Water and Rivers Commission | WN28 February 2002

Natural Heritage Trust

Water notes

Water notes for rivers management

ADVISORY NOTES FOR LAND MANAGERS ON RIVER AND WETLAND RESTORATION

Monitoring and evaluating river restoration works

Monitoring and evaluation are important elements of river restoration projects because they help us understand why some projects succeed, why some fail and what can be done to improve the chances of success in the future.

This Water Note provides community groups with an introduction to the monitoring and evaluating of river restoration works.

Evaluation is not necessarily difficult or expensive but needs to collect relevant information and be targeted to the appropriate audience. The level of evaluation chosen can range from very simple approaches, like taking before and after photographs of revegetation works, to more complex assessments like measuring subtle changes in species richness and populations of native fish in a restored river.

The key is to plan ahead, ensure the project's objectives are clearly defined and choose a level of evaluation that:

- provides answers to the key questions being asked about the project (e.g. did the project raise community awareness as expected?);
- provides the stakeholders who are asking these questions with an appropriate level of confidence in the evaluation results; and
- matches the project's resources in terms of available funds, time and skills.

What is monitoring and evaluation?

It is important to understand the difference between monitoring and evaluation, as these terms are often misused.

Monitoring The gathering of information. Monitoring may involve observing or measuring change and is often the raw material or data used for evaluation. For example, a community group may monitor the survival rate of newly planted seedlings each month over a two year period.

Evaluation An assessment of the effectiveness of a project against pre-defined objectives. It is usually based on some form of monitoring, but unlike monitoring, evaluation involves an assessment of the project's success or failure (Rutherfurd *et al*. 2000). Continuing with the above example, the community group may analyse the monitoring results to determine whether the project did or did not achieve its original objective of more than 75% of seedlings surviving after the first year.

A number of additional terms are explained in the Glossary at the end of this Water Note. Common usage of these terms is recommended, as it will assist communication between groups.

A Ribbons of Blue workshop on how to monitor aquatic macroinvertebrates. *M. Burgess*

The process of restoring or rehabilitating a river is best attempted in stages. Figure 1 describes these stages, their sequence, and when monitoring, evaluation and reporting should take place.

It is recommended that groups who intend to monitor and evaluate their activities ensure that all of the stages in Figure 1 are clearly understood before monitoring and evaluation details are finalised.

Students taking samples of aquatic macroinvertebrates from Lake Leschenaultia.

Macroinvertebrate sampling on the Steere River near Hopetoun. Local biologist Andy Chapman has been studying the populations of native fish in local rivers and received support from the WRC for associated water quality monitoring.

Attempts to restore a degraded river's ecological health can be compared to a medical procedure to restore an element of human health. Both examples should have clear objectives, monitoring and evaluation. Like most river restoration projects, medical procedures aim to restore certain elements of a person's health (rather than all elements), and may only be partially successful, leading to the need for rehabilitation.To expand upon this analogy, Table 1 documents the key project, monitoring and evaluation stages for a river restoration project and a medical procedure.

Testing the salinity of the Warperup Creek, a tributary of the Pallinup River. This was part of a floodway condition assessment carried out in late 2001.

Seven tips for successful monitoring and evaluation

1. Plan ahead

Evaluating the success of a project requires planning before restoration works begins, to ensure that:

- All of the necessary indicators can be monitored. For example, if it is determined that regular photographs will be used as a form of monitoring to evaluate the success of bank stabilisation works over time, then a set of pre-work photographs would be valuable.
- Relevant background information is gathered and reviewed. For example, if a project is seeking to restore a deep pool in a river that has filled with sediment, some research may be required to find out what the pool was like prior to, or shortly after, European settlement.
- Lessons are learnt from similar projects that have been undertaken in the region. In particular, these projects may provide useful information on the time needed for changes in physical and biological processes to occur (e.g. bank stabilisation, increase in fish numbers).
- Practical details are quickly resolved, such as who will be doing the monitoring and what resources are available.
- Preparing a simple document like that shown in Table 1 is a good way to start planning the monitoring and evaluation components of the project. It is recommended that this be done in a workshop setting, involving key members of the group.

