## Wetland Management Series

# WET-RehabEvaluate

**Guidelines for monitoring and evaluating wetland rehabilitation projects**

WRC Report TT 342/09
March 2009

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SOUTH AFRICAN national biodiversity institute SANBI

Working for Wetlands

UNIVERSITY OF KWAZULU-NATAL

Obtainable from:

Water Research Commission
Private Bag X03
Gezina
0031

The publication of this report emanates from a project entitled: *Wetlands Research Programme: Wetland Rehabilitation* (WRC Project No. K5/1408)



WRC Report TT 342/09

ISBN 978-1-77005-641-1

Set No 978-1-77005-631-2

Printed in the Republic of South Africa

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*Front cover*: A gabion structure in the Gatberg Wetland near Ugie, which has been designed to raise the water table and limit erosion at the head of a gully.
*Photograph:* Japie Buckle

*Inside front cover*: Boneberg's frog (*Natalobatrachus bonebergi*), commonly known as Ngoye frog, is a threatened endemic species along the coastal region of KZN.
*Photograph:* Errol Douwes

## Preface: Background to the *WET-Management* Series

The need for wetland rehabilitation in South Africa is compelling: loss and degradation of wetlands have been great and national policy and legislation provides clear direction and support for rehabilitation. However, rehabilitating wetlands is often complex because wetlands and their links with people are complex (e.g. through the ways that people use wetlands and the different benefits that people receive from the ecosystem services that wetlands supply). Thus, a series of tools has been developed to assist those wishing to undertake wetland rehabilitation in a well-informed and effective way (Box 1P).

These tools were developed as part of a comprehensive nine-year research programme on wetland management which was initiated in 2003 by the Water Research Commission (WRC) and a range of partners that examines wetland rehabilitation, wetland health and integrity and the sustainable use of wetlands. The rehabilitation component, which was co-funded by the WRC and the Department of Environmental Affairs and Tourism, through the Working for Wetlands (WfWetlands) programme, was prioritised to take place first because of the need to provide a firm scientific and technical foundation for the extensive rehabilitation work already underway.

The Working for Wetlands Programme is a national initiative that seeks to promote the protection, rehabilitation and wise use of wetlands in South Africa. As part of this initiative, WfWetlands has a national programme for the rehabilitation of wetlands, including a structured process of prioritising rehabilitation sites and supporting their rehabilitation. At the same time, however, it is acknowledged that sustainable use of wetlands in the long term can be achieved only through the dedicated participation of civil society, whose wetland interests may have a strong local focus. Thus, the tools have been developed in such a way that they can be applied outside of the Working for Wetlands Programme, and without having to engage the process of national or provincial prioritisation should the user not desire to do so. Even so, the tools encourage local wetland rehabilitation efforts to strengthen links with the national initiative and the opportunity this provides for fruitful partnerships.

The series consists of a roadmap, two background documents, eight tools and an evaluation of the success of six individual projects (Box 1P). From Table 1P it can be seen that some of the tools (e.g. *WET-RehabMethods*) are designed to be used by those dealing specifically with wetland rehabilitation and its technical requirements. Other tools (e.g. *WET-Health*) have much wider application such as assessing impacts associated with current and future human activities in Environmental Impact Assessments or assessing the Present Ecological State of a wetland in an Ecological Reserve Determination.

One can locate the tools in terms of some basic 'who', 'what', 'where' and 'how' questions that any team undertaking wetland rehabilitation should be asking (Table 2P). Furthermore, each of the tools can be used individually, but there are close links between them (Figure 1P).

## Box 1P: Overview of the *WET-Management* Series

The series includes documents that provide background information about wetlands and natural resource management, tools that can be used to guide decisions around wetland management, and an evaluation of rehabilitation outcomes in a number of case studies.

### WET-Roadmap

*WET-Roadmap* provides an introduction to the *WET-Management* tools and includes:

- A brief outline of the documents and tools in the *WET-Management* series and how they inter-relate
- An index of wetland rehabilitation related terms
- Reference to specific sections in the relevant tools.

### WET-Origins

*WET-Origins* describes the remarkable geological and geomorphological processes that give rise to wetlands in South Africa, and provides a background description of:

- The geology, geomorphology, climate and drainage of southern Africa
- An introduction to wetland hydrology and hydraulics
- Geomorphic controls on different wetland types
- Wetland dynamics due to sedimentation and erosion.

It incorporates this understanding into a methodology that can be used to help develop insight into the hydrological and geomorphological factors that govern why a wetland occurs where it does, which is useful when planning rehabilitation.

### WET-ManagementReview

*WET-ManagementReview* has four parts:

1. An assessment of effectiveness at programme level, including:
   - a national overview of land-uses affecting the status of wetlands and the institutional environment that affects wetlands.
   - an overview of 5 natural resource management programmes affecting wetlands and their impact in different land-use sectors; Working for Wetlands, Working for Water, LandCare, the Crane Conservation Programme of the Endangered Wildlife Trust, and the Mondi Wetlands Programme.
2. An assessment, using the *WET-EffectiveManage* tool, of the management effectiveness of 21 wetland sites in a variety of different land-use and land-tenure contexts.
3. An assessment of stakeholder participation in wetland rehabilitation at six wetland sites.
4. A framework for assessing the effectiveness of collaboration between partners, described and applied to a site where a rehabilitation project has been underway for several years.

### WET-OutcomeEvaluate

*WET-OutcomeEvaluate* is an evaluation of the rehabilitation outcomes at six wetland sites in South Africa, including an evaluation of the economic value of rehabilitation. The six sites are:

1. Killarney Wetland
2. Manalana Wetland
3. Kromme River Wetland
4. Dartmoor Vlei
5. Kruisfontein Wetland
6. Wakkerstroom Vlei.

## WET-RehabPlan

*WET-RehabPlan* offers a process that can be followed to develop comprehensive wetland rehabilitation plans. It has three main elements:

- Introduction to rehabilitation, planning and stakeholder involvement.
- General principles to follow in planning wetland rehabilitation.
- Step-by-step guidelines for undertaking the planning and implementation of wetland rehabilitation at a range of scales from national/provincial to catchment to local. It directs the user to the right tools and sections at appropriate points in the rehabilitation process.

Good planning ensures a rational and structured approach towards rehabilitation as well as a clear understanding of the reasons for rehabilitation, the actions and interventions required, and the benefits and beneficiaries.

## WET-Prioritise

*WET-Prioritise* helps to identify where rehabilitation should take place once the objectives of rehabilitation are identified. It works at three spatial levels. At national and provincial level, an interactive GIS modelling tool assists in identifying priority catchments by evaluating a range of scenarios, based on different combinations of 13 socio-economic and bio-physical criteria (e.g. Biodiversity Priority Areas, High Poverty Areas). Once a catchment is selected, the tool helps to identify areas for rehabilitation within that catchment. Finally, individual wetlands are selected based on the predicted cost-effectiveness and sustainability of rehabilitation.

*WET-Prioritise* provides step-by-step guidelines applicable at all three spatial scales, including:

- Identifying objectives and an appropriate scale.
- Developing prioritisation criteria.
- Applying the criteria, usually in a two step process of rapidly screening all candidate sites to arrive at a preliminary set of sites, from which individual priority sites are selected.

Three case examples of prioritisation are described.

## WET-Legal

*WET-Legal* presents South African legislation that is relevant to wetland rehabilitation, including the Conservation of Agricultural Resources Act (CARA), National Environmental Management Act (NEMA), and National Water Act (NWA), as well as relevant international agreements such as the Ramsar Convention on Wetlands. *WET-Legal* lists the environmental impacts potentially associated with typical wetland interventions and the legislative provisions that apply to each of these impacts. It also covers laws compelling rehabilitation and the legal responsibilities of different parties involved in rehabilitation.

## WET-EcoServices

*WET-EcoServices* is used to assess the goods and services that individual wetlands provide, thereby aiding informed planning and decision-making. It is designed for a class of wetlands known as palustrine wetlands (i.e. marshes, floodplains, vleis or seeps). The tool provides guidelines for scoring the importance of a wetland in delivering each of 15 different ecosystem services (including flood attenuation, sediment trapping and provision of livestock grazing). The first step is to characterise wetlands according to their hydro-geomorphic setting (e.g. floodplain). Ecosystem service delivery is then assessed either at Level 1, based on existing knowledge or at Level 2, based on a field assessment of key descriptors (e.g. flow pattern through the wetland).

## WET-Health

*WET-Health* assists in assessing the health of wetlands using indicators based on geomorphology, hydrology and vegetation. For the purposes of rehabilitation planning and assessment, *WET-Health* helps users understand the condition of the wetland in order to determine whether it is beyond repair, whether it requires rehabilitation intervention, or whether, despite damage, it is perhaps healthy enough not to require intervention. It also helps diagnose the cause of wetland degradation so that rehabilitation workers can design appropriate interventions that treat both the symptoms and causes of degradation. *WET-Health* is tailored specifically for South African conditions and has wide application, including assessing the Present Ecological State of a wetland for purposes of Ecological Reserve determination in terms of the National Water Act, and for environmental impact assessments. There are two levels of complexity: Level 1 is used for assessment at a broad catchment level and Level 2 provides detail and confidence for individual wetlands based on field assessment of indicators of degradation (e.g. presence of alien plants). A basic tertiary education in agriculture and/or environmental sciences is required to use it effectively.

## WET-EffectiveManage

*WET-EffectiveManage* provides a framework that can be used to assess management effectiveness at individual wetlands based on 15 key criteria (e.g. the extent to which a regularly reviewed management plan is in place for the wetland). A scoring system is provided for rapidly assessing the criteria. This tool is Chapter 2 in the *WET-ManagementReview* manual.

## WET-RehabMethods

*WET-RehabMethods* is used to guide the selection and implementation of rehabilitation methods that are appropriate for the particular problem being addressed and for the wetland and its catchment context. It provides detailed practical rehabilitation guidelines for inland palustrine wetlands and their catchments, and focuses particularly on wetlands associated with natural drainage networks. It can be adapted to meet specific needs. Some aspects of the tool require high levels of civil engineering expertise, but it is designed primarily for rehabilitation workers who have completed training in soil conservation, life sciences or engineering at a diploma level or higher, and who have practical field experience.

*WET-RehabMethods* includes the following:

- Key concepts relating to wetland degradation, particularly those

resulting from erosion.

- Guidelines for the selection of an appropriate type of rehabilitation intervention (including both 'soft' and 'hard' engineering options).
- Detailed guidance, provided for designing a wide variety of intervention types (e.g. determining an adequate spillway to account for runoff intensity).
- Detailed guidance provided for the implementation of the different intervention types.

## WET-RehabEvaluate

*WET-RehabEvaluate* is used to evaluate the success of rehabilitation projects, and is designed with the understanding that monitoring and evaluation are closely tied to planning, which, in turn, should accommodate monitoring and evaluation elements. *WET-RehabEvaluate* provides the following :

- Background to the importance of evaluation of wetland rehabilitation projects.
- Step-by-step guidelines for monitoring and evaluation of rehabilitation projects, both in terms of project outputs and outcomes. The outcomes are based on system integrity and the delivery of ecosystem services, and results from *WET-Health* and *WET-EcoServices* are therefore included. The guidelines include: review project objectives, identify performance indicators and standards, develop and implement a monitoring and evaluation plan, evaluate and report on performance.

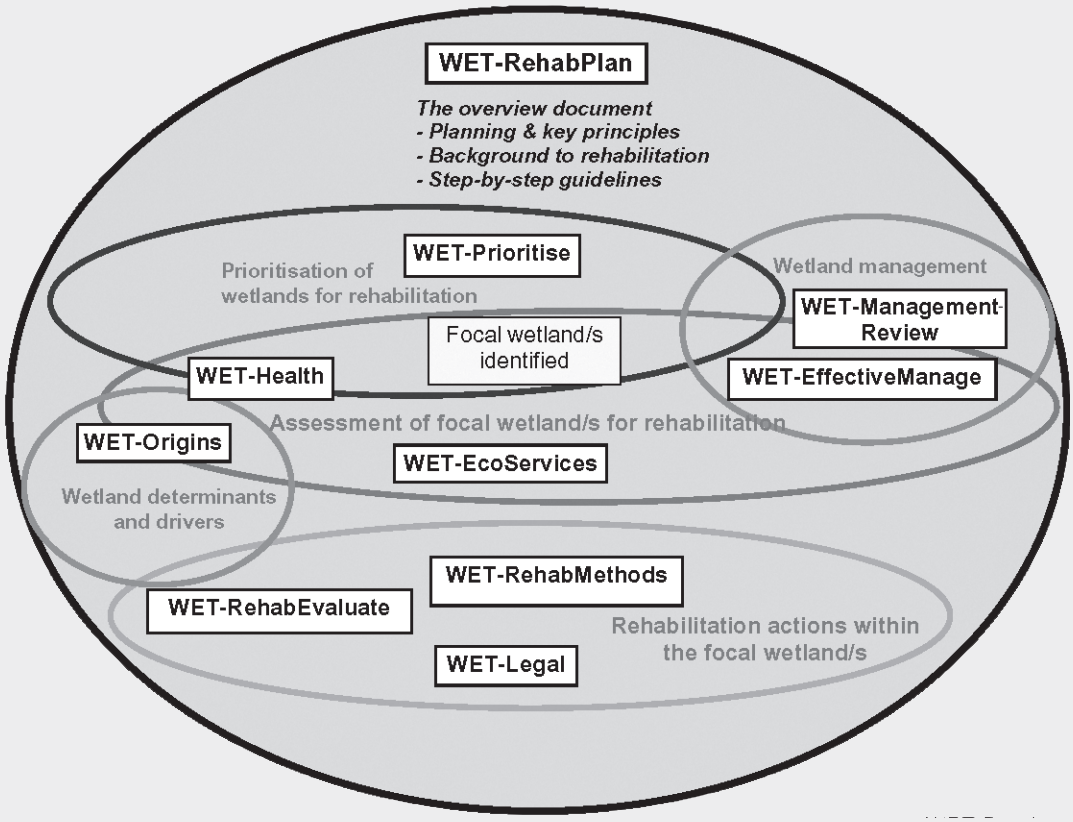


**Figure 1P: How do the *WET-Management* tools relate to each other in a rehabilitation context?**

**Table 1P: Likely relevance of the background reading and tools in the *WET-Management* series to a variety of different potential uses**

| Potential users | *WET-Origins* | *WET-Management - Review* | *WET-RehabPlan* | *WET-Prioritise* | *WET-Effective-Manage* | *WET-Legal* | *WET-Rehab-Methods* | *WET-Eco-Services*[1] | *WET-Health*[2] | *WET-Rehab-Evaluate* |
|---|---|---|---|---|---|---|---|---|---|---|
| Rehabilitation planning - wetland specialist | | | | | | | | | | |
| Rehabilitation planning - engineer | | Part 1 | Step 5 | | | | | | | |
| Rehabilitation programme coordination - *national* | | | | | | | | | | |
| Rehabilitation programme coordination - *provincial* | | | | | | | | | | |
| Rehabilitation implementation | | | Step 5 | | | | | | | |
| Impact assessment | | Part 1 | | | | | | Level 1 | Level 2 | |
| Wetland management | | | | | | | | | | |
| Ecological Reserve Determination - DWAF officials & consultants | | Part 1 | | | | | | Level 1 | Level 2 | |
| Catchment planners - CMAs and others | | Part 1 | | | | | | | | |
| Broad-scale biodiversity conservation planning | | Part 1 | | | | | | | | |

The tool is likely to have some relevance

The tool is likely to have a very high level of relevance

[1] *WET-EcoServices* is of particular relevance in determining the Ecological Importance and Sensitivity (EIS) of a wetland.

[2] *WET-Health* is of particular relevance ino determining the Present Ecological State (PES) of a wetland.

CMA = Catchment Management Agency
DWAF= Department of Water Affairs and Forestry

**Table 2P: Rehabilitation-related questions typically posed at different spatial levels, and the tools most relevant to assisting the user in answering each question**

| Common questions | Tool/s likely to be relevant in addressing the question |
|---|---|
| **Questions that might typically be asked at the national or regional level** | |
| What is causing the degradation of wetlands? | *WET-Health* (Level 1) & *WET-ManagementReview* |
| Which are the most important wetlands? | *WET-Prioritise* & *WET-EcoServices* (Level 1) |
| Which wetlands should we rehabilitate? | *WET-Prioritise* |
| How should wetland rehabilitation be integrated within broad-scale catchment management? | *WET-Prioritise* & Dickens *et al*. (2003) |
| **Questions that might typically be asked at the local level** | |
| How effectively is the wetland being managed? | *WET-EffectiveManage* |
| What is causing the degradation of the wetland? | *WET-Health* (Level 2) |
| Is the wetland in need of rehabilitation? | *WET-Health* (Level 2) & *WET-Origins* |
| How do I decide what rehabilitation interventions will be appropriate for meeting my rehabilitation objectives? | *WET-RehabPlan* (Step 5F) & *WET-RehabMethods* |
| What are specific technical considerations I must make when designing a rehabilitation intervention? | *WET-RehabMethods* |
| Will the planned project be legally compliant? | *WET-Legal* |
| How do I evaluate my rehabilitation project? | *WET-RehabEvaluate* |
| Who should be involved in the rehabilitation project? | *WET-RehabPlan* |
| How do I align my rehabilitation project with catchment-, regional- or national-level programme/s? | *WET-RehabPlan* & WfWetlands Strategy (Working for Wetlands, 2005) |

**The National Water Act defines wetlands as:**

*'....land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which in normal circumstances supports or would support vegetation typically adapted to life in saturated soils.'*

This is the definition used by the *WET-Management* Series.

## Summary

The overall purpose of *WET-RehabEvaluate* is to facilitate the dissemination of lessons learnt and provide a means of reporting on the success of specific wetland rehabilitation initiatives. The monitoring and evaluation of an identified wetland rehabilitation project's performance is therefore considered vital to inform the evaluation of wetland rehabilitation success. *WET-RehabEvaluate* provides a background to the importance of performance evaluation of wetland rehabilitation projects and step-by-step guidelines for the monitoring and evaluation of rehabilitation projects, both in terms of the project outputs and outcomes. *WET-RehabEvaluate* includes: reviewing project objectives, identifying performance indicators and standards, developing and implementing a monitoring and evaluation plan, and evaluating and reporting on wetland rehabilitation performance. The process of monitoring and evaluation of wetland rehabilitation projects is outlined.

*WET-RehabEvaluate* therefore provides guidance for people undertaking all these steps for the evaluation of wetland rehabilitation projects. The focus of the manual is the monitoring and evaluation of the implementation of the wetland rehabilitation process as well as the outcomes of the rehabilitation for individual projects rather than the monitoring and evaluation at a programme level. The approach of the evaluation is to maximise the learning opportunities within the wetland rehabilitation process.

The initial step in the process is to meet with the people involved with the wetland rehabilitation projects being assessed and highlight the importance of the evaluation in disseminating the lessons learnt. The rehabilitation project objectives are then revisited to ensure that they are measurable; the level of monitoring required is then determined and adequate indicators are derived to monitor a project's progress. The level of monitoring is based on the outputs and outcomes of the project, where the outputs are the interventions that are implemented to achieve the objectives, and the outcomes are the effects of those interventions on the state of the wetland system. Level 1 monitoring focuses on the project outputs and Level 2 focuses on the aesthetic, production, hydro-geochemical and ecological outcomes within the wetland system. The indicators depend on the outputs and outcomes outlined during the planning of the wetland rehabilitation project. A level of success is then outlined for each indicator. The attainment of these success standards is used as an indication of project progress. The implementation of monitoring activities only commences once adequate planning has taken place to ensure that the objectives, outputs and outcomes of the project can be suitably measured and that the data acquired can be translated into meaningful, actionable information. Reporting on results of monitoring, determining and implementing corrective action, and subsequent reporting on the overall evaluation of the rehabilitation process, are the final steps of a monitoring and evaluation programme.

## Acknowledgements

The Water Research Commission (WRC), South African National Biodiversity Instutute (SANBI) and Working for Wetlands (WfWetlands) are gratefully acknowledged for funding the development of this tool. The entire WfWetlands team has taken an active interest and participated in the development of this tool. The WRC has been very supportive in offering strategic and administrative assistance. The research programme was managed by Fred Ellery of the University of KwaZulu-Natal (UKZN), who was ably assisted by Kerry Philp.

The valuable contributions of Chris Dickens of INR, Mark Graham of Ground Truth, Arend Hoogervorst of Eagle Environmental, Mandy Uys of Laughing Waters, Bill Russell, Charles Breen and Samantha Adey for reviewing earlier drafts of the document are gratefully acknowledged. Arend is also thanked for highlighting the importance of the pre-evaluation stage and for his considerable inputs in the pre-evaluation section of the document. Michael Braack is thanked for input regarding the monitoring of the implementation of wetland rehabilitation activities. Andile Mncube and Doug McCulloch are acknowledged for their respective inputs into the manual. Karen Ellery provided substantial editorial input during the production of this document.

## Citation

The correct citation for this document is:
Cowden C and Kotze DC, 2009. *WET-RehabEvaluate: Guidelines for monitoring and evaluating wetland rehabilitation projects.* WRC Report No TT 342/09, Water Research Commission, Pretoria.

## Feedback

In South Africa the rehabilitation of wetland ecosystems is still in its infancy. In order to promote the growth of this activity, this manual needs to be revised by including the experiences of those individuals involved in wetland rehabilitation within South Africa. Any comments or advice can be sent to:

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# TABLE OF CONTENTS

# 1. THE IMPORTANCE OF PERFORMANCE EVALUATION

> "*With no formal check on the success of the project, it is difficult to improve the techniques we use, because we don't know if they need improving*" (Rutherfurd *et al.,* 2000).

The rehabilitation of wetland ecosystems within South Africa is a relatively recent initiative and is widely considered to be in its infancy. In order to facilitate the dissemination of the lessons learned, formal monitoring and evaluation procedures would need to be designed for wetland rehabilitation projects within the country.

