for native fish, for naturalness, or for recreation.

Stage 2 provides the knowledge to support the stream rehabilitation goals and to analyse and evaluate stream rehabilitation strategies. Lack of understanding of physical, chemical and biological processes can hinder the success of stream rehabilitation projects. Research can improve understanding but rehabilitation goals should be considered when setting research priorities.

Where there is good understanding of the constraints to achieving goals, stage 3, strategy development and selection, may not present a barrier. But if there is insufficient understanding at stage 2, and stage 1 is unclear, then it will be difficult to select the right strategies. Improved understanding is necessary to choose between on-site or off-site works, social or engineering approaches, or high and low intervention strategies. Without adequate understanding, managers are likely to select techniques they are most familiar with rather than those that are most likely to ensure success.

The clarity of goals at stage 1 also largely determines our ability to undertake stage 7 - project evaluation. Evaluating success is part of an adaptive process. If objectives have not been met then all the project stages need to be reviewed to determine where more effort is required.

We do not have a good record of specifying clear goals for stream rehabilitation in Australia. As noted by the Australian National Audit Office (ANAO 1997), a key factor in value-for-money program delivery, is a rigorous assessment of needs, to ensure that projects which maximise the likelihood of achieving program objectives receive funding. However, in a review of programs that have supported stream rehabilitation work, the ANAO noted that a comprehensive assessment of needs was not undertaken. In particular, the ANAO criticised the process used to choose projects to be funded by the Natural Heritage Trust (NHT). It noted that project selection was often based on intuitive judgements, rather than a robust needs assessment and called for more research to support this aspect of the NHT.

### 3. OVERCOMING BARRIERS TO SUCCESSFUL STREAM REHABILITATION

The above view of the “state of play” suggests that the main barriers to successful rehabilitation occur in stages 1, 2 and 3, (examples are provided in table 1). This is simply because getting it right at the strategic level has the potential to produce more successful outcomes than getting it right at a single site. Improvements in our ability to set appropriate objectives, understand the problems and choose the right strategies, have the potential to profoundly influence stream rehabilitation progress in Australia. Improvements in designing and implementing works or activities can also have a positive impact but there is less scope for improvement, and a smaller sphere of influence.

#### 3.1. River rehabilitation as a subset of river management

River rehabilitation goals at a regional or catchment level are a subset of society's broader goals for rivers. River rehabilitation objectives cannot be set without consideration of the compromises that might be imposed by other sets of values and other expectations for the river.

#### 3.2. Proactive or reactive management

River management, and river rehabilitation in particular, needs to move beyond problem-driven management. Good river management will not just be reacting to perceived problems. Instead, good river management includes using participative processes to determine desirable river conditions and then implementing a range of proactive strategic activities to move toward specified goals.

A continuation of the current emphasis on problem-driven management will encourage localised “bandaid” solutions. The aim of river management should not be to treat isolated problems at individual sites. Instead, river managers should aim to understand the system, the pressures and problems, and to implement broad strategies that move the river toward a future condition that meets the agreed aspirations of a range of stakeholders.

River management should aim to manage *systems* rather than treat *symptoms*. To do this successfully, we need to set clear goals for rivers at scales of catchment, reach and site. To achieve this, we need to see a move away from problem-based reactive management, toward objective-based proactive management.

#### 3.3. Setting goals for rivers

How should we set goals for river management? How should we set goals for river rehabilitation? These are two key research questions.

This issue has been addressed to an extent within the various attempts at “strategic planning” for river management that have been undertaken (and are currently being undertaken) in various States (e.g. ORMB 1995). Despite a range of approaches, there is

no common view on how to go about this multi-objective planning process; the techniques vary from the purely qualitative to the excessively quantitative. But regardless of the apparent rigour; all the approaches ultimately rely on the particular value system of the assessor (Dumsday 1998).