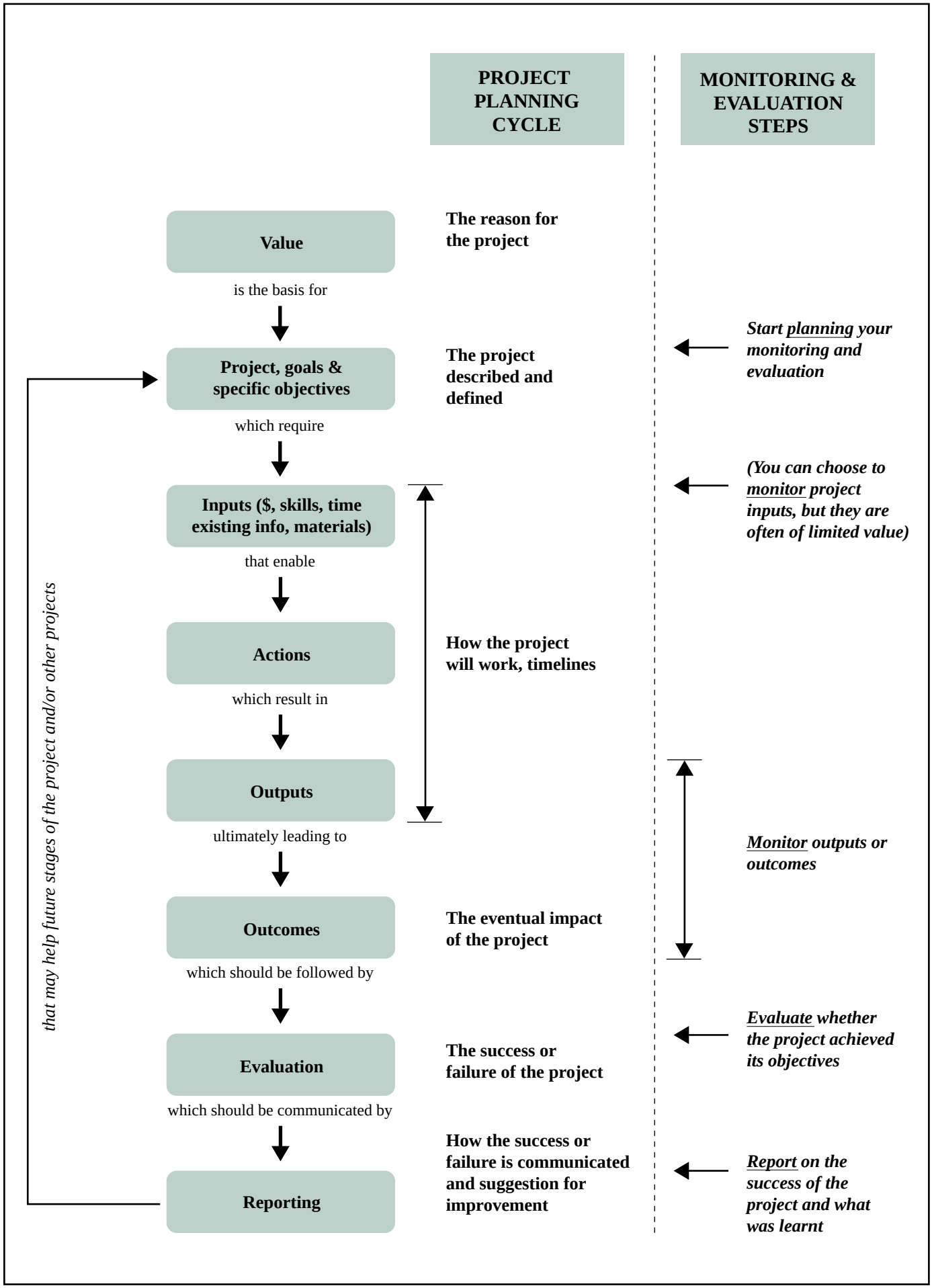

Figure 1. The stages of a well-managed project. [Modified from Woodhill & Robins 1998].