The evaluation of project performance provides several benefits to wetland rehabilitation projects (Rutherfurd *et al.*, 2000; Woodhill and Robins, 1998). Evaluation of project performance:

- demonstrates the worth of the project or the organisation that is implementing the wetland rehabilitation
- provides assurance to funding agents and the public that the project has achieved its objectives
- allows the implementation of strategic, adaptive management practices, timely maintenance and corrective action, all of which improve the focus and procedures of a project as it proceeds
- provides insights and experience relating to wetland rehabilitation, which provide opportunities for learning for those involved and also for future projects, and
- shows positive or negative changes in both the physical and biological aspects of the wetland following the rehabilitation activities and relative to the objectives set at the commencement of the project.

It is important to note that *WET-RehabEvaluate* focuses on the monitoring and evaluation at a project or site level. While the evaluation of wetland rehabilitation at a project level may not provide insights into the performance of a national scale programme, it does require the collection of information for each project that, when summarised, provides information used to assess wetland rehabilitation at a broader scale.

Performance evaluation of the various wetland rehabilitation projects in South Africa is limited and is often non-existent. This is related to a wide range of issues that are associated with interventions in natural systems (Rutherfurd *et al*., 2000; Woodhill and Robins, 1998):

- Natural systems are complex and often respond slowly to implemented changes.
- The evaluation of project success is generally difficult, slow and expensive.
- Funding agents are not prepared to fund long-term monitoring, or to wait for the results.
- Individuals are not willing to accept that an implemented project has resulted in failure.
- Evaluation is often seen as an unwelcome aspect of funding and is viewed with suspicion.

Monitoring and performance evaluation are most effective when they are an integral part of a strategic adaptive management process (see Kotze and Breen, 2009). Therefore any management plan and system should incorporate monitoring and performance evaluation. Zentner (1988) highlighted the fact that the lack of monitoring was a common element of unsuccessful wetland rehabilitation projects. Ideally, monitoring and evaluation should take place for the duration of the project and for a specified period thereafter (Woodhill and Robins, 1998).

NOTE:
There is often confusion relating to the difference between monitoring and evaluation of rehabilitation projects:

- *Monitoring* involves the regular, systematic gathering of information based on observations and measurement of change in wetland characteristics in relation to a pre-defined state in order to provide the data for evaluation (Water and Rivers Commission, 2002).
- *Evaluation* is the assessment of the effectiveness of a project against pre-determined objectives, and is usually based on monitoring (Rutherfurd *et al.*, 2000).

## 2. PERFORMANCE EVALUATION AND WETLAND REHABILITATION

This document is a performance evaluation manual for wetland rehabilitation projects that are implemented in South Africa. Its purpose is to outline procedures for evaluating the success of wetland rehabilitation relative to the objectives of the project. Objectives for wetland rehabilitation projects relate to a series of desired outcomes that are the positive effects of interventions upon the state of the system concerned (e.g. raising of the water table and the re-establishment of vegetation dominated by hydric species). The physical interventions themselves (e.g. a concrete structure to plug a drainage canal) are outputs that are put in place to promote the achievement of the desired outcomes. Performance evaluation of a wetland rehabilitation project is an assessment of the extent to which the project has achieved the desired outputs and outcomes.

Performance evaluation is required within wetland rehabilitation projects to provide a measure of whether or not the objectives (ecological, social and economic) of wetland rehabilitation are being met. The following two examples illustrate the importance of performance evaluation:

- Where rehabilitation is funded by a funding agent. If the funding agent does not have any information about the projects it has funded that shows the outcomes of these projects, it becomes increasingly difficult to maintain support for such projects (Woodhill and Robins, 1998).
- Where rehabilitation is being carried out to offset impacts associated with the loss of wetland habitat. If the regulatory authorities do not have information about the mitigation projects in the province and/or country to show the outcomes of such projects, it would be increasingly difficult to justify that the level of impact on wetland habitat has been adequately offset.

It is important to note that in many instances the monitoring and evaluation of wetland rehabilitation that is undertaken for funded and private rehabilitation projects has different priorities in terms of the monitoring of outputs and outcomes. Wetland rehabilitation projects funded by funding agents are more likely to be monitored and evaluated at a higher level of accuracy with regard to the outputs of the project to account for expenditure, while for privately undertaken wetland rehabilitation, the outcomes may be more important. This manual takes into account the requirements of both types of wetland rehabilitation projects, and uses the Working for Wetlands Programme (WfWetlands) as an example of funded wetland rehabilitation being implemented in South Africa. Therefore, while the manual provides WfWetlands with a means of recording and reporting on implemented projects in a manner that ensures that funding agents have confidence in reported performance results, it also assists organisations, groups and individual landowners implementing a wetland rehabilitation project to improve the monitoring and evaluation of their project.

Figure 2.1 illustrates the process of wetland rehabilitation for scenarios from national level projects to local projects. WET-RehabEvaluate outlines steps 5C, D, G, H and J. These steps are considered to be important in facilitating learning, in future planning and in illustrating the worth of implemented projects.

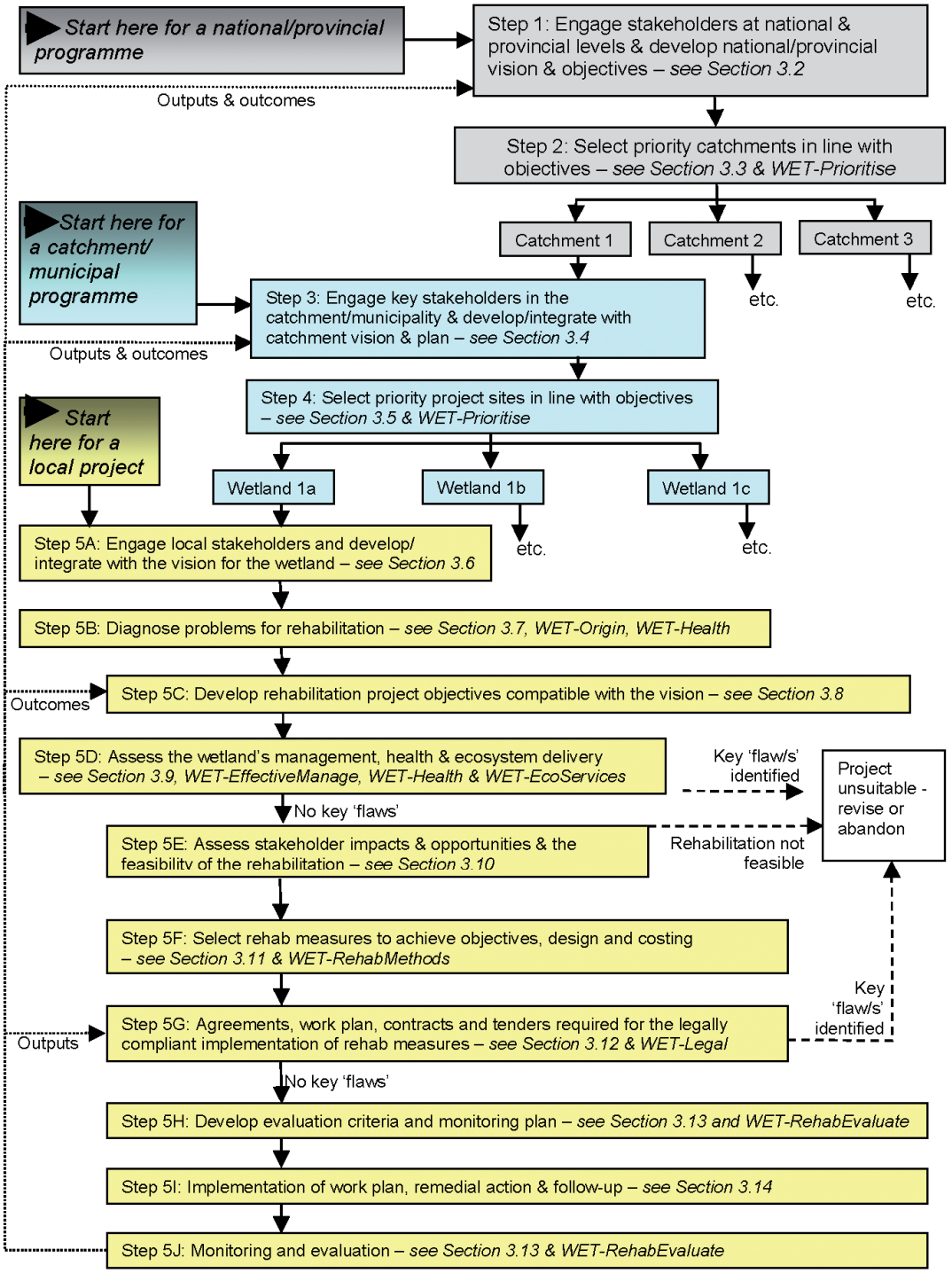



**Figure 2.1: A framework for planning of wetland rehabilitation activities from national to local scale, showing individual steps and feedback loops (from *WET-RehabPlan*: Kotze *et al.*, 2009a).**

# 3. THE PERFORMANCE EVALUATION PROCESS

The process that should be followed during the planning and implementation of wetland rehabilitation performance evaluation is illustrated in Figure 3.1. The starting point is the definition of the project's objectives as outputs or outcomes. Project success is evaluated on the basis of outputs and outcomes. Outputs refer to the interventions that would need to be implemented to achieve the intended outcomes of the project. Outputs are therefore a reflection of the achievement of the rehabilitation project's execution and survival objectives, while outcomes illustrate the achievement of objectives set with regard to the ecological functioning, physical condition and aesthetics of the system (Rutherfurd *et al.*, 2000)

Once the project objectives have been defined, while taking into consideration the outputs and outcomes, they are used to determine the objectives for performance evaluation (see example below). Following an intervention, the level of monitoring that is required needs to be determined such that appropriate performance indicators and success standards can be identified for each of the indicators.

A monitoring plan should be drawn up to identify the performance indicators, success standards, localities or sites, and the frequency and intensity of sampling. The implementation of monitoring and evaluation only takes place once the planning of these components has taken place. Following the monitoring and evaluation, the results are reported on and used in the planning and implementation of similar future projects. Within wetland rehabilitation projects it is preferable that monitoring is ongoing, even if only at a low intensity, while project evaluations, depending on the indicators being measured, may only take place three years after the completion of the required interventions. Each component of the performance evaluation process is reviewed within this document, and follows the sequence given in Figure 3.1.

For example:

| | |
|---|---|
| **Objective** | Stabilise existing headcut erosion within a wetland system using a gabion basket weir. In this instance the successful installation of the gabion basket would be an output, and the effective stabilisation of the nick point erosion would be an outcome. |
| **Performance indicator** | Advancement of the headcut erosion |
| **Success standard** | No advancement of the headcut erosion within the wetland system. |

**The running example**

An example which runs through all of the steps is presented to provide the reader with a better sense of how the wetland-rehabilitation monitoring and evaluation process is undertaken. The example, which is presented as a box for each step, is entitled 'The running example' and allows the reader to track how the monitoring and evaluation process was initiated, the objectives were reviewed, the indicators were monitored, and the information from the monitoring and evaluation was presented. 'The running example' focuses on the monitoring and evaluation undertaken for the Killarney wetland rehabilitation project, which forms part of the large Ntsikeni wetland in the Ntsikeni Nature Reserve, and which was a component of the national Working for Wetlands Programme. This example is reported on in detail by Cowden *et al.* (2009).

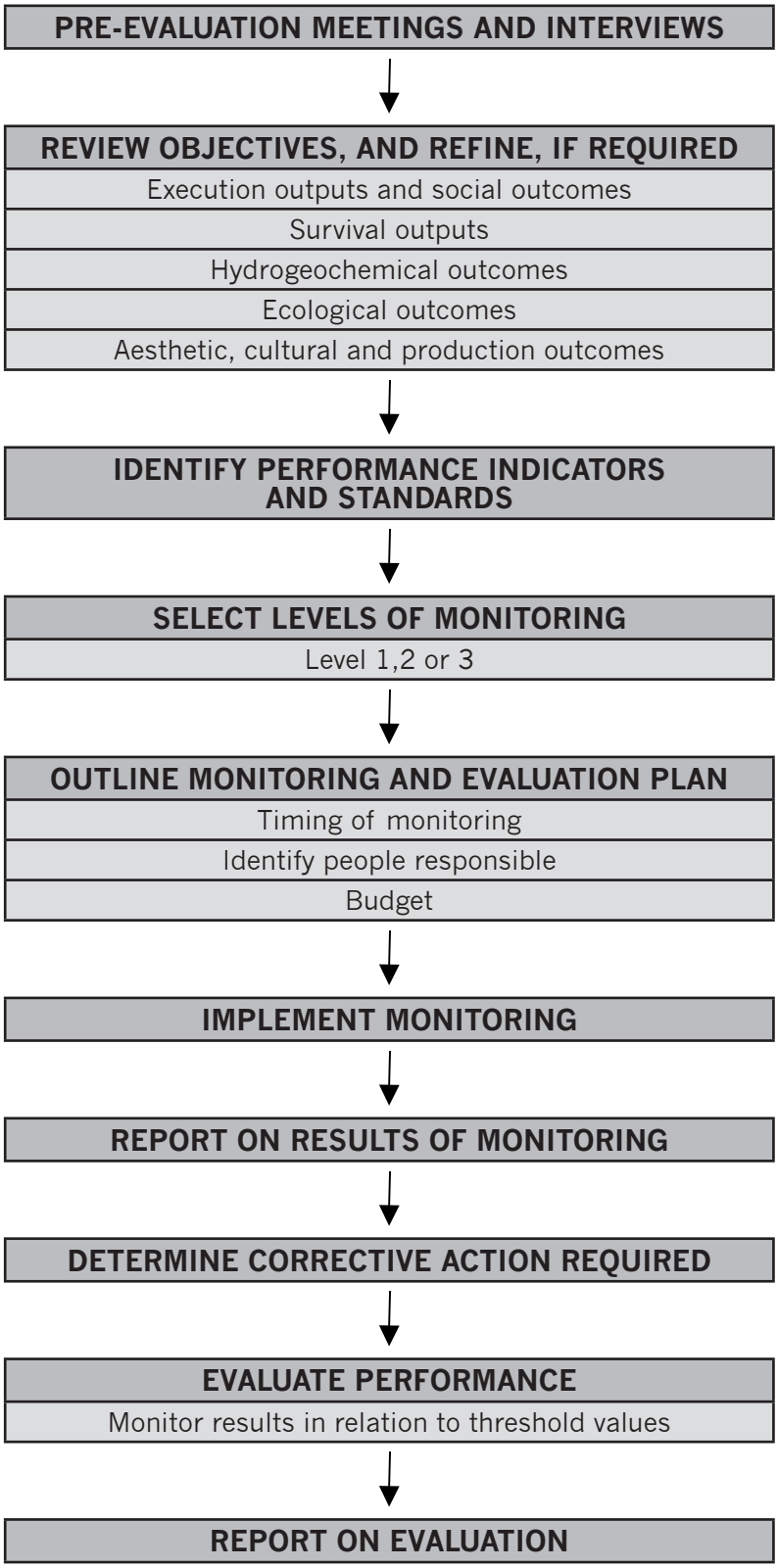



**Figure 3.1: The performance evaluation process of wetland rehabilitation**

# 4. PRE-EVALUATION

There are potentially great benefits to evaluating the effectiveness of projects, in particular the contribution made to the progressive improvement of the competency of the project participants. An evaluation can, however, be a very threatening and stressful experience for the organisation being evaluated. The success and acceptability of an evaluation depends largely on how the evaluation is introduced and handled. For example, an organisation whose work is being evaluated may adopt a defensive stance if they perceive that the process is giving a negative view of their operations, rather than perceiving the evaluation as being a key aspect of a learning process. In this defensive state of mind, these individuals are likely to hold back a lot of potentially very useful information, which will compromise the evaluation and result in the loss of valuable opportunities for learning and improvement.

It is critical, therefore, that the evaluation be initiated in a positive light as something designed to improve the competency of all those who are involved in the project/s being evaluated. To achieve this requires face-to-face meetings and interviews between the coordinator of the evaluation process and individuals from within all levels of the project, prior to the commencement of the evaluation process. These meetings should engender trust and put project participants at ease through emphasis on the positive aspects of the evaluation. The meetings should also provide a valuable opportunity for developing a common understanding of the purpose of the evaluation as this will influence what is included in the evaluation and the level at which it is undertaken.

When conducting an evaluation, there may be a temptation to deal mainly with the upper levels of management in an organisation. While it is critical to draw on the strategic perspective that individuals at this level have to contribute, it is important to remember that individuals at lower levels in the organisation also have their own perspectives to contribute. The people at the lowest level in the organisation are often more closely involved with 'on the ground' activities than other members of the organisation, and therefore their eyes and ears are closer to the ground than anyone else. Thus they are likely to have a valuable contribution to make regarding operational issues as well as through observations they make of different project outputs and outcomes. The evaluator should emphasize the important role of their contribution to the overall evaluation process.

**The running example**

*Once the specific project was identified, the organisation responsible for the implementation of the project, HWR (Highland Wetland Rehabilitation), was contacted to discuss the performance-evaluation process and the team's requirements in terms of information relating to the implementation of the wetland rehabilitation. In this case the evaluators were part of a private consultancy contracted by WfWetlands.*

*The initial site visit, attended by a representative from HWR, was scheduled for the collection of the required baseline information to assist with the identification of the portion of the wetland where the rehabilitation activities had been planned. The monitoring and evaluation process was explained to a representative of HWR and this facilitated HWR's involvement in the subsequent collection of monitoring data.*

*This shows that, with the correct explanation of the monitoring and evaluation process, the evaluation team can potentially transform the perceptions of the people or organisation being evaluated to promote their interest and involvement in the process.*

# 5. PROJECT AIMS AND OBJECTIVES

> *"If you don't know what you want out of the project, how can you tell if you have got it?"* (Rutherfurd *et al*., 2000)

As highlighted in *WET-RehabPlan* (Kotze *et al*., 2009a) wetland rehabilitation is assumed to be a sub-component of the overall management of the wetland, with rehabilitation taking place within the context of formalized management of the wetland system. The aims and objectives of the proposed wetland rehabilitation should therefore be developed while taking into consideration the overall management of the wetland.

*WET-RehabPlan* outlines how the aims and objectives of a wetland rehabilitation project should be described.

## Aims

The aim of the wetland rehabilitation should outline exactly what the project is attempting to achieve, with the focus being on the functional attribute/s that will be the high-order outcome of the rehabilitation of the wetland. For example, 'enhance flood attenuation of the wetland through the promotion of diffuse flow' rather than simply the 'promotion of diffuse flow'. The aim should also focus on the single most important (or the two most important) outcome/s of rehabilitation, as it is seldom possible to achieve multiple high-order aims for individual projects.

## Objectives

The objectives of rehabilitation also deal with the rehabilitation outcomes, but at a lower level than the aim, and describe the outcomes that will contribute to the achievement of the aim. Objectives do not describe the specific interventions (e.g. a concrete or gabion weir) used to achieve the specified outcomes. The objectives should be measurable to allow the evaluation of project success.

Rutherfurd *et al*. (2000) describe the process of setting objectives as a series of five tasks:

1. How much change do you want to see?
2. What area of wetland do you want to improve?
3. How long are you willing to wait for a response?
4. What type of objective should you set?
5. Is the objective achievable?

Woodhill and Robins (1998) and Rutherfurd *et al*. (2000) identify a number of important characteristics of project objectives as they relate to outputs and outcomes. Project objectives should ideally be:

**S**pecific
**M**easurable
**A**chievable
**R**elevant
**T**ime-framed

The recovery of wetland habitat is generally measured in terms of years or decades, and it is therefore essential that the objectives reflect the time that it is likely to take for recovery and that all participants are fully aware of the extent of the recovery time. In those instances where the recovery of the wetland system is likely to be long-term, the setting of a series of objectives may help to track the recovery of the system. For example, one may set objectives based on the improvement in water quality following the first year and then stipulate further improvements after three years and so on. Alternatively, objectives may need to be set in terms of maintenance rather than improvement. That is, when protecting an existing service, the objective may need to be based on maintaining a certain condition rather than allowing it to deteriorate.

**The running example**

Aim:

The aim of the wetland rehabilitation within the Killarney wetland was described as the maintenance of biodiversity within the Ntsikeni Nature Reserve by reinstating wetland plant species within the desiccated portion of the wetland.

Objective:

The primary objective of the rehabilitation within the Killarney wetland was described as restoring more permanent flooding of the wetland between the two gullies that cross the wetland downstream of the road crossing such that species characteristic of seasonally to permanently flooded conditions re-establish on the site.

## 5.1 Revisiting existing project aims and objectives and refining where required

Although the project has progressed several steps along the critical path shown, it is necessary to return to the objectives and review them to ensure that they are clearly outlined and useful in the performance evaluation process. In many instances the aims and objectives determined for the wetland rehabilitation project would be clearly defined, but in some instances they may be less clear and need to be refined to ensure that they are in accordance with the requirements of *WET-RehabPlan*.

Example (as per *WET-RehabPlan*):

*Wetland rehabilitation was initiated on a private landowner's property to recreate habitat for a pair of Wattled Crane that historically bred in the wetland. How does one create good or effective crane habitat? The best that one might do is address hydrological and geomorphological issues in the hope of creating the right habitat for suitable plant communities and therefore cranes. This makes it difficult to set measurable objectives. In order to be able to evaluate the rehabilitation project, one should thus set achievable objectives, and describe the range between what would be considered a very disappointing result, and what would be considered a great success. This will depend largely on the problems being dealt with, but in many cases the best one can do is describe the intended path and outcomes. The end product will lie between the best that one can hope to expect and a result that is acceptable although not ideal.*

Clear objectives are important:

- One is forced to work out exactly what would be considered a success.
- Measurable objectives are a prerequisite for designing specific intervention strategies and for evaluation.
- They allow one to set the scope and scale of the project.
- They reveal where the objectives are contradictory or in conflict with one another, for example, re-creating certain habitats for one species may not allow one to meet the objectives with respect to another.
- They add rigour and accountability to rehabilitation.