The lack of a reliable practical process for setting river management and river rehabilitation goals at a regional or catchment level, presents a major R&D challenge. In catchment management more generally in Australia, we now recognise the importance of engaging the community in decision-making and this is no less true of stream rehabilitation projects. Therefore, the goal-setting process needs not only to acknowledge technical and socio-economic understandings but also to attend to community expectations and aspirations as well. This process must be sufficiently pragmatic and broadly based to ensure that compromises can be reached across catchments. For example, it may be appropriate to allow a section of river to degrade in one area in order to maximise naturalness somewhere else.

The selection of 'Heritage Rivers' in Victoria provides an example of successful goal setting. Following detailed investigation and consultation, the Land Conservation Council (1989) nominated various heritage rivers and natural catchment areas to be managed and protected. These recommendations were passed into law through the Heritage Rivers Act (1992) which restricts land and water uses and requires the preparation of management plans. Any stream rehabilitation activities in these areas must comply with these plans and with the Act.

The Goulburn River downstream of Eildon Dam in Victoria provides an example where distinct goals may be appropriate in different reaches. Operation of the dam has resulted in reduced temperatures and decreased flood frequency which has “alienated the section of the river between Eildon and Seymour (138 km) from habitation by native fish species” (Gippel & Finlayson 1993 p33). Gippel and Finlayson argued that it may be more pragmatic to manage this section for recreational fishing of introduced species rather than to supply the environmental flows and reservoir destratification that would be necessary to provide for native fish. In compensation, the natural habitat value of the rest of the river could be protected or rehabilitated where necessary. This recommendation contrasts with the actions of the Victorian Government which has recently moved to increase environmental flows despite the water being too cold to allow spawning of native fish (Gippel, in press; Department of Natural Resources and Environment 1995).

#### 3.4. Using indicators to assist goal setting

The development of indicators of river condition or health such as AusRivAS (Parsons & Norris 1995) or the Index of Stream Condition (Ladson *et al.* in press) may assist objective setting. These techniques allow managers to quantify the current condition of a stream and to specify a desirable future state. They can also

help to choose issues that need investigation and guide strategy selection. However, they must be used with care.

An important restriction of these indicators is that they are limited to measuring environmental condition so they do not take account of any of the other requirements that people have for rivers such as utilitarian demands. It is likely that rivers that require rehabilitation will also have to meet the needs of a variety of users.

These indicators have been developed centrally by specialists with limited input from the wider community. Imposing objectives from outside can cause resentment that is best avoided by using a participative approach to goal setting. Using these environmental indicators will be most helpful after the overall goals for a rehabilitation project have been established.

### 3.5. Negotiating trade-offs

Setting goals and objectives requires trade-offs to be made. Addressing many of the large-scale stream rehabilitation issues in Australia such as environmental flows will result in winners and losers - providing more flow for fish is likely to result in less flow for irrigators.

Key issues in setting goals and objectives are the valuing of environmental improvements and the problems of uncertainty. It seems easier to quantify the costs of stream rehabilitation than the benefits. For example, consider the provision of environmental flows. Reducing flows to irrigators results in a well-defined cost to a well-defined group. The group is likely to politicise their problems and there will be pressure for compensation or scrapping of the rehabilitation project.

The benefits of environmental flows are much less clear. It is generally not possible to accurately quantify the expected environmental improvement or to identify beneficiaries so collective political action to lobby effectively for these benefits is unlikely (Hardin 1982).

The easy way out is to spend more money on environmental flow research and development rather than actually implementing environmental flows. Blame for the lack of action can then be placed on the need to wait for research outcomes rather than our inability to reach an appropriate tradeoff between environmental and utilitarian values in setting goals for rivers.

### 3.6. Setting policy level goals

Many of the issues of stream rehabilitation are analogous to the problems of managing 'common property' such as those outlined in 'The Tragedy of the Commons' (Hardin 1968). Common property tends to be over-exploited. In the case of streams, this over-exploitation leads to many of the problems that need to be addressed through stream rehabilitation. New stream rehabilitation techniques will not halt the over-exploitation since the pressures that degrade streams will continue. Effective stream rehabilitation will require clarity about goals and objectives for rivers and

the institution of new regimes to better manage the natural resource. This is being partly addressed through the COAG agreement on water resources (Pigram *et al.* 1994). The economic benefits of the COAG agreement are widely acknowledged but the environmental benefits are less clear. For example Bjornlund and McKay (1995) find that there are some benefits, but argue that other instruments are also required to address environmental problems. In other words, the COAG agreement has its own objective, that of economic efficiency. There may be some benefit to the environment if water is used more wisely, but it is important to set broader objectives for the condition of rivers, particularly those that are part of irrigation schemes.