	RIVER EXAMPLE *(The restoration of a river's riparian zone)*	**MEDICAL EXAMPLE** *(The removal of cataracts in a person's eyes)*
The Project		
Vision	• The river will once again support typical native species and be a place enjoyed by the community.	• The patient will once again lead an enjoyable life.
Goal	• To rehabilitate the riparian zone to improve the condition of the riparian zone and waterway health. (Complete restoration to pre-European conditions is not possible due to significant changes to the catchment).	• To improve the patient's sight so that they can lead an enjoyable life. (Restoration of fully functional eyes is unlikely).
Objectives ***(examples only)***	• To improve the river condition (as measured by the 'Stream Condition Index', see Glossary and WRC 1999a & 1999b) within 5 years of the restoration works. [outcome-related] • To complete the planting and fencing in accordance with the River Action Plan. [output-related] • To ensure the number of hours contributed by volunteers is greater than 150 hours. [input-related]	• To improve the patient's eyesight leading to a better quality of life. [outcome-related] • To completely remove the cataracts in one operation. [output-related] • To minimise the use of hospital resources. [input-related]
Actions	• Plant and fence in accordance with the River Action Plan.	• Remove cataracts.
Project Inputs	• Weed control, site preparation, plants, stakes, volunteer hours, herbicide, fence posts, wire, expert advice, qualified personnel for hazardous activities, Aboriginal consultation, fire management plan, dieback survey, etc.	• Hospital resources (time, equipment, medication, etc.).
Project Outputs	• Trees, shrubs and sedges/rushes planted. • Fences installed.	• Cataracts removed.
Project Outcomes	• An increase the health of the river over 5 years, in terms of bank stability, stream condition, habitat diversity, stream cover and riparian vegetation.	• Improvement in the patient's eyesight and lifestyle.
Monitoring ***(for project outcomes only)***		
Indicators	• Numerous physical and biological factors (e.g. abundance of native species, stream cover, evidence of stock in the river).	• The quality of sight. • Quality of life.
Monitoring Methods	• Use the 'Stream Condition Index' method and forms to rate the over-all condition of the riparian zone. Photographs from fixed points could supplement this. • Survey and photograph the reach before and after works and then 5 years later.	• Measure the quality of sight before and periodically after the operation using 'Snellen's (eye) Chart'. • Measure the patient's own perceptions about the quality of their life before and periodically after the operation using a questionnaire and interviews.
Evaluation ***(for project outcomes only)***		
Evaluation Process	• Assess the pre- and post-restoration survey data and photographs obtained from using the above methods. • Determine whether the 'Stream Condition Index' has increased, decreased or remained the same. Use the photographs to validate the conclusions. • Make recommendations about the success of the restoration, how to improve future activities, and/or the need for further rehabilitation measures (e.g. removal of weed species).	• Assess the pre- and post-operation monitoring data. • Determine the quality of vision and the quality of life that has been achieved. • Make recommendations about the success of the operation, how to improve future operations, and/or the need for further rehabilitation measures (e.g. use of visual aids).

Table 1. River restoration is like a medical operation. See Glossary for definitions of inputs, outputs and outcomes.

2. Design the approach for the intended audience

From a practical perspective, evaluation can be defined as whatever it takes to convince the relevant person (or people) of the success or otherwise of the project (N. Marsh, *pers. comm*. 2001). Community groups should identify who will ultimately use the evaluation results and understand their needs so that the monitoring and evaluation can be designed accordingly. For example, consider a typical revegetation project, where:

- The funding body wants to know, with a high degree of certainty and accountability, that the funds were spent as agreed. This could be achieved by the group through sound record keeping.
- The funding body also wants to know, with a moderate degree of confidence, that the fauna diversity has increased at the work site. This could be achieved by periodic bird and reptile counts.
- The community group members want to know in general terms if their efforts have made a difference. This could be achieved through monitoring the survival rate of planted trees and shrubs.