Once it has been established that a project's objectives are measurable, it is important that the objectives are defined according to the outputs and outcomes identified in the project (Rutherfurd *et al*., 2000).

**The running example**

*The objective set for the rehabilitation planned within the Killarney wetland was considered to meet the abovementioned criteria, except that*

- *it lacked specific time-frames for vegetative response; and*
- *it did not describe the range between what would be considered a disappointing result, and what would be considered a success in terms of vegetative cover of seasonal and permanent zone wetland species.*

*However, the timeframes for the objectives can be inferred as being the time required for vegetation to respond to improved hydrological integrity (three to five years). The range of vegetative cover of seasonal and permanent zone wetland species is described in the section on Success Standards. The objective does highlight the importance of specialist involvement in the monitoring of the wetland-rehabilitation activities, with specific knowledge required regarding the mixture of species within the identified portion of the wetland.*

## 5.2 Project objectives, outputs and outcomes

Wetland rehabilitation projects are planned to achieve one or more of a number of outcomes. The nature of these is dependent on a range of factors that includes the importance of the wetland to society, the level of interest shown by the funding agent or public in the success of the project, and the amount of time and funding available. The desired outcomes may vary from, for example, raising the level of the water table at the rehabilitation site to restoring habitat for a particular endangered animal species. The means to achieve the desired outcomes are then accomplished by planning and implementing a series of physical interventions. These may be termed project outputs. All rehabilitation projects should specify both outcomes and outputs. A useful framework for considering the types of outputs to be evaluated is given here and has been modified from Rutherfurd *et al*. (2000):

- project execution and social outputs
- survival outputs
- hydro-geochemical outcomes
- ecological outcomes, and
- aesthetic, social and production outcomes.

The execution outputs of project objectives are those that involve the implementation or execution of the proposed rehabilitation activities. The survival outputs of a project are those that relate to the physical endurance of the implemented rehabilitation activities to predetermined events (e.g. the selected return period of flood events). In the context of WfWetlands, the social outputs of the project objectives relate primarily to the number of days that are worked by particular categories of people (e.g. unemployed women) and the wages that they earn. The physical, chemical and ecological outcomes of the project objectives are the positive changes that are made to the biological and hydro-geochemical aspects of the system, and that ultimately improve the state of the wetland. The objectives for aesthetic and production outcomes are those that involve the improvement in the appearance and production of important resources for human use within the wetland system (e.g. craft materials) following the implementation of the rehabilitation activities.

## 5.3 Performance evaluation and types of outputs and outcomes

The project objectives should determine what type of indicators will be used to assess the performance of the wetland rehabilitation project. The following sections outline the types of outputs and outcomes associated with wetland rehabilitation projects.

### 5.3.1 Execution and social outputs

These types of project objectives involve the provision of specific deliverables in the rehabilitation plan, in accordance with the Best Management Practices (BMPs) of WfWetlands (Working for Wetlands Programme, 2004). These should be considered as minimum performance standards for the project, while bearing in mind that poverty relief and skills development are key components of wetland rehabilitation for the WfWetlands programme. Social outputs that are linked to wetland rehabilitation projects are of great importance to the funding agent and can therefore be considered a primary output. The specific deliverables related to social issues within WfWetlands include:

- compliance with the Occupational Health and Safety Act (No. 85 of 1993)
- poverty alleviation
- job creation, and
- skills training:
  - life skills (reading, writing, AIDS-awareness)
  - first aid
  - construction techniques.

The execution outputs of a project include the erection of structures as specified within the rehabilitation plan, such that materials and labour are utilised as planned. The deliverables of these projects are generally measured in terms of cubic metres of structure built within a specified time period, according to production norms. Production norms provide a measure of the workload expected during the duration of the wetland rehabilitation project. Generally, these norms are derived from time-and-motion studies implemented for labour intensive projects throughout the country and are modified to suit local site conditions (e.g. soil moisture and water levels). These norms exist for a number of project areas within South Africa, but in many cases these norms are still being developed for various wetland rehabilitation tasks under various environmental conditions.

In order to measure execution outputs it is important to keep records of ongoing works (e.g. total cubic metres of gabion baskets). However, this type of output should be seen as the starting point for performance evaluation as it is important to also evaluate the project outcomes.

**The running example**

*The gully erosion that was altering the hydrology of the Killarney wetland required the design and implementation of structural rehabilitation-interventions as a means to improve the hydrological integrity of the system. The wetland rehabilitation planned within the Killarney wetland formed part of the WfWetlands programme and thus the wetland rehabilitation included specific requirements of implementation and social outputs. The rehabilitation therefore comprised the following execution outputs:*

- *structural interventions ( concrete weirs and earthen berms)*
- *compliance with BMPs*
- *poverty alleviation and job creation, and*
- *training.*

### 5.3.2 Survival outputs

Survival outputs are considered to be the minimum requirement of project objectives for the rehabilitation of stream systems in Australia (Rutherfurd *et al*., 2000). For example, the implementation of rehabilitation activities is considered to be successful if the implemented work survives the occurrence of predetermined flood levels, such as a 1 in 10 year flood event (Rutherfurd *et al*., 2000). Measuring the attainment of these objectives relies on the initial monitoring of execution outputs and subsequent visits after flood events or at predetermined intervals (Rutherfurd et al., 2000). The WfWetlands BMPs require, at a minimum, the monitoring of structural survival for compliance with the Occupational Health and Safety Act, and at specific monitoring intervals (see Section 9.2).

### 5.3.3 Hydro-geochemical outcomes

An improvement in the ecological condition of a wetland system is often achieved through the improvement of the condition of the system. Some evaluation procedures rely on measuring the changes in the condition of the system, and assume that the ecological components of the system will follow suit (Rutherfurd *et al*., 2000). This form of evaluation requires the assurance that the changes being measured are due to the intervention, rather than due to a change in the natural dynamics (e.g. natural wet/dry cycles) or other external factors. In order to ensure that changes to a wetland system are related to the implementation of rehabilitation activities, reference wetlands should ideally be monitored in conjunction with the rehabilitated wetland site as a means of providing a basis for

**The running example**

To comply with the requirements of the WfWetlands Best Management Practices, the structural integrity of the interventions within the Killarney wetland would have to be monitored at the following intervals:

- 1 Month
- 2 Months
- 3 Months
- 6 Months
- 1 Year
- 2 Years
- 3 Years

The rehabilitation interventions designed within the Killarney wetland were designed to withstand 1 in 10 year flood events. The survival outputs of the interventions would therefore need to be monitored following 103 mm of rainfall within the wetland's catchment in a day. This information is derived from the analysis undertaken by the wetland engineer using the Soil Conservation Service (SCS-SA), a model for determining design flood estimates for small catchments in Southern Africa. A rainfall station's data was reviewed for the site and it is understood that this level of rainfall event has not occurred in the Killarney wetland's catchment since the completion of the interventions. It should be noted that the difficulty in determining the occurrence of the specified rainfall event without the presence of a rainfall station near the rehabilitated wetland will often be a limitation of this type of monitoring.

**The running example**

*The primary objective of the wetland rehabilitation of the Killarney wetland was to improve the hydrological integrity of the system by restoring more permanent flooding of the wetland between the two gullies. The proposed rehabilitation therefore comprised hydrological outcomes. Monitoring the system's hydrological conditions required baseline monitoring to ensure that the changes in hydrology were linked to the rehabilitation rather than to natural factors. However, due to budgetary constraints baseline monitoring was not implemented in reference wetlands.*

comparison, and to rule out those changes not associated with the rehabilitation activities. The monitoring of the project objective outcomes relies on the presence of baseline data (for both reference and test sites) as a means to evaluate project performance.

### 5.3.4 Ecological outcomes

Project objectives that are based on ecological outcomes generally attempt to return the population size, diversity and sustainability of plant and animal communities within the wetland system to a condition that is closer to the natural state. Evaluation of these outcomes, as for the physical and chemical outcomes, requires the assurance that the changes that are being measured are caused by the intervention rather than by a change in the wetland system. For example, increased water levels within a wetland could be associated with the removal of dense infestations of alien vegetation within the wetland's catchment area, rather than with the implementation of a structural intervention aimed at raising the water table. The monitoring of ecological outcomes should ideally rely on the presence of baseline and reference wetland data as a means of evaluating project performance. A reference wetland can either be a separate wetland or a portion of the rehabilitated wetland that is not affected by the rehabilitation process. If no comparative reference wetland is used, the baseline information from the rehabilitated wetland provides some measure of changes related to the wetland rehabilitation activities, but the evaluator needs to take cognisance of catchment activities that may also influence changes in the wetland.

**The running example**

*The objectives of the wetland rehabilitation within the Killarney wetland were aimed at changing the hydrology of the system to promote a change in plant species diversity to those that were more characteristic of permanent and seasonal wetland areas. Again, the monitoring of the system's vegetation would require baseline monitoring to ensure that the changes in vegetation were linked to the rehabilitation work rather than to natural factors. However, due to budgetary constraints vegetation monitoring was not implemented in reference wetlands.*

### 5.3.5 Aesthetic, social and production outcomes

Wetlands potentially have features, such as the diversity of colours and textures that contrast with the surrounding landscape, the presence of attractive flowers and vegetation, areas of open water, and the absence of litter and other unsightly human disturbance, which make them of high scenic or cultural value (Ammann and Lindley Stone, 1991). Wetland habitats can also potentially supply grazing for livestock, plants for crafts and construction, land for the cultivation of certain crops, sand, clay, peat, medicine and food. Given that the dependence by the rural poor on natural resources from a wetland may be high (Dugan, 1990; Kotze, 2002; Kotze *et al*., 2002), the greater the number of households whose livelihoods depend on a wetland, and the greater the importance of the wetland.

A number of wetland rehabilitation projects can therefore be implemented that improve the aesthetic, cultural and production benefits supplied by a particular wetland area and that would attempt to improve these benefits of the area. Aesthetic outcomes rely on people's opinions regarding the appearance of the wetland area and therefore to be able to implement the evaluation of aesthetic and social outcomes, colour photographs or videos of the initial condition of the area (Rutherfurd *et al*., 2000) would have to be available.

**The running example**

The Killarney wetland occurs within the Ntsikeni Nature Reserve and it is considered to be aesthetic and therefore important for tourism. Photographs were taken of the area prior to the rehabilitation-intervention to illustrate the changes occurring in the appearance of the wetland system following the alteration of the hydrological condition and the subsequent vegetative response.

# 6. WETLAND CHARACTERISTICS AND PERFORMANCE INDICATORS

To monitor the change in a wetland system, the characteristics that are envisaged/planned to change should be identified. Wetland characteristics have a number of performance indicators that can be measured as a means of monitoring a change in the wetland that is associated with rehabilitation interventions. Performance indicators are the attributes that are used to evaluate the progress of the system towards meeting the rehabilitation objectives (Streever, 1999). It is important to note that, due to the inherent dynamics and spatial variation of wetlands, no single factor or characteristic of wetland systems can be used as an indicator of the health of all wetlands or as the direction of change (Hansen *et al.*, 2000). A suite of indicators should be used to monitor changes within wetland systems.

Performance indicators should be linked to the rehabilitation objectives and limits or success standards should be specified for each of these indicators. Indicators are useful for monitoring and evaluation procedures if they have consistency, reliability and predictive capacity in measurement (Romstad, 1999). The following are examples of wetland characteristics that could be used to derive appropriate indicators for monitoring and evaluation. The characteristics are grouped according to the aforementioned types of objectives for wetland rehabilitation projects.

### Execution and Social Outputs

- Planning and prioritisation of wetland rehabilitation
- Physical structures for wetland rehabilitation
- Social aspects
  - Number of people employed
  - Number of days worked per person
  - Number of training days per person
  - Number of dependents per person
  - Wages earned per person
  - OHS compliance/performance per project
- Compliance with Best Management Practices

### Survival Outputs

- Structural integrity
- Survival of interventions at specified flood levels

### Hydro-geochemical Outcomes

- Wetland area (e.g. extent and wetness zone)
- Flow characteristics (e.g. water distribution and retention)
- Hydrological properties of the wetland (e.g. water quantity and quality)
- Sedimentation
- Soil properties (e.g. organic content)
- Erosion features

### Ecological Outcomes

- Vegetation species composition, structure and cover estimations
- Birds (e.g. breeding pairs, fecundity)
- Amphibians (e.g. red data species, distribution)
- Mammals and reptiles (e.g. distribution)
- Ecological processes

### Land use Activities

- Activities within the wetland
- Activities within the catchment

### Aesthetic, Social and Production Outcomes

- Assessment of appearance
- Assessment of the availability of craft material, grazing land and other natural resources
- Level of utilisation for livelihoods
- Awareness and participation of stakeholders
- Assessment of cultural value.

**The running example**

The following indicators were identified as a means of monitoring the various characteristics of the wetland rehabilitation planned for the Killarney wetland:

*Execution and Social Outputs*

- Physical structures for wetland rehabilitation
- Social aspects
  - Number of people employed
  - Number of days worked per person
  - Number of training days per person
- Compliance with WfWet Best Management Practices (including OHS aspects of construction)

*Survival Outputs*

- Structural integrity

*Hydro-geochemical Outcomes*

- Flow characteristics (e.g. water distribution and retention)

*Ecological Outcomes*

- Vegetation species composition, structure and cover estimations
- Ecological processes

*Aesthetic, Social and Production Outcomes*

- Assessment of appearance of the wetland

# 7. SUCCESS STANDARDS

The importance of measurable objectives for wetland rehabilitation projects is highlighted in Section 5. It is also important for the evaluation of a project's performance that the expected/achievable quantitative values for monitored indicators are determined prior to the implementation of the rehabilitation activities. A success standard is defined as an observable or measurable threshold for a particular indicator for wetland characteristics as identified by the objectives, against which the rehabilitation project can be compared. If these standards are met for selected indicators, the related objectives are considered to have been successfully achieved. Success standards are often also referred to as threshold values.

## 7.1 Importance of success standards

Success standards allow wetland rehabilitation projects to be evaluated in terms of achieving the objectives set for the project. In order to determine the success of rehabilitation projects, a quantitative value is required for the indicators to be measured.

## 7.2 Determination of success standards

The success standards are derived from the initial assessments made with *WET-EcoServices* (Kotze *et al.*, 2009b) and *WET-Health* (Macfarlane *et al.*, 2009), which identify those characteristics of the wetland that are important, as well as those characteristics that can be improved through the implementation of appropriate interventions. The success standards may therefore vary according to various sites and, in some cases, regions. Success standards should identify (Hymanson and Kingma-Rymek, 1995):

- the indicator to be measured
- the condition or level that defines success
- the period over which success must be attained / sustained

An important consideration when determining these success standards is achieving a balance between accountability and flexibility. The following general guidelines have been included to provide guidance for determining the success standards of a project (Ossinger, 1999):

- standards should be precise and unambiguous, and define appropriate monitoring and corrective action
- standards should be measures, rather than actions
- standards should utilise a range of values (minimum/maximum) rather than utilising fixed numbers, except when the project needs to achieve specific values (e.g. employment equity requirements)
- standards should be reviewed and approved by appropriate specialists, ensuring that they are achievable and capable of being monitored with available resources, and
- standards should facilitate the implementation of corrective actions for those projects considered to have failed in achieving their objectives, by providing a definitive objective to achieve success (Wetlands Research Programme, 1999).

From the above example, it is evident that both projects could be considered successful as the set objectives were achieved. However, the objectives that were set for *Option 1* did not include success standards, and is therefore unlikely to be highlighted as requiring corrective action, unless it was compared directly to another wetland of similar performance to *Option 2*.

**Example:**

| | Option 1 | Option 2 |
|---|---|---|
| **Project Objectives** | The establishment of indigenous vegetative cover* (%) within the wetland system | The establishment of 85%** indigenous vegetative cover* within the wetland system after 3 years** |
| **Project status 3 years after wetland rehabilitation activities** | Following the implementation of the planned wetland rehabilitation activities, the vegetative cover achieved was determined to be 50%. | Following the implementation of the planned wetland rehabilitation activities the vegetative cover achieved was determined to be 90%. |

* Indicator
** Success Standard

**The running example**

*The objective of the rehabilitation planned for the Killarney wetland lacked success standards for promoting the vegetative cover dominated by seasonal- and permanent-zone wetland plant species.*

*The objective should have included a statement that stipulated a range between what would be considered to be a disappointing result, and what would be considered to be a success in terms of the cover of seasonal- and permanent-zone wetland species. The following success standard should have been included in the rehabilitation objectives set for the rehabilitation of Killarney Wetland:*

*To restore more permanent flooding of the wetland between the two gullies that cross the wetland downstream of the road crossing such that vegetative coverage comprises 75% obligate wetland plant species, such as Carex spp., within 3 years of the reinstatement of near-natural hydrological conditions associated with the rehabilitation activities.*

# 8. LEVELS OF MONITORING

"*It is better to complete a focused evaluation well than have a grand plan for evaluation that is never implemented*" (Woodhill and Robins, 1998).

During the compilation of the wetland rehabilitation plan (see Section 9), the level of monitoring should be identified and subsequently, also the appropriate monitoring techniques and monitoring frequency. This allows the project manager to identify the performance criteria that will be used to measure the success of the project. Determining the details of the evaluation and monitoring also allows for the adequate planning and budgeting of these activities, as the different levels of monitoring require different inputs and provide different information (Figure 8.1). The primary reason for monitoring and evaluation is to assess the progress of wetland rehabilitation and to indicate the steps that are required to address problems in the system or a component of the system that has not been successfully remedied by rehabilitation.

Monitoring should be conducted at every site where wetland rehabilitation is undertaken. However, the objectives and techniques for monitoring may for various reasons, vary from site to site.

These reasons include:

- the objectives of the rehabilitation
- the cost of the interventions
- the ecological importance of the wetland being rehabilitated, and
- the benefits that may be derived from the rehabilitation.

For purposes of wetland rehabilitation in South Africa, three levels of monitoring are considered to be appropriate:

- *Level 1:* Assessment of execution and social outputs (for WfWetlands this would encompass compliance with WfWetlands Best Management Practices)
- *Level 2:* Rapid assessment of rehabilitation outcomes as well as an assessment of the same outputs as in Level 1, and

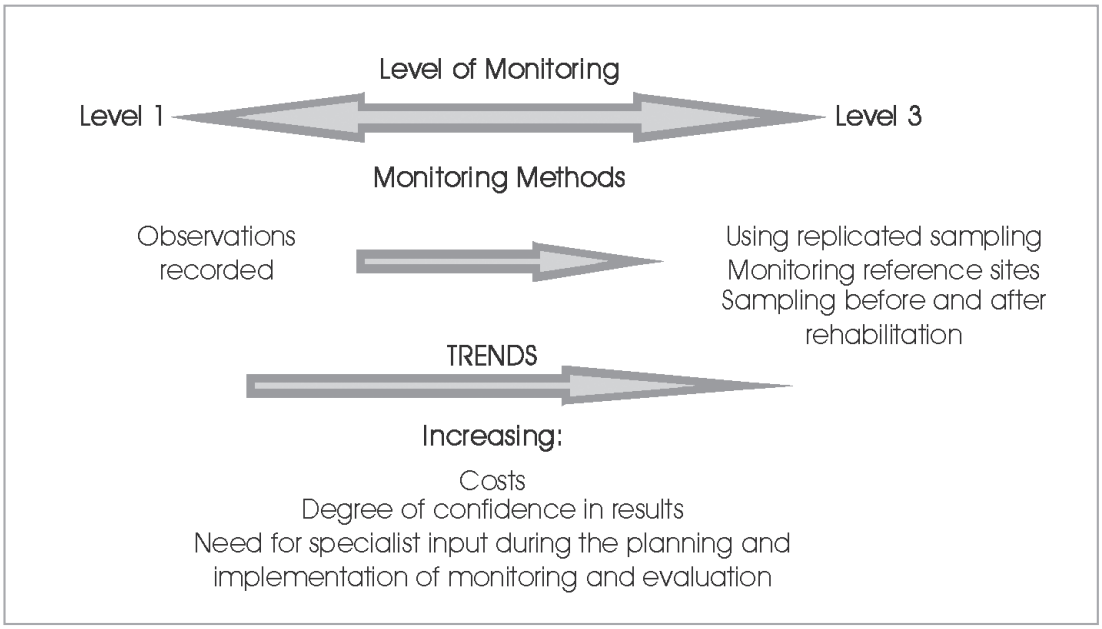



**Figure 8.1: Overview of the options and degree of sophistication of wetland rehabilitation monitoring (after Water and Rivers Commission, 2002)**

- *Level 3:* Comprehensive assessment of rehabilitation outcomes as well as an assessment of the same outputs as in Level 1

*Level 1* monitoring should be done during the implementation and within a month of completion of the interventions. *Level 2* monitoring should be conducted for a duration of at least two years or seasons after completion of the interventions. *Level 3* monitoring should assess the outputs and outcomes of the wetland rehabilitation project at a finer resolution, greater frequency and over a longer time period than *Level 2*. For instance if *Level 2* monitoring involved two seasonal sampling trips per year, *Level 3* may require four seasonal sampling trips per year for a duration of five or more years.

## 8.1 Level 1 monitoring

*Level 1* monitoring focuses on the assessment of the project's attainment of execution and survival outputs as described in Section 5. Within WfWetlands, best management practices (BMPs) have been compiled for the effective and appropriate management of wetland rehabilitation projects and compliance with the requirements of existing legislation (Working for Wetlands Programme, 2004). *Level 1* monitoring is designed to measure a project's compliance with these BMPs and the survival of the rehabilitation structures put in place. The implementation of this level of monitoring should be considered as a minimum requirement for all WfWetlands projects.

The monitoring required for this level relies on the existence of an information-management system (See Section 10) to record the information that relates to the planning, design, and implementation of the wetland rehabilitation operations. This involves recording and monitoring of the information that relates to the implementation activities and to the social aspects. This level of monitoring would be carried out by the wetland rehabilitation implementer and requires sound engineering knowledge, and should be reviewed by an engineer external to the project. In the WfWetlands programme the review of the monitoring would be carried out by the WfWetlands regional coordinator.