There are similar concerns about the water allocation process in Victoria. With the establishment of a water market, the environment has been granted a legal right to water, but the quantity is often based on what is left over once users' demands have been considered. It is important that the desire for economically efficient water delivery does not become the over-riding goal that determines the condition of our rivers - at least not without public debate.

### 3.7. The need for evaluation

In order to make informed decisions, decision-makers need access to information about project performance; that is, the extent to which a project has been successful in achieving its objectives. Unless the goals of the project are clear it is difficult to carry out a fair or useful evaluation.

Project evaluation is still an active area of research but there are some procedures available for general use. Methods to evaluate the physical performance of rehabilitation works are discussed by Stewardson *et al.* (1999) and some of the environmental indicators discussed in section 3.4 may be useful. The key issue is to plan for evaluation before any works are done and to match evaluation with project objectives.

### 3.8. River rehabilitation research and development

The stages of a river rehabilitation project (figure 1) also provide a framework for setting priorities in river rehabilitation R&D. Maximum return from R&D will come from tackling the highest order issues first. The higher up the hierarchy that we get it right, the greater the likelihood of outcomes being successfully influenced. R&D at technique or implementation stage can only ever affect a limited number of outcomes. Improved methods for goal setting in rehabilitation are a clear R&D need. Focusing R&D at the highest possible level will have the greatest influence so it is important to concentrate at the problem definition, priority, objective and goal setting end of the stream rehabilitation problem.

#### 4. CONCLUSION

Stream rehabilitation works will be successful and effectively targeted when we are clear about the goals, when the scientific understanding is sufficient, when the appropriate technique is selected, and when works are implemented, maintained correctly and evaluated. Failure at any one of these stages is likely to cause less than optimal outcomes for the whole project. Improvements in our abilities to set appropriate objectives, understand the problems and choose the right strategies have the potential to profoundly influence stream rehabilitation progress in Australia.