3. Check that the project's objectives are clear and measurable

In practice, only some of the project's objectives are usually evaluated. For example, for both the scenarios given in Table 1, only one of the three project objectives were monitored and evaluated.

When checking the project's objectives and choosing which ones to evaluate, consider:

- How easy they will be to monitor and evaluate given the resources available (i.e. funds, expertise, time). For example, if the project objective is to increase the water rat population in the area, it may be possible given available resources to monitor the abundance of their scats and bleached, half-eaten crayfish exoskeletons, but not the water rats themselves.
- Whether the desired change (e.g. water quality) is actually likely to be improved by these actions. It is important to recognise that the upstream catchment can impact on the area being monitored.
- How much confidence the group has in their restoration techniques. For example, if the aim is to increase the abundance of native fish species in a river section, and the group is confident from local research that the provision of large woody debris (snags) will do this, then measurable objectives could be primarily set around simply installing and maintaining the snags. Monitoring would therefore focus on the presence of snags with a reduced emphasis on monitoring the presence of native fish.
- Monitoring a range of objectives, where resources allow, to minimise the impact of unforeseen circumstances on evaluation, such as prolonged drought that prevents water quality sampling.

4. Choose an appropriate level of evaluation

As described in Figure 2, different levels of evaluation can be chosen. The level of evaluation will be a result of:

- the needs of the stakeholders and the degree of confidence needed in the results; and
- the available resources in terms of a group's monitoring budget, equipment, skills, time and levels of enthusiasm for running a monitoring program.

For example, suppose a community group wants to know whether revegetation activities on a river reach have led to an increase in the number of bird species. Depending upon the group's resources and the needs of the people who will use the evaluation results, the group may decide to:

1. simply rely on anecdotal observations from members of the group that regularly visit the site;
2. conduct a bird survey before and after revegetation works; or
3. do the same as option 2, but at both the work site and at a number of undisturbed sites nearby, with similar characteristics to the restored site.

In this example, as the complexity of evaluation increases, so does the confidence that the community group has in the results. To illustrate, suppose the number of bird species actually increased from 20 to 22 species at the work site over the revegetation period, but this trend also occurred at the undisturbed sites nearby. If the group had used:

- Option 1 above, they may not have noticed the subtle change at all. Even if they did, they would have very little confidence that the change was a direct result of the revegetation.
- Option 2 above, they may have concluded the revegetation was associated with an increase in the number of bird species. However, they would still be uncertain that the increase was caused by the revegetation and not other factors (e.g. seasonal influences).
- Option 3 above, they may have concluded that the restoration works made no measurable difference to the number of bird species present.

The monitoring and evaluation described in this Water Note provides an indication of improved ecological health but is unlikely to assess the complex interrelationships that a scientist would want to study.

5. Choose an appropriate monitoring method

It is important to use monitoring methods that are appropriate to the project's objectives and are within the available budget. Don't be tempted to use a monitoring method just because it is familiar to the group unless it clearly matches the project objectives. For example, a group may be familiar with macroinvertebrate monitoring and try to use this to measure the performance of a new wetland that aims to strip nutrients from a polluted rural stream. It would be more appropriate in this case to monitor changes in nutrient loads entering and leaving the wetland, or measure the mass of nutrients trapped in sediment and biomass within the wetland.

It is advisable to keep monitoring focussed, relatively simple and achievable by the available resources and group skills. For example, while the overall goal of a project may be "to improve a river's health", one practical objective for a community group to monitor and evaluate may be "to install three riffles that remain stable over the winter". This approach makes the reasonable assumption that stable riffles will have a positive effect on the river's health. Taking such an approach can greatly simplify the monitoring effort.