## 8.2 Level 2 monitoring

*Level 2* monitoring focuses on the assessment, at a coarse level, of the project's attainment of the hydro-geochemical, ecological, or aesthetic and production outcomes, as described in Section 5. This level of monitoring is a rapid assessment technique for monitoring the outcomes of wetland rehabilitation projects. The wetland rehabilitation projects within WfWetlands should strive to conduct *Level 2* monitoring, especially if the functional importance of the particular wetland system is found to be high. The functional importance of a particular wetland is determined by a functional assessment of the system (See Section 11.2). In those instances where only Level 1 monitoring is conducted, written justification for selecting only this level needs to be provided by the project manager and will be subject to review by the technical advisors.

Baseline monitoring needs to be carried out prior to the intervention to provide comparable data for monitoring, following the wetland rehabilitation. This level of monitoring should be carried out by the WfWetlands assistant technical advisors, and it requires an understanding of and a background in wetland functioning and management.

**The running example**

The collection of information that is required for the majority of the *Level 1* monitoring was undertaken by Highland Wetland Rehabilitation and Working for Wetlands as part of the management and implementation of the rehabilitation. The required information was supplied by the respective parties and included details on the following aspects of the project:

- costs
- compliance with BMPs
- employment, target groups and remuneration, and
- training.

In addition to the supplied information a site-visit was undertaken following the completion of the interventions to determine if the interventions were constructed in accordance with the designs and to assess the structural integrity of the interventions. As per *WET-RehabEvaluate* the monitoring of structural stability and integrity focused on the presence of the following forms of structural vulnerability:

- undermining
- sliding, tilting or overturning
- side bank collapse
- scouring/erosion downstream
- scouring/erosion upstream
- side cutting around structure
- exposed soil, and
- premature decay of the structural material (*e.g.* gabion wire, earthwork settlement etc.).

The productivity and efficiency of the rehabilitation was not assessed for the Ntsikeni Nature Reserve project as it was considered unlikely to generate realistic figures due to the unique nature of the site in terms of its remote location and limited accessibility. It is important to note that the Ntsikeni Nature Reserve project formed part of a cluster of projects, and as such the supplied data was considered to be diluted and in some instances it comprised of estimates rather than accurate data.

The following indicators were measured at *Level 2* intensity for the Killarney wetland to inform the monitoring and evaluation process.

*Assessment of Wetland Ecosystem Service-Delivery and Integrity*

The outcomes of the wetland rehabilitation were assessed in terms of the effects on ecosystem integrity and the delivery of ecosystem services. The integrity of the wetland system was described using *WET-Health* (Mcfarlane *et al.*, 2009) and the delivery of ecosystem services was described using *WET-EcoServices* (Kotze *et al.*, 2009b). As described in *WET-RehabPlan* (Kotze *et al.*, 2009a), the use of these methods made it possible to derive hectare equivalents for the comparison of the integrity of the wetland before and after rehabilitation.

*Groundwater elevation*

The groundwater level within the Killarney wetland was initially measured using auger holes at different locations along each of the transects and by measuring the depth to the water table from the soil surface. The location of these sample points was recorded using a GPS, accurate to 1 m, which made finding these points easier for subsequent monitoring events.

Permanent peizometers were installed at a later stage and allowed for the relatively easy measurement of water levels. The sampling frequency was increased from the recommended biannual sampling (*WET-RehabEvaluate*) to monthly monitoring, which was undertaken by Highland Wetland Rehabilitation.

*Vegetation species composition*

The *WET-RehabEvaluate* technique for monitoring vegetation was used to determine the nature of the vegetation communities in the Killarney wetland system. The monitoring technique included:

- the definition of the vegetation-types (sedge meadow, wet grassland) within the wetland
- field assessments of each vegetation-type detailing the composition and relative contribution of the species present in the vegetation-type, and
- the description of the hydric status of dominant species.

A series of 5 m x 5 m quadrats was sampled at intervals along each transect across the wetland. The position of the quadrats coincided with discernible changes in vegetation-type.

View of the research team sampling vegetation quadrats

## 8.3 Level 3 monitoring

*Level 3* monitoring assesses, at a finer and more intensive level, the project's attainment of the outcomes of the wetland rehabilitation activities. This level of monitoring may be selected for projects where:

- the wetland rehabilitation objectives for the project call for a fine level of monitoring (e.g. increased population of a certain fish species)
- uncertainty exists in terms of achieving the objectives, and opportunities for gaining new insights are potentially great
- the project has relevance to key research questions, as well as being accessible to research bodies and personnel
- the prioritisation outlined in the rehabilitation process (Figure 2.1) determines the wetland to be particularly important, or
- the wetland is found to be functionally important.

Baseline monitoring of both the rehabilitation site and the reference site needs to be carried out prior to rehabilitation interventions as a means of providing comparative data for the monitoring that follows the wetland rehabilitation. This provides some assurance that any changes to the wetland system under examination are related to the rehabilitation activities rather than to regional changes that may broadly affect wetland systems.

*Level 3* monitoring requires that the practitioner has a greater background in wetland science and an understanding of wetland functioning and management than does *Level 2* monitoring and it requires greater resources for the monitoring. The wetland systems identified for *Level 3* monitoring may also be used by educational facilities and/or as research sites for post-graduate projects in wetland management and rehabilitation. The detailed description of Level 3 monitoring of wetland rehabilitation is beyond the scope of this manual, due to the intensive nature of the monitoring activities. The monitoring and sampling procedures required to achieve this level of monitoring should be determined by specialists on a site-specific basis.

If the following indicators were included in the project objectives it is likely that they would need to be monitored at Level 3 due to the intensive nature of the sampling procedures at this level:

- water quality (pH, $N_2$, $O_2$ etc.)
- fish species
- frog species
- birds
- mammals, and
- reptiles.

As Level 3 monitoring activities comprise of finer scale and more intensive monitoring of the characteristics of the wetland, the implementation of the Level 3 monitoring at Killarney wetland was limited to the finer-level of monitoring of specific indicators. in particular as the project had relevance to key research questions, and was accessible to research bodies and personnel.

*Electrical conductivity*

The electrical conductivity (EC) of the water within the wetland was measured with an EC meter at each of the peizometer holes. Electrical conductivity provides an indication of the dissolved salts within the system and is used an indication of the nutrient load of the water within the wetland. It was anticipated that the electrical conductivity would alter with the alterations to the system's hydrology, especially with the spreading of water across the wetland, which increases the potential for nutrient uptake within the wetland.

*Gully cross-sections*

Gully cross-sections were surveyed with a dumpy level along the transect lines, and post-rehabilitation data was compared with cross-sections surveyed during the initial site-visit, to determine whether there had been any infilling or alteration to gully morphology since the completion of the rehabilitation. This would provide some indication of the impacts of the rehabilitation on the system's geomorphology.

View of the research team surveying gully cross-sections

# 9. DEVELOPMENT OF A MONITORING PLAN

## 9.1 Wetland rehabilitation monitoring plan

Wetland rehabilitation projects should have a monitoring plan outlined prior to the implementation of the rehabilitation activities. The monitoring plan should provide the framework for monitoring and evaluation, and should include the following important information:

- level of monitoring
- indicators to be measured
- success standards
- frequency, interval and timing of monitoring
- sampling or measuring techniques to be used
- people or organisations responsible, and
- funding and budget.

In the overall wetland rehabilitation process outlined in Figure 2.1, it is clear that the monitoring and performance evaluation plan must be completed prior to the implementation of the project. It is not a component of the process that can be worked on once implementation has started.

## 9.2 Frequency and timing of monitoring

Monitoring is defined as the regular collection of information to measure the variation from a predetermined state. 'Regular' is defined as the occurrence of the activity at least once every two years. The timing of monitoring needs to be stipulated within the monitoring plan that is compiled for each of the WfWetlands projects (Table 9.1). If limitations are not initially set for the timing of these activities, vital information may not be collected, or alternatively, information could be collected unnecessarily. The monitoring period of a project will depend on the particular indicators that are being examined, the importance of the project, and the resources that are available. The monitoring period for wetland mitigation projects is generally between three and five years, with extended monitoring periods being adopted if necessary (Zedler, 2001). For example, in some cases the accumulation of sediment and re-vegetation within a constructed basin may take in excess of five years (WB Russell *Pers. comm.*, 2004). The WfWetlands BMPs state that compliance of wetland rehabilitation projects with the Occupational Health and Safety Act (No. 85 of 1993) requires the monitoring of structural survival and integrity at the following intervals after completion of the construction activities:

- 1 Month
- 2 Months
- 3 Months
- 6 Months
- 1 Year
- 2 Years
- 3 Years.

*Level 1* monitoring should be carried out this frequently but the selected indicators for the project may require additional monitoring events due to seasonal patterns and sampling techniques. For example, it is advised that the monitoring of vegetation takes place during the growing season, when most plants have inflorescences and their identification is generally more reliable than in other seasons. This may not coincide with the above mentioned timing of monitoring for survival outputs, depending on the timing of the initial rehabilitation activities.

**Table 9.1: Examples of the timing and frequency of monitoring events for Level 1, 2 & 3 monitoring**

| MONITORING ACTIVITIES | TIMING | FREQUENCY | RESPONSIBLE PERSON |
|---|---|---|---|
| **LEVEL 1** | | | |
| Implementation of rehabilitation activities according to designs* | - | Weekly / monthly | Implementers,Technical Advisors,Engineer, Soil Conservation Technician |
| Productivity/ efficiency* | - | Monthly | Implementers |
| Compliance with BMPs* | - | Weekly / monthly | Implementers, Technical Advisors |
| Structural integrity | - | Predetermined intervals (see above) | Implementers, Engineer, Soil Conservation Technician |
| Event-based monitoring | Following specified flood levels | - | Implementers |
| Employment, target groups and remuneration | - | Monthly | Implementers |
| Contractor's performance | - | Monthly | Implementers |
| Training | - | Monthly | Implementers |
| **LEVEL 2** | | | |
| Wetland assessments | - | Before and 3 years after completion | Technical Advisors |
| Erosion stabilisation | Winter | Annually | Technical Advisors |
| Sediment accumulation | Winter | Annually | Technical Advisors |
| Water level | Summer and winter | Biannually | Technical Advisors |
| Vegetation inventory | Late spring / summer | Annually | Technical Advisors |
| Aesthetics | Late spring / summer | Annually | Technical Advisors |
| Social awareness | - | On completion | Technical Advisors |
| Social involvement | - | On completion | Technical Advisors |
| **LEVEL 3** | | | |
| Water quality | Summer and winter | Biannually | Researchers |
| Fish | Spring / early summer | Biannually | Researchers |
| Macro-invertebrates | Summer - autumn | Annually | Researchers |
| Mammals and reptiles | - | Seasonally | Researchers |
| Birds | Summer and winter | Biannually | Researchers |
| Frogs | Spring / summer Oct-Feb or Aug-Nov | Annually | Researchers |

*These monitoring activities are carried out during the implementation/construction of the project interventions.

The running example

The *Level 1* monitoring was recorded by the project implementer (HWR) on a weekly basis and was verified by the WfWetlands Provincial Co-ordinator in Project Inspection Reports. The information contained within these reports formed the basis for monitoring certain Level 1 characteristics. The monitoring of the structural integrity was carried out following the completion of the interventions. It is uncertain if the structural integrity is currently being recorded in accordance with the time periods outlined in the WfWetlands Best Management Practices.

View of the intervention during construction (BMP compliance)

The *Level 2* and *Level 3* monitoring required the collection of baseline information and were therefore carried out prior to the implementation of the rehabilitation activities. The monitoring was repeated following the completion of the wetland rehabilitation activities. In the upper reaches of the Killarney wetland, this was 2 years after the implementation of the interventions.

## 9.3. Parties responsible for monitoring and evaluation

The parties responsible for the monitoring and evaluation of projects should be identified prior to the implementation of the wetland rehabilitation project. The implementation of monitoring and evaluation procedures should be verified by qualified independent persons or organisations i.e. qualified individuals who are not actively involved with the implementation of the project. This would assist in the stakeholders (interested in project success) seeing the results as being unbiased (Woodhill and Robins, 1998). The independent review of monitoring and evaluation processes should take place at least on an annual basis for the duration of monitoring activities.

The following people would be actively involved in the monitoring and evaluation of wetland rehabilitation projects:

- Implementers (contractors responsible for the implementation of the wetland rehabilitation activities) that are directly responsible for the contractors, materials and day-to-day management of the project;
- Technical advisors (specialists/ consultants, such as engineers or soil conservation technicians and wetland ecologists) that would look at specific aspects of wetland rehabilitation and provide external monitoring and assessment of a project's status; and
- Researchers (scientists) involved in detailed research relating to specific features of the wetland system in order to improve local knowledge and assist in determining benchmark/baseline information for subsequent projects.

Wetland rehabilitation projects within the WfWetlands programme rely on the implementers of the rehabilitation activities taking responsibility for *Level 1* monitoring with verification of these results by the regional co-ordinators. Provision should also be made for the designer of the interventions to indicate his/her satisfaction with the intervention upon completion. This would improve project management by allowing the implementers to carry out adaptive management, if problems are identified.

## 9.4 Funding and budget

The majority of wetland rehabilitation projects do not include budgetary allocations for the monitoring and evaluation of project success, especially beyond the implementation of the project and for provision of the deliverables. Cost allocations for monitoring, performance evaluation and reporting should be made within the initial rehabilitation plan and project budget. This should also ensure that monitoring and performance evaluation is in fact undertaken.

Failure to achieve the outputs specified by the funding agent may result in the cancellation of funding for the next financial period. The project manager should therefore ensure that the achievement of the outputs is clearly reported to the funding agent. Monitoring and performance evaluation serves to provide funding agencies with evidence that the outputs are being effectively delivered. Landowners, government agencies and the public may require additional performance evaluation to convince them of the project's success. This would require additional funds to report on the success of the project in relation to the stated objectives i.e. outcomes.

**The running example**

*The Level 1 monitoring was the responsibility of the project implementer and the information was verified by the WfWetlands provincial co-ordinator. The monitoring of integrity, following the completion of the structural-interventions, was also carried out by the research team, in accordance with WET-RehabEvaluate.*

*The Level 2 and 3 monitoring activities were carried out by the research team, with assistance from the project implementer in terms of monitoring the water levels using the peizometers. The Level 2 and 3 monitoring activities were undertaken by the research team as the majority of the characteristics that were monitored required specialist expertise (e.g. vegetation monitoring)*

It is recommended that at least *Level 2* monitoring should be carried out for all wetland rehabilitation projects within WfWetlands. This requires that the indicators and sampling frequency be identified before budgeting so that funds can be accurately allocated for the monitoring techniques suggested for each of the indicators (see Section 5.3.2). It is recommended that the funding organisation provides some guidance for the allocation of funds towards the monitoring and evaluation of the wetland rehabilitation project performance. Guidance should be provided for project implementers within the submitted rehabilitation plans with regard to the budget that is allocated for the purpose of monitoring and evaluation.

In some instances the funding may be provided by the same party that is undertaking the implementation (e.g. private developers). Even in this case, where there is no accountability to an outside party, it is good practice to set aside resources for monitoring and evaluation.

**The running example**

*The Level 1 monitoring information was recorded by Highland Wetland Rehabilitation (HWR) and site visits were undertaken by the WfWetlands regional co-ordinator to carry out Best Management Practice audits. The WfWetlands programme also included a budget for the implementation of independent audits that primarily focused on the implementation of the outputs of the project. These costs are usually included in the management fee and 1% of the budget is allocated for auditing.*

*The Level 2 and 3 monitoring undertaken on the Killarney wetland was a component of a research programme, and therefore the costs of the monitoring and evaluation were not accrued by the WfWetlands programme. Fortunately, the multidisciplinary team was able to undertake the monitoring of a number of the indicators over a short, intensive sampling period, which reduced the potential costs of the monitoring. The monitoring of the hydrological indicators relied on the monthly measurement of the water-levels within the wells by the project implementer (HWR) during the implementation of the wetland rehabilitation. Due to the remote nature of the site and the required frequency of sampling, the monitoring by the project implementer greatly reduced the potential costs of monitoring the water levels in the wells.*

# 10. INFORMATION MANAGEMENT SYSTEMS FOR MONITORING AND EVALUATION

## 10.1 Characteristics of information management systems

An information management system (IMS) is a means of digitally storing, accessing and reporting on recorded information. For the evaluation of wetland rehabilitation projects, an IMS would be designed for the capture and recording of information that relates to the rehabilitation of wetland systems. An IMS is considered to be a necessary tool in the evaluation of the performance of specific projects and regions within a wetland rehabilitation programme. An IMS can be used to store project information in a central location, thereby allowing the person/s implementing the performance evaluation to quickly obtain the necessary information from a single source. An IMS is particularly important when the evaluation is taking place at a regional or programme level, where a large amount of information from several projects requires processing and synthesis.

An IMS is designed to allow for the capture of essential information that is required for the effective implementation and planning of projects. Key functions of an IMS include the ability to:

- analyse data for planning purposes
- analyse data for decision support
- track progress over time, against what was planned
- assemble data and information for monitoring and performance evaluation purposes, and
- notify relevant parties of target dates.

The data captured in an IMS tends to be typically quantitative rather than qualitative. Pre-defined criteria are programmed into the system to allow for data analysis according to these criteria. For example, if it is required that the number of women employed within a region should be above a particular percentage of the total number of people employed, this information would be readily available to the regional managers through a query on the stored information and they would be able to determine if this was not the case within a particular region. Large amounts of data can be processed efficiently and can provide the manager with timeous output to assist with decision making. The performance of a project is often evaluated based on the quantitative output generated by an IMS and presented in a report. It is therefore essential that the data recorded and delivered by the IMS provide an accurate and realistic assessment of performance.

## 10.2 An information management system for wetland rehabilitation

Storing information that relates to wetland rehabilitation is vital to ensure that monitoring and evaluation is accurate and that the lessons learnt can be easily shared. Information storage should be carried out by all people that implement wetland rehabilitation, from national programme participants to private land owners. To facilitate the storage of information by all people implementing wetland rehabilitation, a national database that can be remotely accessed should be established.

An IMS that is designed and developed for wetland rehabilitation should use information optimally to facilitate the successful planning, management, monitoring and evaluation of wetland rehabilitation. For the purposes of WfWetlands, the information recorded within the IMS should be recorded per wetland unit to allow for the assessment of rehabilitation success for the wetland rather than for the project level. An example of a conceptual IMS designed

for wetland rehabilitation is illustrated in Figure 10.1. Such a system facilitates the input and storage of the following information relating to the rehabilitation of wetland ecosystems within South Africa:

- inventory of proposed rehabilitation sites
- inventory of rehabilitated sites
- initial assessment results
- detailed wetland survey information
- rehabilitation objectives
- rehabilitation designs/plans (including required amendments)
- budgets and planned tasks
- operational progress (completed tasks)
- labour related information
- monitoring data, and
- performance evaluation information.

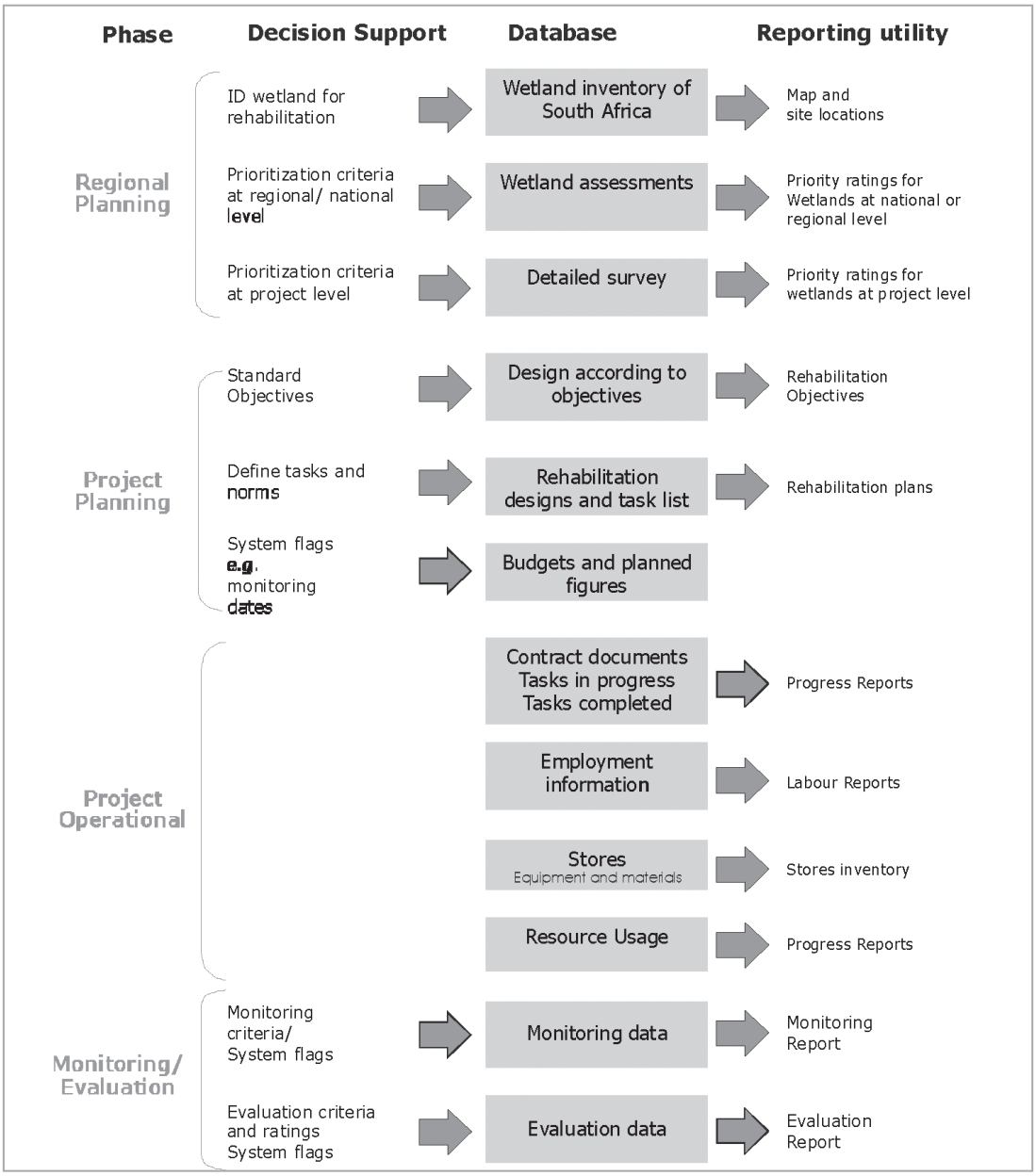



**Figure 10.1: Conceptual information for the design of a wetland rehabilitation Information Management System.**

The IMS that is presented in Figure 10.1 incorporates all the possible information that is available for wetland rehabilitation projects within a national programme. However, the following information should be considered as the minimum requirement for all wetland rehabilitation projects:

- wetland inventory wetland assessments (*WET-EcoServices*, *WET-Health* )
- problems within the wetland systems
- rehabilitation objectives
- intervention designs and details
- monitoring data, and
- evaluation data.