#### 5. ACKNOWLEDGEMENTS

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#### 6. REFERENCES

- Australian National Audit Office (1997) Commonwealth Natural Resource Management and Environment. Programs: Australia's Land, Water and Vegetation Resources, Audit Report No. 36 1996-97, AGPS, Canberra.
- Beschta, R. L., Platts, W. S., Kauffman, J. B. and Hill, M. T. (1994). Artificial stream restoration - money well spent or an expensive failure? Proceedings of Environmental Restoration Conference, The Big Sky Resort, Montana, August 2-5, The Universities Council on Water Resources.
- Bjornlund, H. and J. McKay (1995). "Can water trading achieve environmental goals?" *Journal Australian Water & Wastewater Association* **22**(6): 31-34.
- Department of Conservation and Natural Resources (1995) The Bulk Entitlement Conversion Process. State Government of Victoria, Melbourne.
- Dumsday, R. G. (1998). Policy Analysis for Land and Water Resources. National Land and Water Resources Audit, Land and Water Resources Research and Development Corporation, Canberra.
- Gippel, C. J. (in press). Managing Regulated Rivers for Environmental Values: Selected Case Studies from Southeastern Australia. In: *River Management: the Australasian experience*. Eds S. O. Brizga and B. L. Finlayson, John Wiley and Sons.
- Gippel, C. J. and Finlayson, B. L. (1993). Downstream Environmental Impacts of Regulation of the Goulburn River, Victoria. Hydrology and Water Resources Symposium, June 30-July 2, Newcastle, Institution of Engineers, Australia.
- Hardin, G. (1968). "The Tragedy of the Commons." *Science* **162**: 1243-1248.
- Hardin, R. (1982). *Collective Action. Resources for the Future* pp248.
- Heritage Rivers Act 1982 (Victoria)
- Ladson, A. R., White, L. J., Doolan, J. A., Finlayson, B. L., Hart, B. T., Lake, P. S. and Tilleard, J. W. (in press). "Development and testing of an Index of Stream Condition for waterway management in Australia." *Freshwater Biology* **44**(1).
- Land Conservation Council (1989). *Rivers and Streams Special Investigation*. Government of Victoria, Melbourne
- Ovens River Management Board (ORMB) (1995) *Strategic Plan for the Ovens River Management Board*. Wangaratta, Victoria.
- Parsons, M. and Norris, R. H. (1996). "The Effect of Habitat-Specific Sampling on Biological Assessment of Water Quality using a Predictive Model." *Freshwater Biology* **36**: 419-434.
- Pigram, J. J., Musgrave, W. F., Hooper, B. P., Dudley, N. J. and Bryant, M. J. (1994). "Cooperative Federalism and Water Reform." *Journal Australian Water & Wastewater Association* **21**(4):21-26.
- Snowy Water Inquiry (1998) *Snowy Water Inquiry Final Report*. New South Wales and Victorian State Governments.
- Stewardson, M. J., Rutherford, I. D., Tennant, W. K. (1999) Physical evaluation of rehabilitation works in Broken River and Ryans Creek, North East Victoria. Proceedings of the Second Australia Stream Management Conference, 8-11 February 1999, Adelaide, South Australia.
- Rutherford, I. D. (in preparation) *Australian Manual for Stream Rehabilitation*. Land and Water Resources Research and Development Corporation
- Rutherford, I. D., Ladson, A. R., Tilleard, J. W., Stewardson, M. J., Ewing, S. A. Brierley, G. and Fryirs, K. (1998) Research and development needs for river restoration in Australia. Occasional Paper 15/98 Land and Water Resources Research and Development Corporation, Canberra.

**Table 1. Steps to ensure that stream rehabilitation projects are successful and effectively targeted.**

<b>Stage of stream rehabilitation project</b>	<b>Possible reasons for project being unsuccessful or ineffectively targeted</b>	<b>Example</b>	<b>To ensure the rehabilitation project is successful</b>	<b>Example of research and development needs</b>
Developing goals and objectives	Disagreement about vision or objectives for the river system or conflict between goals.	River regulation effectively delivers water for irrigation but cold water releases from dams reduce native fish populations. Are multi-level offtakes warranted or is that expense that can not be justified?	Develop participative techniques for setting goals and objectives about rivers Seek community input in articulating overall goals for rivers.	Develop procedures to allow optimal trade-offs between competing demands.
Understanding the constraints that prevent the goals and objectives from being achieved	Wrong problem is addressed	Habitat, which is in poor condition, is improved in an attempt to increase fish numbers but the over-riding problem is poor water quality.	Thoroughly investigate and understand the problem to be addressed. Use professional advice and scientific input.	Scientific research into physical, chemical and biological stream processes.
Selecting the most appropriate strategy to address goals and objectives	Inappropriate technique selected. Appropriate technique not available.	Gabions (wire baskets) used to control bank erosion in a gravel bed stream. Gravel erodes the wire and the gabions fail.	Use guidelines and professional advice to select appropriate techniques	Research & Development to find better techniques
Designing and/or specifying techniques to implement the strategy	Inappropriate design or specification	Inappropriate tree species selected. Erosion control works not designed to withstand high flows.	Use professions to specify or design works or programs.	Key requirement is to obtain competent advice.
Implementing works or activities	Poor construction/ Implementation. Appropriate materials are not available.	Trees were not watered in at planting, tree guards not placed effectively.	Use trained staff or contractors to implement works on the ground	Just do it. The main issue is to ensure effective communication through published guidelines and training.
Maintenance or follow up activities	Inappropriate maintenance or no maintenance	Fences damaged during floods are not repaired allowing stock damage to a plantation.	Plan and budget for regular and emergency maintenance.	Just do it.