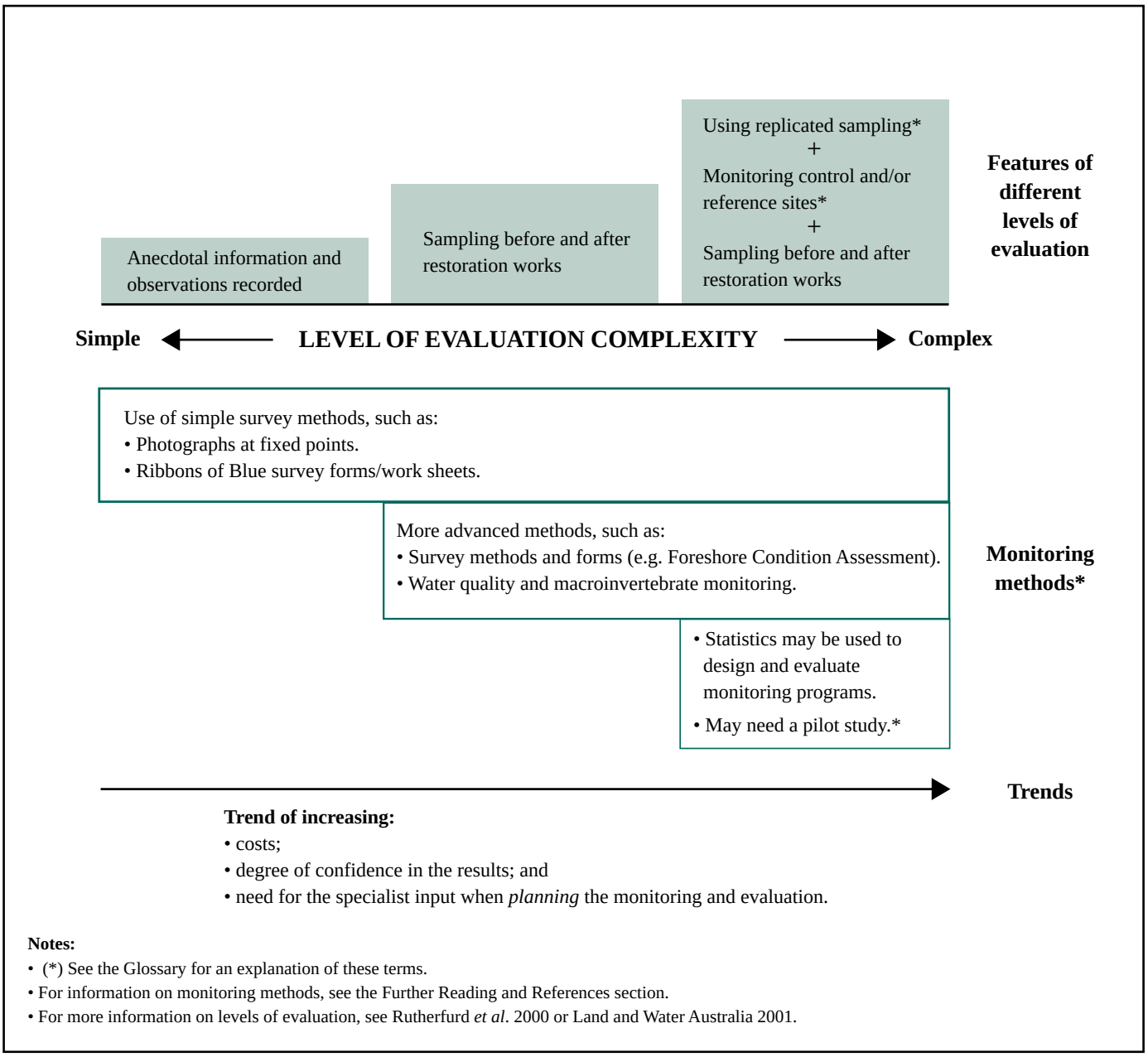

Figure 2. The features of different levels of evaluation.

In the previous example, an annual bird survey was used as an appropriate monitoring method to match the project's objectives. A wide variety of specific monitoring methods can be chosen to appropriately evaluate project objectives. Further information on these can be found in Woodhill & Robins 1998 and Rutherfurd *et al*. 2000.

In addition, the use of more general survey methods that assess the broad condition of stream foreshores are recommended. These are relatively simple and inexpensive, combine a wide range of physical, biological and chemical factors to provide a more holistic picture of the river's condition, and are widely used so results can be compared between work sites. A commonly used foreshore assessment is that of Pen and Scott (1995), *Stream foreshore assessment in farming areas.* A revised version of this document can also be found in WRC (1999a & 1999b).