**The running example**

The information relating to the implementation and management of the wetland rehabilitation (i.e. *Level 1* monitoring information) undertaken in the Killarney wetland was recorded on WfWetlands' In-Form system and WET-IS (WfWetlands' planning information system). However, discussions and correspondence with Highland Wetland Rehabilitation highlighted that the recording of the implementation information was not assigned to specific wetlands. The Ntsikeni Nature Reserve project formed part of a cluster of projects, and the costs/materials associated with all the projects within the cluster were diluted with information from other projects. Where possible, Highland Wetland Rehabilitation supplied information relating to the implementation of the rehabilitation activities in the Killarney wetland, but did caution that these values were estimates that were derived from the information recorded for the cluster.

The information collected for *Level 2* and *Level 3* monitoring, however, was recorded by the individual researchers, which limited the availability of the information for follow-ups and independent monitoring. The monitoring of the wetland rehabilitation was therefore limited to the researchers and thus limited the potential of the involvement of external parties and the implementer in certain aspects of the monitoring and evaluation. Ultimately, involvement in the *Level 2* and *3* monitoring of all wetlands should be made available to interested parties, as this can greatly reduce the costs of monitoring and evaluation and also be used as a means to promote awareness.

This highlights that information needs to be captured for individual wetlands to be able to evaluate the rehabilitation at a later stage and the importance of an information-management system for all levels of monitoring to promote the greater awareness and involvement in the monitoring and evaluation of wetland rehabilitation projects, especially those carried at a national scale.

# 11. IMPLEMENTATION OF MONITORING

Monitoring is the regular collection of information to measure the variation from a predetermined position (Kotze *et al.*, 2001) and as such it forms the basis of performance evaluation. The implementation of monitoring and evaluation activities relies on the recording and availability of the information required to measure performance, such as training, species data or structural integrity. In order to record and report on this information, an information management system should be developed (Section 10).

Various indicators have been incorporated into the different levels of monitoring and in some cases these are present for all the levels. In some cases particular indicators have only been included in a single level of monitoring due to the intensity of data collection or the lack of rapid assessment techniques.

An important component of wetland rehabilitation monitoring is baseline monitoring, which provides reference data prior to the implementation of rehabilitation activities within the wetland. A comparison of 'before' and 'after' data improves the confidence in the monitoring and evaluation results for a rehabilitated wetland (Rutherfurd *et al*., 2000). The specific baseline data that are collected will be determined by the project objectives. The importance of incorporating monitoring into the wetland rehabilitation plan is highlighted by the need for baseline data for *Level 2* and *Level 3* monitoring.

## 11.1 Level 1 monitoring

### 11.1.1 Implementation of rehabilitation activities

*Materials*

The quantity of each material type used in a wetland rehabilitation project should be recorded for each wetland, preferably in an IMS database. Information that should be captured should include those materials that were purchased and the amount of material used during the implementation of the rehabilitation activities. Often the quantity of materials used during a project cannot be assessed on completion of the project. This is primarily due to the concealment of many material types in the construction phase of the project. Site visits would therefore need to take place at specific stages of the implementation to ensure the correct usage and quantity of materials on site.

*Productivity/Efficiency*

WfWetlands has production norms for various regions of South Africa and these norms should be used as a measure of each project's productivity or efficiency by allowing the comparison of the efficiency of the project against the regional production norms. The amount of time required to complete each task during the implementation of the wetland rehabilitation activities should be known and recorded. Tasks would include activities such as packing gabions, erecting shuttering or mixing concrete. The collection of this data must be an ongoing process until such time as the information that is available covers all possible situations and environmental conditions experienced during the implementation of the wetland rehabilitation projects. This information should be stored in an IMS data base which makes it readily accessible for the evaluation process.

**The running example**

Without the implementation of daily site-visits to record the material and labour inputs for each intervention and the stores records, it is not possible to determine the quantities of materials that are utilised for constructing the interventions within the wetland. It can therefore be assumed that if the interventions have been constructed in accordance with the design specifications, then it is likely that the required materials were utilised to construct the interventions. The interventions within the Killarney wetland were assessed in terms of construction in accordance with the technical designs outlined in the rehabilitation plan.

The productivity and efficiency of the rehabilitation was not assessed for the Ntsikeni Nature Reserve project as it was considered unlikely to generate realistic figures due to the unique nature of the site in terms of its remote location and limited accessibility. It is important to note that the NNR project formed part of a cluster of projects, and as such the supplied-data was considered to be diluted and in some instances it comprised estimates rather than accurate data.

### 11.1.2 Compliance with Best Management Practices

Best Management Practices (BMPs) for the implementation of wetland rehabilitation activities have been adopted from WfWetlands (Working for Wetlands Programme, 2004). The BMPs were drawn up to incorporate the requirements of South African legislation and policies relating to wetland rehabilitation projects. The BMPs comprise two sections with guidelines that outline the requirements for safety and implementation of project activities and the structural requirements and specifications of particular interventions. Wetland rehabilitation projects should, where possible, use these BMPs as guidelines to wetland rehabilitation within South Africa. A checklist derived from the BMPs should be utilised on-site to determine the compliance of each project (Working for Wetlands Programme, 2004).

The monitoring of compliance with the WfWetlands' BMPs should be carried out every week by the project manager.

### 11.1.3 Survival outputs

These assessments should be based on the condition of the structures following construction, at intervals outlined in the WfWelands' BMPs, to comply with the Occupational Health and Safety Act. Survival outputs should be monitored by two means:

- assessment of structural integrity, and
- event based monitoring.

*Structural integrity*

Following the implementation of wetland rehabilitation activities, the structures must be monitored to ensure their long term stability. Monitoring activities must take place directly after completion of the construction and at the sampling intervals outlined within the BMPs (See

**The running example**

The Project Inspection Report includes recording the compliance of the rehabilitation activities with the WfWetlands' Best Management Practices. The Project Inspection Report compiled for the rehabilitation undertaken within the Killarney wetland recorded that Highland Wetland Rehabilitation has complied with the requirements of the Best Management Practices.

Section 9.1). Monitoring should preferably be carried out by the designer of the interventions to allow him/her to 'sign off' the structure or any authorised deviations from the plans. Authorised deviations from the approved plan would include those changes that are recommended to accommodate unforeseen events or conditions on site. It is important that the position of the intervention also be confirmed to correspond with the rehabilitation plan, as in many instances the position is critical to ensure back flooding to upstream interventions ('top-to-toe'). The monitoring of structural stability and integrity should focus on the presence of the following forms of structural vulnerability:

- undermining
- sliding, tilting or overturning
- side bank collapse
- scouring/erosion downstream
- scouring/erosion upstream
- side cutting around structure
- exposed soil, and
- premature decay of the structural material (e.g. gabion wire, earthwork settlement).

In addition, specific information should still be collected for the various types of structures and activities undertaken to achieve the WfWetlands project objectives. Table 11.1 gives the required focus for monitoring the structural integrity of various wetland rehabilitation structures to ensure the long term stability of the implemented structures.

The results of each site visit should be recorded on an IMS data base to enable the review of information during the evaluation process. These observations should be recorded on a structural integrity monitoring sheet. It is important that photographic and quantitative data relating to the structure also be recorded. This would allow for the design and budget of remedial action to be planned as soon as possible to implement corrective action.

*Event-based monitoring*

The monitoring of the survival outputs of the project should consist of event-based monitoring as determined by the design level of wetland rehabilitation structures and flood return periods. This assumes that if the structure is built to design specifications it will survive the specified flood level. Event based monitoring should be carried out in addition to the regular site visits stipulated within the BMPs (Section 9.2). It is important to monitor the structures for damage following certain events to ensure that the required maintenance is quickly implemented and to ensure that the intervention continues to provide benefits to the wetland system.

The design of wetland rehabilitation structures requires the determination of runoff intensities for each particular site (Russell, 2008). During the design of a suitable structure for the site, the technician/engineer should make reference to the flood level that the structure is designed to withstand and estimate the intensity and duration of rainfall that would conceivably result in the occurrence of that flood level. This level of rainfall intensity and duration should then be used as the primary trigger for the implementation of monitoring events. The data from the closest rainfall station should be used to determine the occurrence of the specified rainfall intensity and duration. The initial site visit following the completion of the rehabilitation activities should be considered the initial inspection of the site and its ability to survive the specified flood level. This visit serves to ensure that the structure is constructed to the specifications of the design.

If required, additional event-based monitoring can be implemented following the occurrence of rainfall levels less than that of the designed level. For example, the project's monitoring plan may stipulate that a structure designed to withstand a

**Table 11.1: Monitoring focus on the structural integrity of various wetland rehabilitation structures**

| Gabion structure: | Chute: | Concrete work: |
|---|---|---|
| • Dimensions according to specifications<br>• Authorised deviations from plan<br>• Correctly packed rock<br>• Correctly sized rock<br>• Lacing and bracing correctly implemented<br>• Rusting of the wire<br>• Evidence of sliding, tilting, slumping or overturning of the structure<br>• Undercutting due to poor founding<br>• Erosion upstream<br>• Scouring downstream<br>• Evidence of outflanking<br>• Tunnelling upstream/around structure<br>• Adequate downstream shoulder walls, including cut-off walls<br>• Correct installation of materials to retain water. | • Dimensions according to specifications<br>• Authorised deviations from plan<br>• Evidence of outflanking<br>• Evidence of undercutting<br>• Evidence of movement of rock<br>• Evidence of damage to the sidewalls<br>• Evidence of scouring downstream<br>• Debris around the energy dissipaters<br>• Sloped at planned angle<br>• Protection of the entrance approach<br>• Energy dissipaters present, stable and effective. | • Dimensions according to specifications<br>• Authorised deviations from plan<br>• Evidence of sliding, tilting, slumping or overturning of the structure<br>• Cracks evident within the structure<br>• Scouring downstream<br>• Evidence of outflanking<br>• Concrete mixed to specifications<br>• Undercutting due to poor founding<br>• Adequate downstream shoulder walls, including cut-off walls. |
| **Earthen Structures (including berms and diversions):** | **Spreader Canals:** | **Fencing:** |
| • Dimensions according to specifications<br>• Authorised deviations from plan<br>• Excessive settling of the soil (>10% of overall height)<br>• Erosion on the bank<br>• Tunnelling pipes into the bank<br>• Establishment of vegetative cover<br>• Scouring downstream<br>• Evidence of outflanking<br>• Adequate compaction of soil. | • Dimensions according to specifications<br>• Authorised deviations from plan<br>• Erosion of the lip of the canal<br>• Free passage of water through the canals<br>• Scouring within the canal. | • Dimensions according to specifications<br>• Authorised deviations from plan<br>• Signs of sagging<br>• Broken strands of wire<br>• Poorly anchored fencing posts<br>• Animal entry points. |
| **Sloping of Gully Walls:** | | |
| • Authorised deviations from plan<br>• Sloped at planned angle<br>• Topsoil in place<br>• Evidence of gypsum application<br>• Satisfactory establishment of vegetation. | | |

1 in 20 year flood be monitored following every 1 in 10 year flood event and those of greater frequency.

*Corrective actions*

The monitoring of structural integrity relies on the timely recommendation of management activities to correct any problems identified during the monitoring process. These activities are generally referred to as corrective actions. The corrective actions determined during the evaluation of performance of the project should be defined as follows:

- major corrective actions
- minor corrective actions, and
- observations (potential of damage to the structure/risk to develop into a corrective action).

The implementation of the remedial action required to solve the identified problems should take place as soon as possible.

During the planning of the required actions the technician/engineer should provide an indication of a reasonable timeframe within which the required tasks should be completed.

*Major corrective action*

These are situations recorded during the monitoring and evaluation process that are non-compliant with legislation, Occupational Health and Safety requirements, BMPs, social responsibilities or the wetland rehabilitation objectives of the programme. Projects where corrective actions have not been implemented and which fall into this category, should be precluded from future funding until they are corrected.

*Minor corrective actions*

These are situations, recorded during the monitoring and evaluation process, that are non-compliant with the rehabilitation plan and BMPs. These situations are not at a level significant enough to prevent the objectives of the project from being achieved. This level of corrective action would not preclude the project from further funding if they are timeously corrected. However, they do have the potential to become a major corrective action. An example of minor corrective actions would be damage caused by flooding while the intervention is still under construction.

*Observations*

These are situations, recorded during the monitoring process that may lead to corrective action being required if the problem persists over an extended period. In some cases the observation may not need action to be implemented at that time but would need to be closely observed so as to implement corrective action if required. For example, the establishment of vegetation within an area may not be adequate at the time of the monitoring being carried out, but may improve without any intervention in a short period and would be recorded as an observation.

The objectives and deliverables of the corrective actions should be clearly defined within a report. This includes an indication of the costs, human resources

**The running example**

The interventions within the Killarney wetland were assessed in terms of their structural integrity. Generally, the interventions were considered to be structurally sound, but in some instances it appears that the concrete on the spillway may be subjected to corrosion which is likely to be associated with construction techniques or concrete mixing. The structural interventions within the Killarney wetland were also assessed in terms of their compliance with the designs specified within the rehabilitation plans compiled for the wetland system. The majority of the interventions were recorded as having been constructed in accordance with the designs included in the rehabilitation plans for the Killarney wetland. Comparisons of the interventions and the designs were made for critical features of the structures (such as spillway width, key wall length, and shoulder wall length). The general compliance of the interventions with the designs was also reported in the WfWetlands Project Inspection Report. In some instances there was some variation from the designs, but these were noted as posing low risk to the structural interventions' integrity and not compromising the intended outcomes of the interventions, and would generally be attributed to inexperienced contractors and unskilled labour or lack of supervision for short periods.

and materials required to remedy the observed problem. This will ensure that the required actions are implemented and that these actions can be evaluated subsequent to their implementation. Following the implementation of the required corrective actions, a follow-up evaluation should be carried out to determine if the deliverables have been completed and that the objectives of the actions appear to have been met.

### 11.1.4 Social outputs

In some instances, social outputs may be considered important objectives of wetland rehabilitation projects. The funding allocated to WfWetlands is derived from poverty alleviation funds and concerns socio-economic issues that are considered to be important. To ensure that the social commitments of a wetland rehabilitation project are achieved, information relating to these aspects of the project should be recorded.

These aspects include:

*Employment*
- compliance with employment legislation, and
- representation of race and gender in the selection for staff at all levels.

*Target Groups*
- 60% women
- 20% youth (defined as people between the age of 18 and 25 years old), and
- 2% disabled.

*Remuneration*
- person days basis of payment, and
- rate of pay.

*Contractor*
- contractors drawn from the previously disadvantaged groups, including women, and
- contractors working for a maximum of two years on a closed contract.

*Training of contractors and labourers*
- training entitlement
- induction
- wetland awareness
- health and safety
- first aid, and
- training records.

The importance of recording this information is highlighted within the report on the socio-economic impact of the WfWetlands programme (Nkoko and Macun, 2005).

*Employment, target groups and remuneration*

The following information should be recorded for each individual that is involved in the WfWetland rehabilitation projects:
- identity number
- age
- race
- gender
- marital status (Nkoko and Macun, 2005)
- number of dependants
- number of days worked
- number of sick days (Nkoko and Macun, 2005)
- number of training days
- number of incidents/accidents (Nkoko and Macun, 2005), and
- income earned.

This information should be drawn from the IMS database for each project by means of monthly reports, as well as for each region for WfWetlands (Table 11.2). This information should be used to assist in the management of the projects as a means of achieving the threshold values set by WfWetlands.

**Table 11.2: Example of a simple regional report giving employment statistics for the 2003/2004 financial year*.**

| | Actual Values | WFWetlands Threshold Values |
|---|---|---|
| Total number of people employed | 3123 | - |
| Percentage labourers | 67% | - |
| Percentage disabled people | 5% | 2% |
| Percentage women | 56% | 60% |
| Percentage youth | 26% | 20% |
| Remuneration (R/day) | R39.00 | R39.00 |

*The data within this table were not drawn from an actual project/region and are merely for illustrative purposes.

*Contractors*

Poverty alleviation projects aim at providing employment opportunities to as many people as possible by ensuring that as many people as possible are employed for the duration of the project. This is achieved by employing people for only a specified period (specific to each project area), by which time they are expected to have learnt skills that can assist them in obtaining employment outside of the WfWetlands programme. This applies especially to the contractors within the programme.

This social aspect of the WfWetlands projects has to be monitored to ensure that as many people as possible are being employed by the programme and to prevent people being repeatedly included in the projects, despite the two-year limit of an individual's involvement with the programme. Recording a person's identity number should provide the information required on gender and socio-economic status, but should also serve as a means of identifying the length of time that the person has been employed by the programme. This should ensure that those people that have been employed by the programme for the maximum specified period are not issued work contracts for the following year.

Additional information may also be required, such as the amount of training a contractor has received or if the contractor has accumulated enough capital to be able to exit the programme. The additional information to be monitored would depend on the exit strategy adopted by WfWetlands.

*Training*

Personnel within WfWetlands are entitled to two days of training for every 22 days worked. This facilitates the development of skills within the programme. In order to ensure that personnel work the required number of days and receive the deserved training the following information should be recorded per person on a monthly basis for each project:

- the number of days worked, and
- the number of days of training attended.

Nkoko and Macun (2005) recommended the collection of the following specific information relating to the development of skills within WfWetlands:

- type of training received
- purpose of the training
- details of the training person/ organisation
- duration of the training, and
- cost of training.

**The running example**

The following information relating to the personnel involved in the rehabilitation of the Killarney wetland was obtained from Highland Wetland Rehabilitation. It should be noted that the information obtained from Highland Wetland Rehabilitation for the Ntsikeni project is considered to not be representative of the region's performance in terms of compliance with WfWetlands' threshold values or targets due to the limitations associated with the remote sites and difficult working environment.

| | Actual Employment | | WfWetlandsThreshold Figures |
|---|---|---|---|
| | Numbers | Percentage | |
| Labourers | 42 | - | - |
| Disabled | 0 | 0% | 2% |
| Women | 24 | 57% | 60% |
| Youth | 9 | 21% | 20% |
| Remuneration (R/day) | R46.00 | R46.00 | |

The following information relates to the training received by personnel involved in the rehabilitation of the Killarney wetland. It should be noted that WfWetlands require that for every 20 days worked on a project that two days be allocated to personnel training. HWR recorded 7644 days of work for the project, which equates to 764.4 training days.

| | Actual Training Days | WfWetlands Required Training Days |
|---|---|---|
| Training days | 765 | 764.4 |

The collection of the abovementioned information would allow for the evaluation of skills development within the programme.

Although outside the scope of this performance evaluation manual, it is important to note that training materials and content should be regularly evaluated to ensure that they are:

- relevant
- outcomes based, and
- aimed at the correct level of personnel.

The accreditation of courses offered to employees within the WfWetlands programme would also assist in providing marketable skills to employees once they have left the programme. Nkoko and Macun (2005) highlight the importance of sustainable upliftment of the communities involved in wetland rehabilitation by providing accredited training.

## 11.2 Level 2 monitoring

It is suggested that as a standard procedure, outcomes should be assessed in terms of the effects on

- ecosystem integrity; and
- delivery of ecosystem services.

It is suggested that the first be described using *WET-Health* and the second using *WET-EcoServices*. Both of these methods provide details on relevant indicators and their means of description. It is important to emphasize, however, that this manual does not prescribe that all of the components of integrity (i.e. hydrology, geomorphology and vegetation) in *WET-Health* and all of the 15 ecosystem services in *WET-EcoServices* need to be assessed. Instead, the user should be guided by the particular rehabilitation objectives, which may range from being purposefully general in their specified outcomes (e.g. to enhance the delivery of ecosystem services generally) to being specifically narrow (e.g. to re-instate the capacity of the wetland to support the successful breeding of a particular Red Data species). The assessment of a wetland's integrity and ecosystem delivery can be modified for the specific wetland rehabilitation that will be undertaken.

Where the rehabilitation objectives encompass several different outcomes, this manual does not prescribe the relative priority that these should be accorded. Instead, the user should be guided again by the priorities specified in the rehabilitation objectives, and if these have not been prioritised then it may be necessary to do so with input from the key stakeholders. In one project, for example, reinstating the full integrity of the natural vegetation may be secondary to reinstating a particular plant species that is valued by a poor local community, while in another project it may be the primary objective.

### 11.2.1 Wetland integrity and hectare equivalents

When evaluating the ecological outcomes of a project, it is of little value to simply report on the spatial area that has been rehabilitated. It may be, for example, that the integrity of a large rehabilitated area has been only very slightly improved, or conversely, that the integrity of a small rehabilitated area has been considerably improved. Area of wetland also provides no indication of the delivery of ecosystem services. Thus, when assessing rehabilitation outcomes it is important to examine the level at which the integrity of the rehabilitated wetland area and its delivery of ecosystem services is affected by rehabilitation. This can be done by assessing and comparing two scenarios, the situation without rehabilitation (i.e. no intervention) and the situation with rehabilitation. Sometimes it may be necessary to assess several alternative rehabilitation scenarios. An approach and 'currency' is described below for assessing these scenarios. Two case study examples are also given to illustrate the approach

Using *WET-Health* (Macfarlane *et al.*, 2009), both the situation without rehabilitation and the situation with rehabilitation are scored on a scale of 0 (pristine) to 10 (critically altered), and this is undertaken for the hydrology, geomorphology and vegetation components of health. The scores for these three components are respectively integrated based on a weighted average ratio of 3: 2: 2, given that hydrology is considered to have the greatest contribution to health. For example, if hydrology, geomorphology and vegetation scored 6/10, 2/10 and 7/10 respectively, then the integrated score would be ((6x3) + (2x2) + (7x2))/7 =5.1/10. As indicated in *WET-Health*, these ratios may be modified with justification (e.g. vegetation may be weighted much higher if the rehabilitation objectives

place particular emphasis on vegetation integrity). It is important that for all allocated scores, written justification is provided of the rationale underlying the scores. This allows for the assessment to be more readily verified by a third party.

The benefit achieved in terms of health would be determined by comparing the scores for the rehabilitated and non-rehabilitated scenarios. This can be expressed in terms of 'hectare equivalents' of intact wetland, which provides a common currency for comparing different rehabilitation scenarios. Take, for example, a wetland of 60 hectares. Imagine that the health score without rehabilitation is 7 (seriously impacted) owing to the desiccating effect of a network of artificial drains. This translates to a hectare equivalent score of (10-7)/10 x 60 ha = 18 hectare equivalents of healthy wetland. Through the construction of rehabilitation plugs in the artificial drains, the health score may be predicted to be 2 (moderate impact). This translates to a hectare equivalent score of (10-2)/10 x 60 ha = 48 hectare equivalents of healthy wetland. Therefore the rehabilitation will effectively re-instate 48 – 18 = 30 hectare equivalents of healthy wetland.

For areas threatened by headcut erosion which are to be rehabilitated by halting the propagation of the headcut, the benefits in terms of health would be determined by the difference between the current health and the projected health should the headcut proceed to erode through the threatened wetland area. In this case, halting the propagation of the headcut is assumed to secure the current situation. Take, for example, a 30 ha area of wetland threatened by gully erosion, with a current health score of 1/10 (slightly impacted, 27 hectare equivalents of healthy wetland) projected to decline to 7/10 (seriously impacted, 9 hectare equivalents of healthy wetland) if the erosion is allowed to proceed. A rehabilitation intervention that halts this erosion would therefore secure 18 hectare equivalents of healthy wetland.

The concept of 'hectare equivalents' can effectively be applied to off-site mitigation. Take, for example, a development that is to unavoidably destroy 15 ha of wetland, for which there are no on site mitigation options and for which a compensation ratio of 2 to 1 has been specified. This would mean that 30 ha equivalents of intact wetland would be required to compensate for the loss. This could be supplied by the example given above of a 60 ha area with a 50% improvement in health, assuming that it met the other requirements (e.g. was in the same catchment as the impacted wetland etc.). If, in the 60 ha example given above, the improvement in health was only 20% (i.e., a reinstatement of 12 ha equivalents of intact wetland), then this would be inadequate for the mitigation despite the large size of the area in which the rehabilitation took place.

The example given below consists of two WfWetlands rehabilitation projects. The first is Dartmoor wetland, in the Nyamvubu catchment, KwaZulu-Natal, and the second is Kruisfontein, in the Mooi River catchment, KwaZulu-Natal. Prior to rehabilitation, both of these wetlands had been altered through artificial drainage channels, with Kruisfontein considerably more so than Dartmoor, mainly because of two effective diversion drains combined with ridge and furrowing across the entire wetland. At Dartmoor most of the pre-rehabilitation vegetation was still dominated by the original indigenous hydric species, while at Kruisfontein most of the wetland had been cleared of indigenous vegetation, and prior to rehabilitation was dominated by an alien pioneer species *Paspalum dilitatum* and the facultative non-wetland species *Cynodon dactylon*. Both Kruisfontien and Dartmoor had a reasonably high geomorphic integrity under a non-ehabilitation scenario with

Dartmoor showing greater improvement in integrity as a result of rehabilitation. In both cases there was little reinstatement of geomorphic integrity that took place as a result of rehabilitation.

Figure 11.1 and Table 11.3 indicate the integrity of the wetland with rehabilitation and without rehabilitation for the two sites (a more detailed assessment of the rehabilitation outcomes at these two sites, together with four additional sites, is given in Kotze and Ellery (2009)). For Dartmoor, the difference between the adjusted area with and without rehabilitation provides an indication of the integrity or 'functional area' that has been reinstated. Thus, in functional terms, the rehabilitation of Dartmoor is equivalent to fully reinstating the integrity of 9.1 ha of wetland that had been totally altered (i.e. starting with integrity of 10/10). In functional terms, the rehabilitation of Kruisfontein wetland is equivalent to fully reinstating the integrity of 5 ha of wetland that had been totally altered (i.e. with integrity of 10/10). Comparing the two wetlands, it can be seen that although Kruisfontein is considerably smaller than Dartmoor and does not achieve nearly as high a level of integrity after rehabilitation, the functional area that will be re-instated is relatively high for Kruisfontein (5 ha equivalents out of a possible total of 18 ha equivalents whereas Dartmoor is 9.1 ha equivalents out a possible total of 70 ha equivalents.

The example above highlights, as emphasised earlier, that a comparison of 'intact area' is considered to be much more meaningful than a simple comparison of the size of the wetland area in which rehabilitation interventions take place. It would be very misleading, for example, to state that 70 ha of wetland has been rehabilitated at Dartmoor and only 18 ha of wetland has been rehabilitated at Kruisfontein.

**Table 11.3: A summary of the effect of rehabilitation on the integrity of the Dartmoor and Kruisfontein wetlands**

| | Dartmoor | Kruisfontein |
|---|---|---|
| Size of the area in which rehabilitation occurs (ha) | **70 ha** | **18 ha** |
| The situation without rehabilitation: | | |
| Hydrology | 2.9 | 8.2 |
| Geomorphology | 2.3 | 2.5 |
| Vegetation | 2.0 | 9.0 |
| **Overall** | **2.5** | **6.8** |
| **Hectare equivalents without rehabilitation** | **52.5 ha** | **5.8 ha** |
| The situation with rehabilitation: | | |
| Hydrology | 1.5 | 6.6 |
| Geomorphology | 0.7 | 2.0 |
| Vegetation | 1.3 | 4.5 |
| **Overall** | **1.2** | **4.7** |
| **Hectare equivalents without rehabilitation** | **61.6 ha** | **9.5 ha** |
| **Hectare equivalents of intact wetland re-instated/maintained** | **9.1 ha** | **3.7 ha** |

Note: integrity is scored on a scale of 0 (pristine) to 10 (critically altered)
The scores for the three respective components (Hydrology, Geomorphology and Vegetation) are integrated based on a weighted average ratio of 3: 2: 2

| Integrity classes |
|---|
| Unmodified, natural (0/10%) |
| Largely natural with few modifications (1/10%) |
| Moderately modified (3/10%) |
| Largely modified (5/10%) |
| Extensive loss of habitat and function (7/10%) |
| Critical (10/10%) |

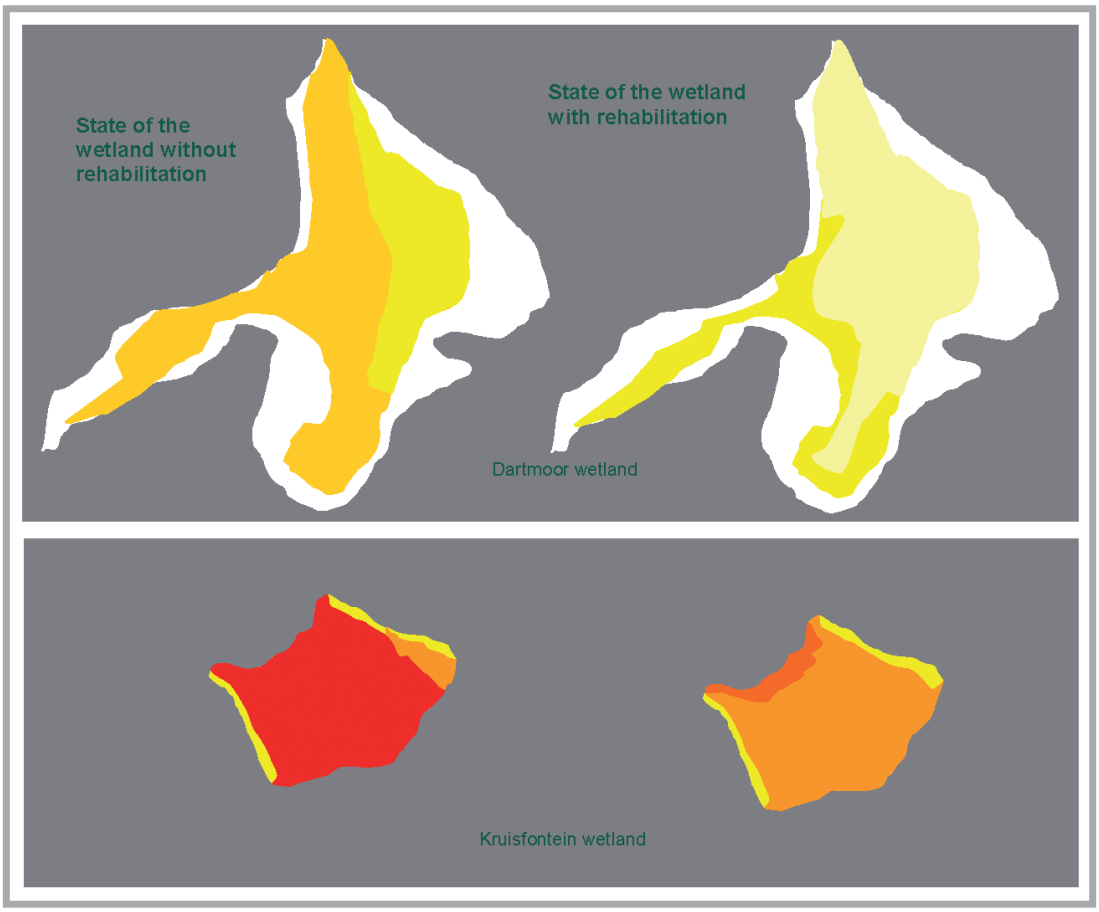



**Figure 11.1: The hydrological integrity of Dartmoor and Kruisfontien wetlands under pre- and post-rehabilitation scenarios**

### 11.2.2 Delivery of ecosystem services

The next question to examine is: what are the implications of the increased integrity in terms of the delivery of ecosystem services? The fact that a wetland is currently delivering a high level of goods and services does not automatically make it a good candidate for rehabilitation. Rather, it is the level to which the delivery of ecosystem services will be affected by rehabilitation that is most important. This can be done by predicting the level of delivery of ecosystem services under a rehabilitated state compared with the level of delivery without any rehabilitation. This prediction is based on the extent to which rehabilitation will affect key characteristics that determine the delivery of services, as in Table 11.4, as elaborated upon in Kotze

**The running example**

It was evident that the rehabilitation resulted in a gain in integrity for all three of the ecological processes within the wetland. It should be noted that the hydrological and vegetative integrity of the system are likely to improve further with the vegetation composition continuing to revert to natural conditions, provided that the natural species are able to out-compete the invasive *Phalaris arundinaceae*. This would result in increased surface roughness and vegetation nearer to historical/natural composition. It is evident from the assessment of the wetland's functioning and integrity that the rehabilitation of the system has resulted in an improvement in ecosystem delivery and integrity. Utilising the health scores determined from the assessment of the Killarney wetland's ecological integrity pre- and post-rehabilitation, it is possible to determine the gain in hectare equivalents of integrity associated with the implementation of the WfWetland rehabilitation activities.

| Derivation of Hectare Equivalents | | Hydrological integrity | Geomorphological integrity | Vegetation integrity |
|---|---|---|---|---|
| Pre-Rehabilitation | Wetland area affected by rehabilitation | 57.50 | 57.50 | 57.50 |
| | Health Score | 3.0 | 1.7 | 3.2 |
| | Hectare equivalents | 40.25 | 47.73 | 39.10 |
| Post-Rehabilitation | Wetland area affected by rehabilitation | 57.50 | 57.50 | 57.50 |
| | Health Score | 1.0 | 1.0 | 2.2 |
| | Hectare equivalents | 51.75 | 51.75 | 44.85 |
| | Gained hectares | 11.50 | 4.02 | 5.75 |

It was apparent that the rehabilitation of the system resulted in an increase in effective wetland area for all three components of integrity. It is important to note that generally the deterioration of the system's hydrology was considered to be the driving factor behind the deterioration of the wetland's functioning and integrity. Vegetative integrity could also be used to assess the rehabilitation of the system, but in this instance it was considered that not enough time had lapsed to illustrate the anticipated response in vegetative condition. The increase in hydrological integrity is therefore the ecological process that was utilised to assess the success of the rehabilitation.

*et al.* (2009b). For example, the pattern of low flows in a wetland has an important effect on the wetland's effectiveness in the assimilation of pollutants (the more diffuse the flow, the better). If by plugging drains, for example, the flow patterns in a wetland can be converted from a very concentrated situation to a very diffuse one, then the effectiveness of the wetland in assimilating pollutants is likely to be markedly enhanced.

It is important to consider both the features of the wetland that determine its effectiveness in service delivery (e.g. flow patterns in the wetland) and the particular context of the wetland (e.g. pollutants upstream; it is in a catchment with a high cumulative loss of wetlands etc.). For hydrological services, for example, wetlands that have had their effectiveness compromised through physical means (e.g. concentration of flow through artificial drainage channels) but that are afforded a high opportunity for performing a particular ecosystem service (e.g. pollutants upstream) are generally good candidates for rehabilitation. A similar principle applies to the other ecosystem services. In the case of the maintenance of biodiversity, for example, good candidates for rehabilitation would be wetlands that have reduced habitat quality (e.g. through invasion by alien plants) and that are of a type that has been subject to a high level of cumulative loss.

If a vision and objectives exist for the catchment in which wetlands are being prioritized, then particular attention should be given to those ecosystem services relevant to the vision and objectives. For example, the supply of good quality water may be very important in a particular catchment, requiring that particular attention be given to the hydrological services assessed by *WET-EcoServices*. In another case, biodiversity may be the most important consideration.

From Table 11.5 it can be seen that for a non-rehabilitated state, the Dartmoor wetland generally provides a generally much higher delivery of hydrological services and maintenance of biodiversity than does the Kruisfontein wetland. This is understandable given the very low level of hydrological integrity of the Kruisfontein wetland.

The rehabilitation of the Kruisfontein wetland led to a noticeable increase in the delivery of hydrological services. This contrasts with Dartmoor, where there was generally only a slight increase in the delivery of services. This is understandable when considering the situation prior to rehabilitation. At Kruisfontein, several features (e.g. the pattern of flow and hydrological zonation) are at their lowest level in terms of the effectiveness of the wetland in supplying hydrological services. Thus there was much that could be done to improve the effectiveness of the wetland. And, in fact, this was achieved at Kruisfontein through restoring a much more diffuse pattern of low flows and a much higher level of wetness. In contrast, at Dartmoor these features are already much closer to their optimal state for the delivery of hydrological services. Therefore the scope for improving the effectiveness of the wetland was much more limited. Furthermore, Dartmoor wetland's catchment was close to pristine condition, while a portion of Kruisfontein wetland's catchment was intensively used for pasture and dairy production. Consequently, Dartmoor was provided much less opportunity for assimilating nutrients than Kruisfontein (i.e. its potential effectiveness for assimilating pollutants was currently not being realized).

Both wetlands provide fairly limited provisioning and cultural services, which are generally not greatly affected by rehabilitation. However, given that the Kruisfontein property is run as an

**Table 11.4: Characteristics that affect a wetland's effectiveness in the delivery of ecosystem services and that are readily affected by human activities and could potentially be influenced by a rehabilitation project**

| Wetland characteristic | Human activities commonly affecting the characteristic |
|---|---|
| 1. Slope of the wetland unit (%) | Lowering the base level of the downstream portion of the wetland, e.g. during the construction of a bridge |
| 2. Surface roughness of wetland unit | Replacement of indigenous vegetation |
| 3. Depressions | Infilling; breaching of oxbow lakes lying close to the main river channel |
| 4. Frequency with which storm flows are spread across the wetland unit | Human modifications such as straightening (see below), widening and deepening of the channel and artificial levees may all serve to reduce the frequency with which flooding out of the channel takes place |
| 5. Sinuosity of the stream channel, if present | Artificially straightening of the channel |
| 6. Representation of different hydrological zones | Level of wetness is typically reduced through artificial drainage channels in the wetland or through diminished inputs |
| 7. Flow patterns of low flows within the wetland | Artificial drainage channels that concentrate flow |
| 8. Extent of vegetation cover in the wetland unit | Removal of the indigenous vegetation and replacement with vegetation having a lower cover; heavy grazing pressure |
| 9. Current level of physical disturbance of the soil in the wetland unit | Tillage and trampling by livestock are probably the most important human disturbances in wetlands |
| 10. Abundance of peat | Reduced level of wetness (see characteristic 6) typically leads to increased levels of oxidation of peat resulting in its depletion |
| 11. Habitat for Red Data species | Typically lost through transformation of vegetation and artificial drainage |
| 12. Complete removal of indigenous vegetation | Results from the establishment of cultivated lands, infrastructure, deep flooding by dams and other wholesale transformations |
| 13. Invasive and pioneers species encroachment | Invasion is often favoured by past disturbance |
| 14. Alteration of the water quality regime of the wetland | Application of fertilizers and biocides on agricultural lands in the wetland and its catchment |

NOTE: wetland characteristics (e.g. underlying geology) that are not readily affected by human activity and characteristics relating to the wetland's context (e.g. an important aquatic system downstream) are omitted from the above list.

ecotourism farm, the increased numbers of birds that are likely to be attracted to the wetland will contribute positively here. In addition, some of the farm labourers utilise *Juncus punctorius* for weaving, a natural resource that is likely to increase in abundance through rehabilitation.

The delivery of two ecosystem services at Dartmoor stand out as being particularly high on carbon storage and the maintenance of biodiversity. There is a high level of storage of organic sediments taking place in the wetland, which, although being compromised to some extent under a non-rehabilitated state, still makes a high contribution. The wetland's high biodiversity value derives from its high integrity, particularly the very high integrity of the vegetation, the fact that the wetland is very well connected to other natural areas in a largely untransformed landscape, and that it is an historical breeding site for the critically endangered Wattled Crane.

Reinstatement of a close to natural hydrology at Dartmoor has significantly improved the the breeding habitat for Wattled Crane, which further improves the *WET-EcoServices* score for biodiversity. However, prior to rehabilitation, Dartmoor

**Table 11.5: Delivery of ecosystem services by the Dartmoor and Kruisfontein wetlands, each under two scenarios, the first without rehabilitation and the second with rehabilitation**

| (a) Ecosystem services | | Dartmoor | | Kruisfontein | |
|---|---|---|---|---|---|
| | | Without rehab | With rehab | Without rehab | With rehab |
| Hydrological services | Flood attenuation | 2.2 | 2.4 | 2.0 | 2.6 |
| | Streamflow regulation | 2.6 | 2.8 | 1.8 | 2.4 |
| | Sediment trapping | 1.6 | 1.7 | 1.5 | 2.0 |
| | Phosphate trapping | 1.3 | 1.7 | 1.8 | 2.6 |
| | Nitrate removal | 2.0 | 2.5 | 1.6 | 3.0 |
| | Toxicant removal | 2.1 | 2.6 | 1.6 | 2.6 |
| | Erosion control | 2.9 | 2.9 | 2.6 | 3.0 |
| | Carbon storage | 3.3 | 3.7 | 1.3 | 2.3 |
| Maintenance of biodiversity | | 3.0 | 3.7 | 1.5 | 2.4 |
| Provisioning & cultural services | Water supply for human use | 0.9 | 1.1 | 0.3 | 0.9 |
| | Natural resources | 0.8 | 0.8 | 1.0 | 1.6 |
| | Cultivated foods | 0.3 | 0.3 | 0.4 | 0.4 |
| | Cultural significance | 0.0 | 0.0 | 0.0 | 0.0 |
| | Tourism and recreation | 1.3 | 1.3 | 0.9 | 1.6 |
| | Education and research | 1.8 | 1.8 | 1.5 | 2.0 |

| Level of importance of ecosystem service: | <0.5 Low | 0.5-1.2 Moderately low | 1.3-2.0 Intermediate | 2.1-3.0 Moderately high | >3.0 High |
|---|---|---|---|---|---|

was already close to the maximum score for biodiversity. Thus, this improvement is fairly small, which belies the considerable benefits this may have when seen in the context of the South African population of Wattled Crane, a critically endangered species. This highlights the importance of not being fixed only on the improved scores as revealed by *WET-Health* and *WET-EcoServices* but being open to other broader scale issues in the prioritization process. These considerations and the importance that they hold will depend on the particular stakeholders engaged in the prioritisation process.

### 11.2.3 Erosion and sedimentation

The monitoring of erosion and sedimentation within the wetland system is in general necessary, as a number of the objectives of rehabilitation projects include the stabilisation of erosion evident within the wetland.