Consideration also needs to be given to the influence of seasons and flow events. For example, if a revegetation project aims to increase the number of frog species in a given area, monitoring the number of different frog mating calls before and after revegetation may be the best method for a community group. However, the timing of such monitoring would need to coordinate with the mating season of species that are likely to be in the area (see Pen 1999).

6. Document the monitoring and evaluation approach

A brief document describing the nature of the proposed monitoring and evaluation can be used to communicate the intention and maintain a record of what needs to be done. This is particularly important if the monitoring is going to be done over several years and/or involve several people.

The document should include key details, such as:

- the project's vision, goals, objectives, inputs, outputs and outcomes (see Figure 2);
- the level of evaluation chosen (see Figure 2);
- the indicators and monitoring methods chosen (including sampling frequency, location, timeframe); and
- who will do the monitoring, evaluation and reporting.

It is also suggested that the document encourages the recording of any major events that could influence the results (e.g. floods, fires, droughts, vandalism, monitoring mishaps).

7. Communicate the results

When communicating the results of an evaluation exercise to affected stakeholders:

- Clearly state whether or not the project was successful, given the project's objectives.
- Highlight the reason(s) for success or failure, and make recommendations for similar restoration projects in the future.
- Make recommendations about additional rehabilitation works if the project's objectives have not been achieved.
- Keep key stakeholders engaged by providing regular feedback on the progress and impacts of the project.
- Demonstrate accountability to those funding the works (e.g. demonstrate that the project occurred in accordance with an agreed plan).
- Consider providing information that can be simply used as a local educational tool.
- Consider using a graphical approach to communicate results (see Figure 3 as an example).
- Provide the Water and Rivers Commission with a copy of any documentation to help disseminate the knowledge that has been gained.