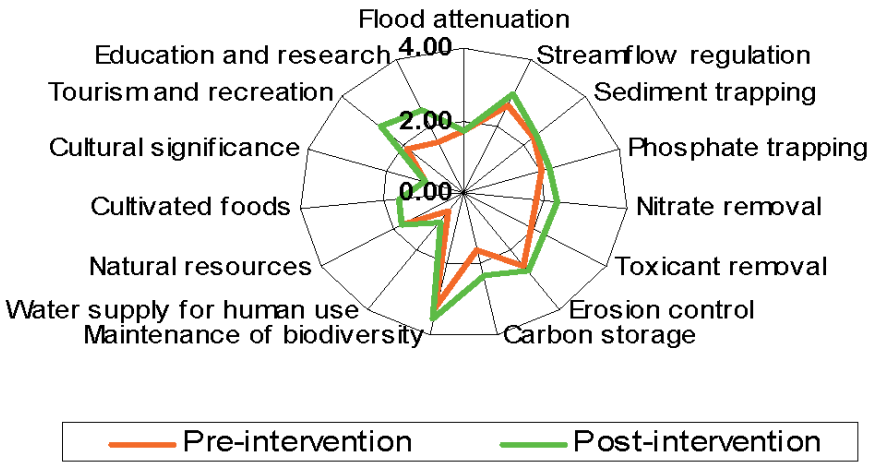
*Erosion*

During the initial wetland survey, information relating to the erosion within the wetland system is collected to allow appropriate design solutions. This information would then serve as baseline data for the monitoring of erosion stabilisation. The following dimensions should be measured for gully and headcut eosion:

The running example

The assessment of the ecosystem service delivery highlighted the importance of the system in terms of maintaining biodiversity and stream flow regulation, with the wetland also providing benefits and services associated with sediment trapping, erosion control and phosphate trapping. The assessment of the level of service delivery post-rehabilitation identifies a number positive impacts on the ecosystem services supplied by the Killarney wetland, but it is important to note that some of the increases in ecosystem delivery are associated with changes in the management of the nature reserve rather than being directly linked to the wetland rehabilitation activities. The following information shows the percentage change in ecosystem delivery of the Killarney wetland from pre- to post-rehabilitation.

| Ecological Services | Percentage Change | Ecological Services | Percentage Change |
|---|---|---|---|
| Flood attenuation | -2 | Maintenance of biodiversity | 10 |
| Stream flow regulation | 13 | Water supply for human use | 39 |
| Sediment trapping | 5 | Natural resources | 0 |
| Phosphate trapping | 11 | Cultivated foods | 0 |
| Nitrate removal | 28 | Cultural significance | 0 |
| Toxicant removal | 18 | Tourism and recreation | 46 |
| Erosion control | 8 | Education and research | 67 |
| Carbon storage | 40 | Note: the improvement in the value of the wetland for tourism is attributed more to an improved access road and a new tourism facility rather than the rehabilitation on its own. | |



*Gully Erosion*

- depth
- width
- length
- steepness of the gully sides
- vegetation cover (% cover) on gully sides
- vegetation cover (% cover) on gully floor.

*Headcut Erosion*

- vertical drop
- percentage slope
- vegetation cover (% cover).

*Equipment required:*

- 1:10 000 maps
- Field markers (600 mm steel rods hammered 0.5 m into the ground)
- Global Positioning System (GPS)
- Measuring tape
- Compass.

*Method:*

Field markers should be placed at a fixed distance of 2 m from the edges of gully and headcut erosion. A GPS position should be recorded for each field marker as well as the bearing and distance to the edge of the headcut/gully erosion. These distances should then be monitored annually to accurately establish that the stabilisation of the erosion has occurred. Monitoring should be scheduled during the winter season, when active progression of erosion is unlikely.

*Note:* In some cases the physical dimensions of erosion within the wetland may be seen to be increasing in size after completion of wetland rehabilitation activities, especially if the slopes of gully banks or headcut erosion are stabilised by means of sloping and revegetation. In these cases the monitoring results should be placed in context of the rehabilitation activities to ensure that the data are not misrepresented to funding agents or the public.

*Sedimentation*

Erosion upstream of wetland systems can often result in the 'burying' of these wetland systems, with the loss of wetland goods and services. The accumulation of sediment upstream of structures within the wetland is therefore often an objective of wetland rehabilitation projects. In these cases the depth of sediment accumulation within the wetland should be monitored using sediment discs or sediment pans (Kleiss, 1993). Monitoring should be scheduled during the winter season, when active progression of erosion is unlikely.

*Equipment required:*

- Sediment discs/pans
- GPS
- Callipers.

*Method:*

Sediment pans/discs would be placed on the soil surface and secured in those areas where sedimentation has been planned to occur. These should be placed at a known distance and direction from reference points that have been recorded with a GPS and appropriately marked (Kleiss, 1993). This would allow for the relocation of the equipment during subsequent visits to the site. The level of sedimentation should be monitored on an annual basis, preferably following the rainfall season (Kleiss, 1993). When monitoring the sediment accumulation within the wetland, the depth of sediment on top of or inside the sediment pan is measured with callipers. The equipment is then repositioned on top of the soil surface to measure the accumulation of sediment over the following year.

### 11.2.4 Water level monitoring

Given the fact that the desiccation of wetlands as a result of artificial drainage and gully erosion is widespread in South Africa, the elevation of the water table is often a rehabilitation objective. In order to be able to determine project success, the level of water within the wetland should be monitored, before and after rehabilitation activities.

Note: A change in hydrology can be inferred from a change in vegetation by noting the extent to which hydrophytic plant species increase or decrease in abundance (Kotze and Marneweck, 1999). By collecting water level data in conjunction with photo points and vegetation surveys, changes in the water regime can be verified by changes in vegetative composition and structure. It should, however, be noted that there may be problems associated with the delayed response of the vegetation to the alteration in hydrological conditions.

*Equipment required:*

- Soil auger
- Graduated drop stick / water level tape measure
- Permanent gauge boards
- Global positioning system (GPS).

The measurement of the water level within the wetland system at a particular point in time should be considered in relation to climatic fluctuations. The results of the monitoring should therefore be related to the average.

*Method:*

*Surface water*

The depth of surface water within the wetland should be measured at biannual intervals, during summer and winter. This will ensure that the water level is measured during the high and low flow periods of the wetland area. This is considered important as the changes to the hydrology of the wetland system may only be obvious at particular times of the year.

This could be achieved by means of two different methods:

1. In those instances where the safety of measuring equipment is guaranteed it may be possible to install permanent gauge boards in the wetland area so as to monitor surface water depth. A coated metal gauge board with 1 cm increments is considered to be appropriate for water level monitoring. It is preferable to have these accurately levelled to a standard height measurement, by means of surveying techniques, allowing for the comparison of data. Ensure that the markers are positioned so that they are readable from an accessible point.
2. Another option for measuring water depth would be the physical measurement of water depth in different locations using a graduated drop stick. These monitoring points should be marked appropriately and the location recorded with a GPS to ensure that the water level can be measured at the same location during subsequent monitoring visits.

*Sub-surface water*

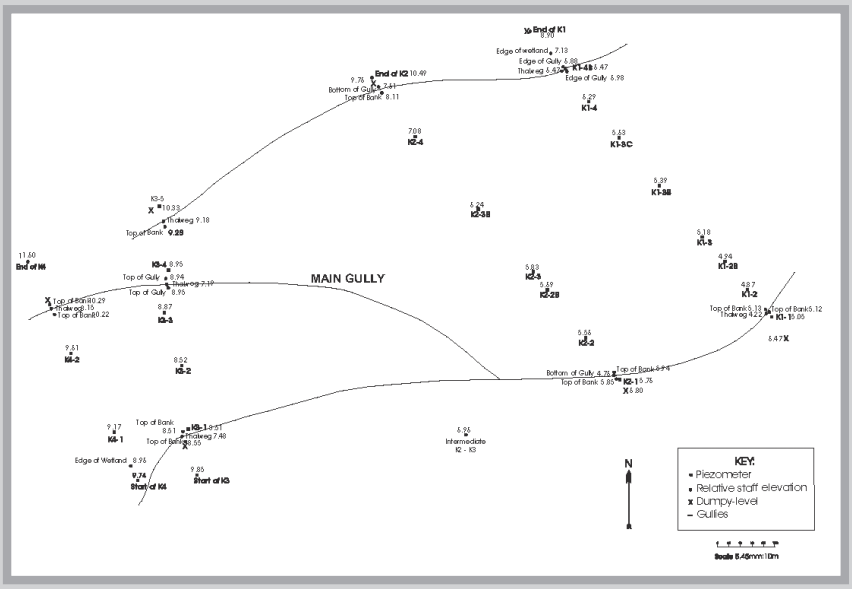
The rapid assessment of groundwater levels within the wetland is based on the augering of holes in different locations within the wetland and measuring the depth to the water table from the soil surface. The locations of these auger holes should be in the expected area of influence on water level of the wetland rehabilitation.

To obtain an accurate measurement, the hole should preferably be augered and left for 24 hours to allow water to accumulate in it. The extended time period allows water to seep into the hole from the high clay soils of most wetland soils in South Africa. Where soil is sandy,

a less extended time period would be required. Permanent peizometers or 'dip-wells' may be installed to allow the relatively easy location of sample points and the measurement of water levels. The location of these measuring points should be appropriately marked and recorded with a GPS to ensure that subsequent samples occur at the same location. As for surface water measurement, the depth to the water table should be measured at biannual intervals, during summer and winter.

## The running example

To monitor effects of rehabilitation on the Killarney wetland groundwater hydrology, 14 groundwater observation wells (peizometers) were installed along transects across the wetland and monitored over the period 14 April 2005 to 18 March 2007. Historical levels of wetness (as indicated by soil characteristics) at each well were recorded. The wetland was mostly seasonally saturated, and became slightly drier up-valley from transects K1 and K2 to transects K3 and K4.




The collected data indicated that the gullies had a substantial effect on maintaining low water level at the edges of the wetland, due to their hydraulic efficiency. However, sites that were some distance from the gullies respond in a predictable way to water inputs and deficits. The monitoring of the water levels also highlighted the significant role of the main gully crossing the wetland between transects K3 and K2, since the gully intercepted surface flow of water on the valley floor from its west. Therefore east of the gully the wetland was not receiving water from upstream, and recharge of groundwater was non-existent despite significant rainfall. The minor gully on the northern edge of the wetland appears to play a similar role.

Although more data would have been preferable overall, the most recent water level measurements (March 2007) indicated that rehabilitation had raised the water table in the wetland and had reinstated a level of wetness consistent with that prevalent historically.

### 11.2.5 Water quality

The South African Scoring System (SASS5 only implemented by practitioners with the required experience and certification) has become the standard technique for the rapid bio-assessment of river systems within South Africa (Dickens and Graham, 2002). A means to determine the changes in water quality that is linked to the functioning of a particular wetland system can be carried out by implementing SASS5 both upstream and downstream of the wetland habitat, within the stream channel.

The use of SASS5 within a palustrine wetland system is not ideal. A system for use in wetlands is currently being developed through the Wetland Health research project based at the University of Cape Town.

### 11.2.6 Vegetation

Vegetation has been used extensively as an indicator of the presence and classification of wetland types (US Environmental Protection Agency, 2002). The relatively high levels of species richness, rapid growth rate, and direct response to environmental change of wetland plant species also make plants excellent indicators of wetland condition (US Environmental Protection Agency, 2002). It should be noted that external specialists would generally be required to accurately identify the wetland species present within the system being monitored.

*Vegetation survey*

This technique of monitoring vegetation is designed to establish which vegetation communities occur in a wetland system. It offers a coarse level of vegetation inventory that can serve as a starting point for finer and more detailed monitoring. There are two components to this monitoring technique, which will produce a baseline vegetation map. The components include:

- definition of the vegetation types (sedge meadow, wet grassland) within the wetland
- field assessments of each vegetation type detailing the composition and relative contribution of the species present to the communities, and
- description of the hydric and invasive status of the dominant species.

*Equipment required:*

- recent aerial photograph of the wetland (if available)
- contour data
- geographic information system (GIS)
- global positioning system (GPS)
- compass
- camera
- plant press
- voucher specimen bags, and
- tape measure.

*Method:*

There are two broad tasks involved when undertaking a vegetation inventory:

- initial mapping and site selection
- baseline vegetation survey.

The vegetation survey should be scheduled to take place in the growing season when the vegetation is easily identifiable from inflorescences. The different vegetation types within the wetland should be mapped off the available aerial imagery, based on texture, tone, colour and canopy spacing. The boundaries of these broad vegetation types (sedge meadow, wet grassland, open water, emergent reeds) should be verified using a GPS on site.

Transects should be set up across the wetland (Figure 11.2) as a means of sampling the different vegetation types within the wetland. The transect endpoints should be recorded with a GPS and the bearing of the transect should be recorded using a compass. These points should be permanently identified by iron fencing standards firmly planted

in the ground. A photograph should be taken at each end of the transects in the direction of the transect prior to sampling. Sampling would be conducted by recording the information along the transect within each vegetation type. The following information should be recorded within each vegetation type:

1. vegetation

- the length of the transect occupied by the different vegetation types represented
- the five dominant species per vegetation type
- the life form of the represented species
  - creeping (e.g. *Cynodon dactylon*)
  - tufted (e.g. *Juncus effusus*)
  - uniform (e.g. *Phragmites australis*)
- aerial cover abundance.

2. GPS location

It is important to record the GPS location and physical description of each site to ensure the repeatability of the sampling.

### 11.2.7 Aesthetic outcomes

This method of monitoring wetland rehabilitation determines the visual appearance of the vegetation prior to and following the rehabilitation activities. A photographic record is an ideal method of documenting visual changes within the wetland system and this is considered to be a minimum requirement for all projects (Rutherfurd *et al*., 2000). A series of photographs should be taken to track broad-scale changes in vegetation in a wetland prior to management as this serves as a valuable resource once changes in the wetland are observed. Panoramic photographs from a high vantage point, combined with permanently established photo-points provide good coverage of the wetland. It is important to note that the use of a digital camera is preferred as the images can be readily stored in an IMS data base for later retrieval by any party wishing to compare the current situation with the historic conditions.

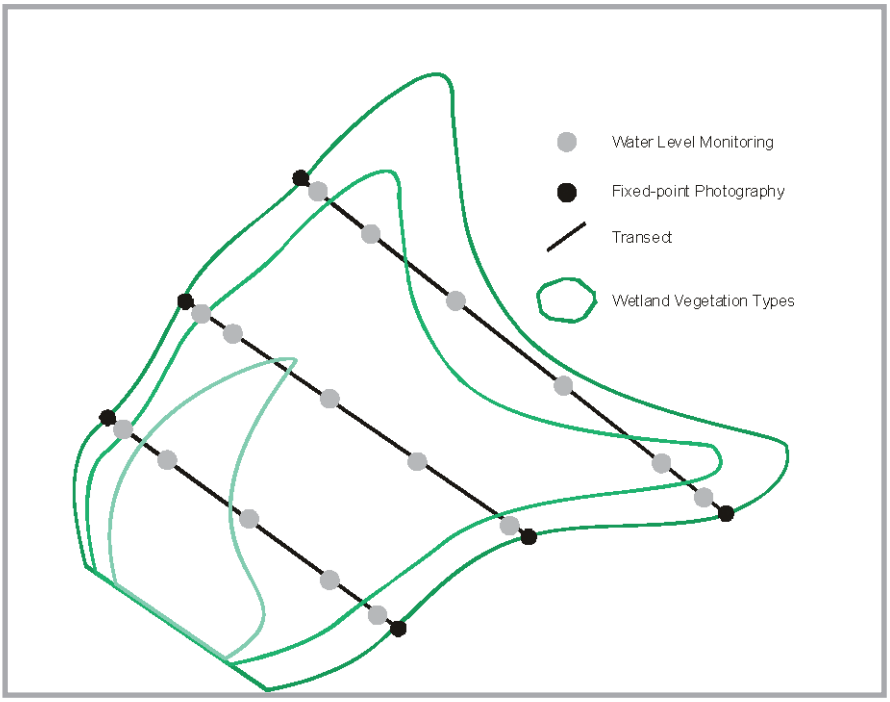



**Figure 11.2: A wetland divided into vegetation types with transects and fixed point photography points**

The running example

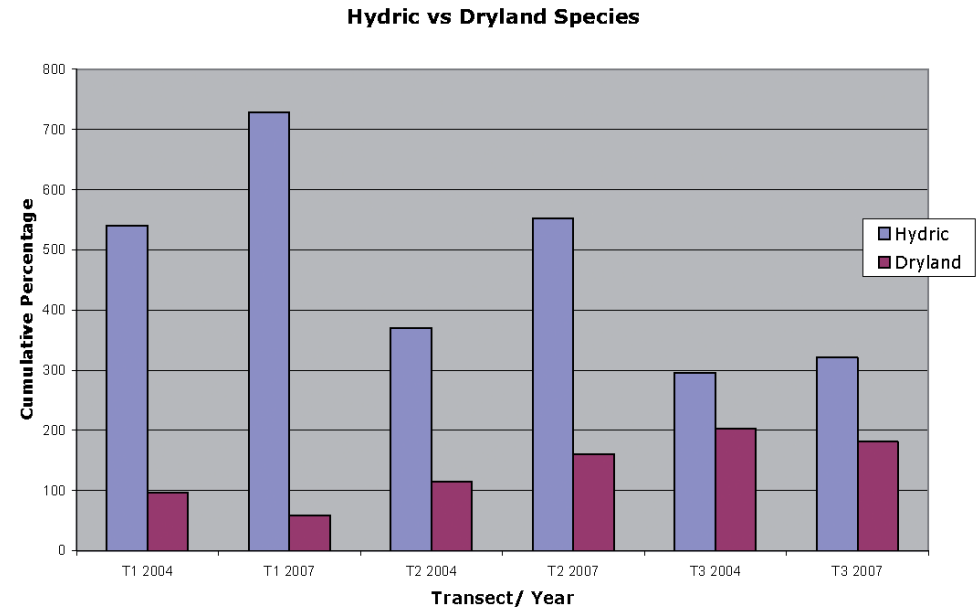
Vegetation was monitored along three of the transects described in the above description of the water level monitoring. The vegetation survey was used to determine the vegetation communities that occur in the Killarney wetland system including:

- definition of the vegetation types (sedge meadow, wet grassland) within the wetland
- field assessments of each vegetation type detailing the composition and relative contribution of the species present to the communities, and
- description of the hydric status of dominant species.

A series of 5 m x 5 m quadrats were sampled at intervals along each transect across the wetland. The position of the quadrats coincided with discernable changes in vegetation type.

Vegetation communities in wetlands tended to follow a gradient in response to varying degrees of wetness, resulting in zones of particular vegetation types within the wetland. At Killarney the wetland margins tend to be dominated by terrestrial species, and the next zone of wetness, the temporary to seasonal zone, was dominated by wetland facultative grass species. The wetter seasonal to permanent zone was dominated by obligate wetland species.

The percentage cover of each plant species within each quadrat was recorded in 2007 and plotted against that recorded for the related quadrat in 2004. The wetland was considered to be wetter in 2007 than in 2004, as shown by the water level monitoring, which is supported by a response in the vegetation within the rehabilitated portion of the wetland.



*Equipment required:*

- digital camera and tripod
- ranging rod
- fencing standards
- compass
- tape measure, and
- GPS.

Setting up permanent photo-points in wetlands is a two step process:

1. Establish a series of panoramic photographs from permanent features to cover large areas of the wetland.
2. Establish permanent photo-points within the area covered by the panoramic photograph. These should be of specific features within the wetland system that are monitored over time (open water, vegetative structure).

*Locating photo-points*

The following guidelines should be followed when locating photographic points across the wetland system for panoramic and fixed point photographs:

- to record changes in the distribution of large emergent vegetation it is important to take panoramic photographs in the areas where a possible change in distribution can potentially take place;
- photo-points should be selected at various locations throughout the rehabilitation site and at points that will be easily accessible at all times (Rutherfurd *et al.*, 2000);
- record the geographical coordinates of each point, with a mapping grade GPS, accurate to less than two metres. This provides any individual with the information required to navigate to the exact location of each photo point;
- a permanent field marker must be placed in the ground at each point, to ensure that photos are always taken from exactly the same point. If possible the orientation of the photo at the point should be recorded on the marker (Kotze *et al.*, 2001; Diers, 2000);
- find locations that include sites close to and at a distance from the wetland inlet, or in both constricted and open water areas, as these may respond differently to rehabilitation; and
- for each location fill in a site location data sheet.

*Panoramic photographs*

The following guidelines should be followed when taking panoramic photographs for monitoring purposes. The photographs should:

- be able to pick up changes in vegetation that occur over large areas of the wetland and in locations that continue to provide information even if the emergent vegetation in the wetland expands
- be taken at a relatively high vantage point so that a photograph series can be taken in the future if the emergent vegetation expands
- include the sky-line in each photograph to provide perspective
- provide a measure of relative height, by erecting a ranging rod at a set distance
- record the location of certain long term features (fence poles, rocks) within the photograph, to ensure that photographs are taken of exactly the same area. It is also preferable to include views of the rehabilitation structures (Diers, 2000). The initial photographs should be laminated and taken into the field as a reference during subsequent monitoring
- record the direction in the panoramic series, to ensure that the same frame is taken repeatedly each time you return to the site.

*Fixed point photographs of specific features*

The following guidelines should be followed when implementing fixed point photography for monitoring purposes:

- the orientation of the photographer should be recorded (Kotze *et al*., 2001).
- The same camera, lens and zoom should be used each time, and if this is not possible, record the settings used. The camera should preferably be located on a tripod at a fixed height (Kotze *et al*., 2001).
- The photographs should be taken annually at roughly the same time of year and at the same time of the day, and under similar weather conditions (Kotze *et al*., 2001). This would limit the variability of the wetland habitat that is associated with vegetative and hydrological changes linked to seasons.
- A standard object, such as, a soil auger or a metre rule should be included in the photograph as a reference for scale (Kotze *et al*., 2001; Diers, 2000).
- Relevant information about factors that may influence features in the photograph (e.g. a recent fire, late or early rains) should be recorded, especially those relating to the appearance of the site (Kotze *et al*., 2001).
- Two photographs should be taken from each of the permanently marked sites, one on either end.
- A data sheet containing information outlined in Appendix 1, should be filled in for each photograph.
- Photographs should be taken seasonally and compared with baseline survey photographs.
- Additional photographs should also be taken when major changes in the vegetation community are observed.