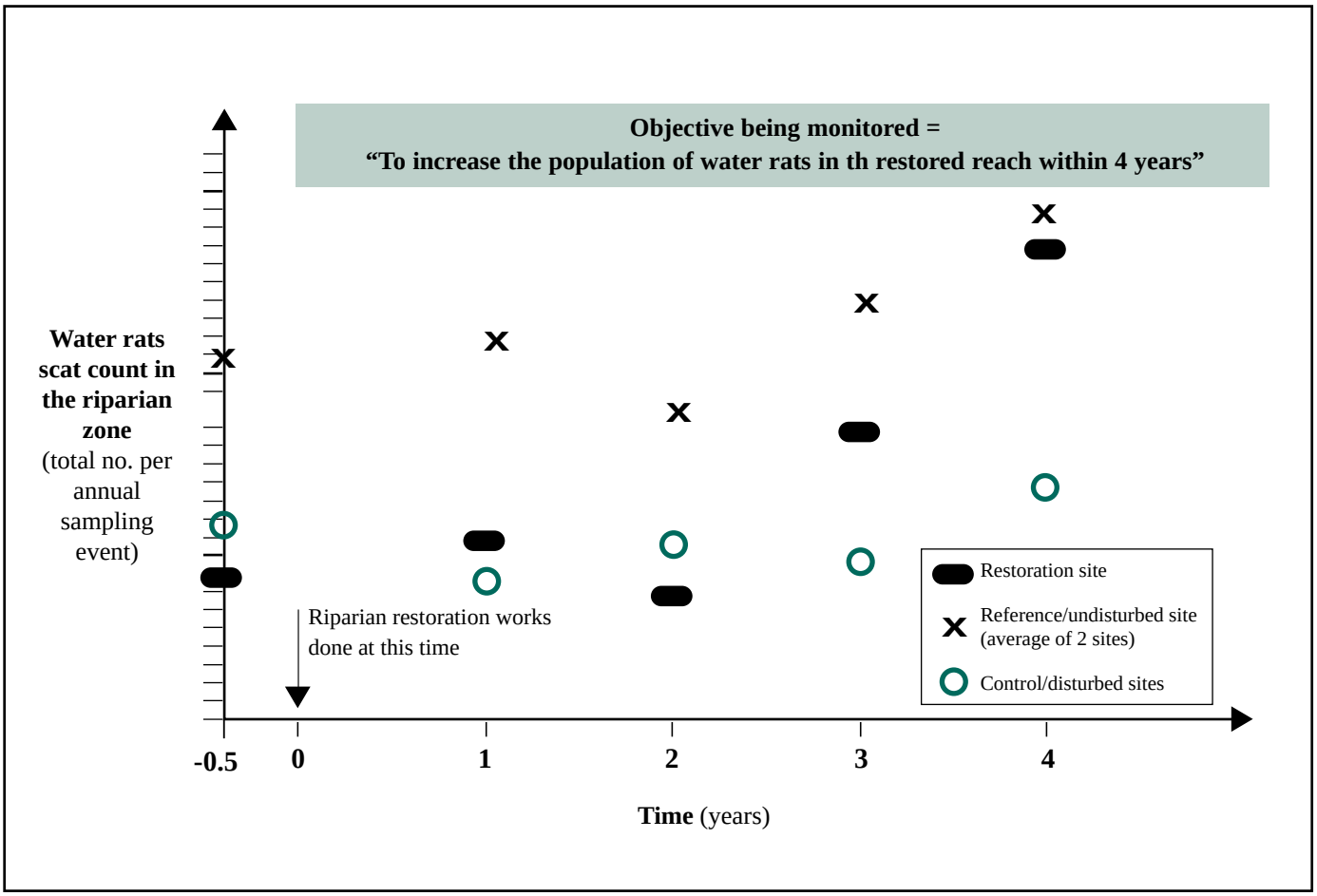

Figure 3. Example of a graphical approach to communicate results.

Commitment

Unfortunately, some river restoration groups decide not to properly monitor and evaluate their projects. Explanations often include lack of money, time and expertise. Yet, as shown above, some forms of evaluation are not expensive, time-consuming or complex. Some objectives may be easily evaluated through monitoring methods such as annual photographic surveys, or water quality testing conducted by Ribbons of Blue. Sound planning of a suitable evaluation strategy before work begins is the key.

A well designed monitoring and evaluation program can be an excellent way of boosting a community group's public profile, funding and membership numbers, as well as the enthusiasm and commitment of existing members. For example, suppose a simple evaluation program concluded that a river restoration project had resulted in an increase in the local abundance of marron or black bream (a popular fish for many recreational fishers). Such information could be used strategically in the local community to gain support for future restoration activities.

Evaluation is also the only way to progressively improve river restoration techniques that are used widely across the State. When this occurs, community groups can use their resources more effectively.

Returning to our medical analogy – if you were a patient undergoing a major surgical procedure, would you be satisfied if your medical team decided not to monitor your health or evaluate whether the procedure worked but rather just waited to see if you survived?

A student monitoring the turbidity of the water at Lake Leschenaultia.

Glossary of terms

Actions The activities that must be carried out, or the strategies that need to be followed, for the objectives to be met (Woodhill & Robins 1998).

Control site A sampling site or reach which is as similar as possible to the rehabilitated site in every way, except that it is not rehabilitated (Rutherfurd *et al*. 2000). Using more than one control site is encouraged for monitoring and evaluation activities.

Ecological health The extent to which ecological processes and functions are resilient and adaptive, giving rise to self-regulation, stability and diversity in populations and ecosystems (K. Trayler, *pers. comm*. 2001).

Goals What the project is hoping to achieve in the longer term (modified from National Landcare Program Evaluation Coordinators 1997). For example, "to improve the health of the river".

Inputs The resources used to achieve the project's objectives, such as time, labour, money, skills, equipment, materials (Woodhill & Robins 1998).

Large woody debris (LWD) A dead tree or portion of tree that has fallen into a stream. Usually considered to be larger than 0.1 m in diameter, and over 1 m long. Also called snags. (Rutherfurd *et al*. 2000).

Monitoring indicators Things that are monitored to allow assessment of progress against the project's objectives (e.g. turbidity of water, survival rate of planted shrubs). "Variables" and "evaluation measures" are equivalent terms that are sometimes used.

Monitoring methods The way indicators are monitored. Methods can be simple, such as taking photographs at fixed points over time, or complex such as statistically based water quality monitoring programs. Monitoring methods not only define how certain samples are taken and analysed (e.g. how to measure the temperature of water), but also cover issues such as how many samples are needed, when and where they should be taken, and whether samples should be taken before restoration work begins.

Objectives The specific aims of the project (e.g. "to install fencing along both sides of the river section by 30 June 2002"). For evaluation purposes, objectives should be **s.m.a.r.t.**:

- **s**pecific;
- **m**easurable, given available resources;
- **a**chievable preferably within the time frame of the project and within 5 years;
- **r**elevant to the project's over-all vision and goals; and
- **t**imeframed (Rutherfurd *et al*. 2000 & WRC 2001a).

Ideally, the objectives used for the evaluation exercise to assess the project's level of success should be all or some of those defined for the overall river restoration project.

Outcomes The actual changes that result from the project's activities, such as improved bank stability (National Landcare Program Evaluation Coordinators 1997).

Outputs The project's activities or products (e.g. the planting of trees). They are intended to produce a change in the condition of the stream (modified from National Landcare Program Evaluation Coordinators 1997).

Pilot study A pilot study may be done before restoration works to better understand the system being monitored. For example, to understand how water quality in the river changes with the seasons and flow events.

Project A set of tasks or activities being carried out by the group to tackle a particular problem or issue (Woodhill & Robins 1998).

Reference site An undisturbed site with similar characteristics to the work site after successful restoration.

Rehabilitation The return (as much as possible) of the original characteristics of a waterway or wetland, including the physical structure and stability, functionality, water quality, flow regime, and plant and animal communities. Ideally, improvements made to the waterway or wetland during rehabilitation should be self-sustaining (modified from Rutherfurd *et al*. 2000).

Replication Repeat sampling to identify the inherent variability in the system (Rutherfurd *et al*. 2000). Can be used to describe monitoring more than one study, control and/or reference site.

Reporting The communication of the findings of the evaluation process (i.e. whether the project's objectives were met and what was learnt).

Restoration The return of a degraded waterway or wetland to the original (pre-European) state in regard to physical structure and stability, functionality, water quality, flow regime, and plant and animal communities (modified from Rutherfurd *et al*. 2000).

Although complete 'restoration' of a river is a goal that is rarely achieved, the term is often used to describe the complete return of a component that was once part of the river ecosystem such as a species, feature or function. For example, it may be possible to restore a population of flooded gums in a river's riparian zone despite not being able to fully restore the entire plant community.

Ribbons of Blue An environmental education network aimed at increasing community awareness and understanding about local water quality, and taking action for a better environment. Ribbons of Blue programs involve school students and community groups in monitoring water quality. Data collected from the sampling provides valuable information for identifying environmental problems and preparing management plans. Ribbons of Blue is part of the Natural Heritage Trust funded Waterwatch Australia network and is coordinated by the Water and Rivers Commission as the lead agency for Waterwatch in Western Australia.

River Action Plan A prioritised list or timetable of onground works and actions to improve the health of a stretch of waterway. A catchment may typically have several River Action Plans. They provide an integrated coordinated approach to onground waterways management at a local scale. Also may be referred to as Local River Action Plan, River Recovery Plan or Site Plan (WRC 2001a).

Stakeholders In this context, stakeholders are those people directly or indirectly impacted on or involved in the river restoration project activities. The community group working on the project is also considered a stakeholder.

Stream Condition Index A rating system used in south-west Western Australia to evaluate the condition of the riparian zone based upon assessments of bank stability, foreshore/ riparian vegetation, stream cover and habitat diversity (WRC 1999b).

Vision A general statement of an improved state that the project will help achieve. It could embody the basic motives or reasons for beginning the project (modified from Woodhill & Robins 1998). For example, 'the river will once again be an enjoyable and safe place for swimming and fishing'.

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