*Aerial photography*

The use of aerial photography as a means of documenting the changes within a wetland system and its catchment relies on recent imagery being available for periods before and after the planned intervention. In cases where this is available the imagery provides a large scale overview potentially showing dramatic changes over time. As with fixed point photography it is preferable for the aerial photography to have been flown at the same time of year. This will ensure that the visible differences are related to the planned intervention rather than seasonal variations within the system.

As well as monitoring the visual changes to a wetland system, the following indicators could also be monitored using remote sensing techniques (Grundling and van den Berg, 2004):

- erosion
- sedimentation
- exposed soil
- open water
- wet surface area (areas that are visibly wet, but do not contain open water)
- water quality in terms of turbidity
- distribution of different vegetation types, and
- alien vegetation.

Monitoring of wetland characteristics using remotely sensed data is limited by scale and the fact that the majority of the indicators are measured in terms of spatial extent or variation. The clustered nature of the WfWetlands projects, however, could greatly decrease the potential costs relating to the monitoring of specific indicators. Remote sensing data, which comprises aerial photography and satellite imagery, could therefore potentially be used to monitor wetland rehabilitation projects. Grundling and van den Berg (2004) outline the various aerial imagery systems within South Africa and the availability of the information.

### 11.2.8 Social outcomes

Social outcomes generally refer to the socio-economic benefits of wetland rehabilitation activities including those that relate to livelihoods and the perceptions and participation of stakeholders. The following are considered to be indicators for the monitoring and evaluation of social outcomes:

- livelihoods (Nkoko and Macun, 2005)
- participation, perceptions and understanding.

It is important to monitor these social outcomes:

- if these have been included explicitly in the rehabilitation objectives, e.g. promote increased awareness of the value of wetlands amongst local people, and
- if social factors have been highlighted as being particularly important to the long term sustainability of the rehabilitation.

Monitoring of social indicators is reliant on the facilitation of workshops, interviews and meetings with participants and stakeholders, using standardised questions to obtain the relevant information. Nkoko and Macun (2005) outline an approach to implementing the monitoring of social indicators.

*Livelihoods*

Livelihoods are considered to be the capabilities, assets and activities required for a means of living. The improvement of people's livelihoods is considered to be one of the core outcomes of the implementation of wetland rehabilitation activities within the WfWetlands programme. In addition to the monitoring of the information outlined for social outputs, Nkoko and Macun (2005) identify the importance of recording the following information in order to establish a baseline for the monitoring of socio-economic outcomes:

- level of education
- previous income earned, and
- work history (occupation, income, and duration).

All the information relating to social aspects of wetland rehabilitation should be recorded for individuals and stakeholders before and after the commencement of the projects, ensuring the presence of baseline and monitoring data to facilitate comparisons of social conditions before and after implementation (Nkoko and Macun, 2005). Nkoko and Macun (2005) identified the lack of information prior to the commencement of the WfWetlands projects as problematic for the evaluation of the social aspects of the programme. In this instance, however, useful data can be derived from comparisons between people currently employed by the programme and unemployed people within the community (Nkoko and Macun, 2005).

The provision of reliable and formal employment to people within a community assists in the provision of a dependable income. This income would then form the basis for improved nutrition, education and medical assistance. The monitoring of earnings before and after the implementation of wetland rehabilitation activities as well interviews and workshops would provide data to assist in determining the project's role in improving people's livelihoods.

The provision of formal employment as well as the training of individuals involved in the wetland rehabilitation projects could provide people with an improved sense of well-being derived from improved knowledge, increased confidence levels and access to medical assistance (Nkoko and Macun, 2005). Monitoring would consist of interviews and workshops to determine the perceptions of the community members with regard to their well-being.

The degree to which community members are considered to be vulnerable to poor livelihoods is likely to be improved by their involvement in wetland rehabilitation projects. The wetland rehabilitation projects would provide dependable income and training. Nkoko and Macun (2005) highlight that this could result in improved food security and investment opportunities (e.g. housing). Monitoring would consist of interviews and workshops to determine the perceptions of the community members with regard to their vulnerability.

Rehabilitation projects may reduce the vulnerability of local livelihoods by contributing positively to the provisioning services of a wetland. A detailed assessment of the livelihood benefits that have resulted from rehabilitation of a rapidly eroding wetland is provided by Pollard *et al*. (2009). This assessment examines the effect of the rehabilitation on the provisioning services (including crop and reed production, water for domestic purposes and livestock, and grazing). The approach used by Pollard *et al*. (2009) in the assessment could be adapted for other sites.

*Sustainable utilisation of natural resources*

Rural communities are often dependent on the environment for the provision of various resources to assist with maintaining and improving their livelihoods. The following are examples of the resources used by communities:

- water for drinking, washing and irrigation
- areas for the cultivation of specific crops
- clay material for manufacturing utensils and building material
- plants for manufacturing craft items and building material
- areas for the grazing of livestock
- animals
- medicinal plants.

In some instances there may be significant opportunities for the reduction of poverty and the promotion of sustainable livelihoods within communities through the sustainable utilisation of wetland resources. However, it should be noted that prior to the setting of such objectives for wetland rehabilitation projects, an assessment should be made to establish the relationship between a community's livelihood strategy and the wetland ecosystem. This is considered to be essential to determine if the community actually utilises the available wetland resources available and to what degree this contributes to the livelihoods of the community. This study would also provide baseline data for subsequent monitoring. It is important to note that post-rehabilitation management and monitoring should be planned so as not to compromise the livelihood strategies of the surrounding communities should there be a dependence on the wetland ecosystem. For example, if the degradation of the wetland habitat is a result of overgrazing, management recommendations should include a grazing strategy, rather than excluding livestock from the area.

*Participation, perceptions and understanding*

The participation, perceptions and understanding of stakeholders in wetland rehabilitation and other aspects of sustainable wetland management are critical to the long term sustainability of the rehabilitation process. The level of participation of different parties involved in the rehabilitation activities should be assessed in all projects. The following framework of WOCAT (1997) can be used (Table 11.6).

The participation of each of the key stakeholders should be assessed, based on the WOCAT framework, for each of the different phases of the project from

initiation to monitoring and evaluation. This framework and its application to six different sites are described in detail in Nxele and Kotze (2009), and an example is given in Table 11.7.

If a rehabilitation project has a specific objective to raise awareness then monitoring will be required in order to assess how effectively this has been achieved. The following are the common methods of promoting awareness and understanding about wetlands and the need for effective management and rehabilitation, and should be reported upon:

- field visits
- distribution of posters, pamphlets and other resources
- schools visits
- community hall meetings
- meetings with community structures and leaders, and
- articles in local newspapers
- bulletins.

However, these may not lead to increased awareness in themselves. Thus, the extent to which discussion about the wetland and the merits of different management and rehabilitation options took place amongst the different stakeholders should be

**Table 11.6: Types of Participation by Different Stakeholder Groups described in the WOCAT (1997) framework**

| | |
|---|---|
| Passive participation | People participate by being told what has been decided and has already happened. It involves unilateral announcements by an administration or project management who do not listen to people's responses. The information offered belongs only to external professionals. |
| Participation in information giving | People participate by answering questions. They sometimes do not have the opportunity to influence proceedings and project findings are neither shared nor checked for accuracy. People participate by providing information necessary for planning, implementing, monitoring and evaluating a project. |
| Participation by consultation | People participate by being consulted or by answering questions. External agents define problems and information-gathering processes and so control analysis. This process does not concede any share in decision making and professionals are under no obligation to adopt people's views. |
| Participation for material incentives | People participate by contributing resources, e.g. labour, in return for food, cash or other material incentives. |
| Participation as a partner | People participate as partners in an initiative, and are fully involved in the decision-making process and in initiating new ideas (also referred to as self-mobilisation). |

**Table 11.7: Type of Participation by different Stakeholder Groups within the Ntsikeni Wetland Rehabilitation Project**

| Types of participation | Phases of the project | | | | |
|---|---|---|---|---|---|
| | initiation | planning | implementation | monitoring | evaluation |
| Passive participation | [HWR] | [HWR] | [CW] [HWR] | | |
| Participation through information giving | [RM] | [RM] [TA] | [RM] | | |
| Participation through consultation | | [RM] | [TA] | | |
| Participation for material incentives | [HWR] | [HWR] | [CW] [HWR] | [HWR] | [HWR] |
| Participation as a partner | [TA] [RM] | [RM] [WfWet] [WRCP] | | [WRCP] [WfWet] | [WRCP][WfWet] |

TA=Traditional Authority; RM=Ntsikeni Reserve Management; CW=Contract Workers; HWR=Highlands Wetland Rehabilitation; WRCP=Water Research Commission Project; WfWet=Working for Wetlands

Note: the running example, the Killarney rehabilitation project, is part of the overall Ntsikeni project given above

reported on. In addition, if training courses or workshops are held then feedback from those attending the training or workshops should be solicited and recorded. Individual people within the community should also be approached and asked if they have learnt anything new since their participation in the wetland rehabilitation project. Finally, it should be added that increased awareness will not necessarily lead to improved management and land-use practices. Thus, it is also important to carry out the assessment given in the following section.

### 11.2.9 Land use activities in the wetland and its catchment

Land use activities within the wetland and the catchment may have a fundamental influence on the functioning of the wetland and the success of the rehabilitation measures (Kotze *et al*., 2001). Wetland degradation by direct or indirect impacts that are not addressed could result in the on-site efforts to rehabilitate a wetland being wasted (Kotze *et al*., 2001).

Factors affecting the quality, quantity and timing of runoff from the wetland's catchment should be closely monitored and these include:

- cultivation (agriculture and plantation forestry)
- burning, and
- grazing.

The occurrences of these activities are subject to wetland management specifications that are outlined in the wetland management plan that is compiled as a component of the wetland rehabilitation process. The compliance of the management of the wetland area with the management guidelines is be evaluated following the completion of wetland rehabilitation projects.

Monitoring land use activities is particularly important in those instances where these activities were identified as contributing to the degradation of the wetland system being rehabilitated. *WET-EffectiveManage* (Kotze and Breen, 2009) provide a set of 15 indicators that can be utilised to rate the management effectiveness of the wetland. One of these indicators is shown as an example in Table 11.8. The management effectiveness assessment for the wetland should be undertaken for the following scenarios:

- prior to the implementation of the rehabilitation, and
- following the implementation of the rehabilitation activities.

Comparisons of the results would then be utilised to assess if the overall management of the wetland has been improved. This was undertaken for several wetlands, and is reported by Kotze and Breen (2009).

**Table 11.8: An indicator and criteria for scoring management effectiveness outlined by *WET-EffectiveManage* (Kotze and Breen, 2009)**

| Indicators | Criteria | Score |
|---|---|---|
| 3. Management plan<br>Is there a management plan for achieving the objectives? | There is no management plan for the wetland | 0 |
| | A management plan exists but it is very seldom used | 1 |
| | A management plan exists and is occasionally used but is seldom if ever revised | 2 |
| | A management plan exists and is being regularly used and periodically revised to incorporate new learnings and altered circumstances | 3 |

Note: the full framework with all 15 indicators is given in Kotze and Breen (2009)

# 12. ASSESSING THE OVERALL PERFORMANCE OF REHABILITATION AT A WETLAND SITE

## 12.1 A framework for assessing overall performance

Let us assume that rehabilitation at a site has been monitored over the specified time period required to make a meaningful evaluation of the project. The monitoring results have been used already to identify problems and needs for corrective action during the implementation of the project. Now is the time to use all the results of the monitoring, and to pull the different dimensions of the project together into an overall evaluation, with a dual purpose.

1. To provide structured reflection on the project. Highlighting key lessons learnt (one generally learns more from mistakes than successes) encourages progressive improvement in the rehabilitation work undertaken. At the very least, lessons should be learnt by the organisation implementing the rehabilitation and this should contribute to enhancing further work undertaken at the site. If possible, these lessons should, through effective communication, also enhance the work undertaken at other sites and by other organisations.
2. To allow well-informed statements to be made about the achievements/worth of the project, which is the main focus of this section of the document.

It is important at this stage to avoid a simple evaluation of a project as having either succeeded or failed. This misses the opportunity to provide a richer evaluation with far greater opportunities for enhancing learning. To achieve the dual purpose described above it is necessary to examine several elements (Table 12.1) with each element elaborated upon in the following sections.

## 12.2 Location within a broad scale context

The importance and contribution of the rehabilitation at a broad scale (e.g. national, provincial and overall catchment) should be considered. This would apply particularly to wetlands rehabilitated within broad-scale programmes (e.g. a

**Table 12.1: Key elements in the assessment of overall performance of a wetland rehabilitation project**

| Key elements | Key questions contained within the key elements |
|---|---|
| Location within broad scale context | • Was the procedure for prioritisation of the project effectively aligned with higher order objectives (e.g. national biodiversity conservation)? |
| Participation and integration in the project | • Was there a defined procedure for identifying stakeholders and promoting participation?<br>• Was the procedure implemented?<br>• Of the identified stakeholders, what proportion considered the process to be inclusive?<br>• Was there meaningful involvement of local people across as much of the project phases (i.e. initiation, planning, implementation and evaluation) as possible?<br>• Were there defined procedures instituted for promoting the long-term protection and wise use of the wetland?<br>• Have the stakeholders who possess specific responsibilities in relation to the wetland demonstrated commitment to implementation of these procedures? |
| Planning and design | • Were the rehabilitation plans and designs technically appropriate and cost effective for achieving the project objectives and with an acceptably low level of risk? |
| Implementation process | • Was the work carried out efficiently and according to safety and environmental requirements (in the case of WfWetlands, these would be outlined in Best Management Practices)? |
| Outputs | • Were the outputs specified in the rehabilitation plan (and any corrective actions identified) completed to specification and at the appropriate time? |
| Outcomes | • Were the outcomes specified in the management objectives achieved?<br>• Has the project yielded good returns on investment (including a consideration of any unintended social and environmental impacts)? |

national wetland rehabilitation programme or a catchment conservation programme). Here it is important to ask whether the procedure for prioritising the site/s selected for rehabilitation was effectively aligned with the higher order objectives of the particular programme/s. For example, if a key national objective is to achieve adequate representation of the diversity of different wetland types present in the country, then it would be important to ask whether the sites selected were predominantly of wetland types subject to high cumulative loss. All other factors being equal, the rehabilitation of these sites would be considered to have higher returns than rehabilitation of wetland types subject to low cumulative loss.

It must be acknowledged, however, that answering questions in relation to broad scale objectives/spatial areas may be difficult because it requires data for these areas, and in many cases this data is lacking. It may also be that measurable objectives have not been set for the particular programme, which would make it difficult to undertake this particular assessment.

Furthermore, it may also be that a rehabilitation project is undertaken outside of such a programme (e.g. a single land owner decides to rehabilitate his/her wetland on a self funded basis), in which case it is much less important to scrutinize the project in relation to higher order objectives.

## 12.3 Participation and integration in the project

The social context of a wetland will vary greatly from one wetland to the next (e.g. a wetland under the ownership of a single private landowner compared with a wetland under multiple land owners or one under common property). In addition, wetland rehabilitation projects can evolve in very different ways. Some may take place primarily as small, local initiatives, while others involve various forms of partnerships between local and outside parties. Thus it is inappropriate to be too prescriptive about assessing participation in the rehabilitation of a wetland. However, we consider that there are a few key principles against which participation and integration of a project can be assessed (Table 12.2).

It is recognised that realistically it will not be possible to achieve the full inclusion of all stakeholders. It will also seldom be feasible to achieve a high level of participation of local people in all aspects of the project. Similarly, the full integration of the rehabilitation undertaken into the effective long term protection and wise use of the wetland may not be feasible. However, within the constraints of your particular project, were reasonable efforts taken to implement the principles? For example, were all the key stakeholders

**Table 12.2: Key principles and rationale for assessing the participation in wetland rehabilitation projects**

| Key principles | Rationale |
|---|---|
| The rehabilitation project should be inclusive of the key stakeholders affected by the rehabilitation. | Engaging stakeholders is particularly important during initiation and planning phases of the project. Stakeholders may potentially have some very good ideas in terms of key issues and possible rehabilitation solutions. In addition, engaging stakeholders will assist in surfacing early in a project any unintended social and environmental impacts that may result from the rehabilitation. Support from the different stakeholders for the rehabilitation project is also considered important for the long-term sustainability of the project. |
| There should be meaningful involvement of local people across as much of the project as possible (initiation, planning, implementation, and monitoring and evaluation). | Local people, particularly the landholders and land users of the wetland in question, generally have the most direct effect on the state of a wetland. Thus the involvement of these people is considered critical for the long-term sustainability of the project. |
| The rehabilitation project should be integrated into the effective long term protection and wise use of the wetland. | A wetland rehabilitation project may be very successful, but unless the factors causing degradation of the wetland are addressed through an effective management system for the protection and wise use of the wetland, the good work achieved in the project may be lost. |

given the opportunity to participate, even though some chose not to do so?

The key question to be addressed regarding the integration of the rehabilitation project is: 'To what extent did the rehabilitation take place within a management system that supported the long-term protection and wise use of the wetland?' The rationale for this question is that if measures to support the long-term protection and wise use of the wetland are weak and the wetland is being poorly managed, then the benefits of rehabilitation could readily be lost through further degradation of the wetland. (This applies particularly to situations where the land-use factors contributing to wetland degradation in the first place are not controlled.) Consequently, the investment in the rehabilitation of the wetland would be wasted. It is suggested that the concise framework of Kotze and Breen (2009) consisting of 15 key questions for assessing how effectively wetlands are managed be used to assess the effectiveness of the management system at the site.

## 12.4 Planning and design

In order to be able determine whether the plan (and the specific designs linked to the plan) were technically appropriate for achieving the intended outcomes of the rehabilitation project (as specified in the objectives), it is necessary to first assess the achievement of the outcomes of the project (Section 12.8). Failure to achieve the intended outcomes may, at the highest level, be due to problems with the planning and design of the project or alternatively due to problems with the implementation of the project. Understanding where the problems lie is critical to being able to improve future rehabilitation work. Thus, it is also necessary to assess the level to which planned outputs have been implemented according to the specifications contained in the plan (Section 12.7). If a plan was implemented to specifications and it still fails to achieve the desired outcomes, then this indicates that there were problems with the original plan and design/s. Thus, although planning and design is undertaken near the beginning of a rehabilitation project, it is one of the last things to be assessed when evaluating a rehabilitation project.

## 12.5 Minimising the risks that the intervention will not survive

Evaluating whether adequate consideration was given to the risks that the intervention will not survive cuts across both the planning and implementation phases of a project. While it is recognised that unpredictable events may have a major bearing on the survival of an intervention, some key considerations are required to minimise the risks of failure (Table 12.3). These considerations have relevance to both planning and implementation. Related to timing of the intervention is the issue of how risk is dealt with when there are delays in implementation. For example, a vulnerable activity in a high risk setting (e.g. sloping of a headcut) is scheduled to take place during the season when risks are lowest. However, owing to delays, the low risk season is missed, which is likely to require postponing the project to the following year to prevent the vulnerable activity taking place in the high risk season.

When evaluating a project, and interventions are discovered that have not survived, the following directed enquiry based on the considerations of Table 12.3 should be evoked in order to help establish the causes of the failure.

- Was the intervention in an unnecessarily high risk location, e.g. on the bend of a channel where the risk is high rather than on a straight portion of the channel where the risk would be lower?
- Did vulnerable activities take place during a high risk season?
- Did the type of intervention carry unnecessarily high risks?

Table 12.3: Key considerations relating to the risks that a wetland rehabilitation intervention will not survive

| Key considerations | Associated rule of thumb |
|---|---|
| Some locations in the wetland have much higher erosion hazards, and therefore higher risks, than others. Notable factors contributing to erosion hazard are high energy flood events and erosive soils. | Interventions should be in locations with as low a risk as possible, recognising, however, that sometimes the problem is such that there is no lower risk location available. |
| Some seasons (notably those in which the major storm events are most likely to occur) are more prone to high energy events than others. | Any vulnerable steps in the project should not be in a season with a high risk but rather be confined to the low risk season/s. |
| Some types of interventions have much higher risks than others. | Select those types of interventions with an acceptably low level of risk for the particular location. |

## 12.6 The process of implementation

The focus of this component is on how the work was implemented, particularly in relation to health and safety and environmental requirements. In the case of WfWetlands, these requirements would be outlined in WfWetland's Best Management Practices (BMPs), and the evaluation in this component would report on the level to which the BMPs have been followed. This component of the evaluation draws primarily on the results of the Level 1 monitoring. The level to which monitoring took place during the course of the project and the extent to which corrective action was required would also form a part of this component of the evaluation.

It is important to examine whether effective monitoring and the identification of corrective actions took place as they play an important role in the implementation process. With regular monitoring and the timeous identification of corrective action, problems can be identified early in the project, allowing the problems to be more efficiently and effectively corrected than if they were identified late in the implementation of the project, by which time it may be too late or too expensive for corrective action.

Another important aspect of evaluating the process is to examine whether the various individuals had the necessary capacity to fulfil their responsibilities in implementing the project. Participation in the rehabilitation process is assessed in Section 12.3.

## 12.7 Outputs

This component of the evaluation examines the level to which the outputs specified in the rehabilitation plan have been completed to design specifications. It also draws primarily on the results of the Level 1 monitoring. It may be, however, that during the course of the project modifications to the designs are required. For example, during the course of the implementation of the project, a flood event may cause the widening of a gully, requiring that the erosion control structure planned for the gully be widened by a corresponding amount. In cases such as these, the original plan would be modified accordingly (in the case of WfWetlands this modification would require approval). The evaluation would then be against the modified plan.

If the planned outputs have not been achieved, it is important to ask the question: Why did this happen? To answer this question it is useful to examine the results of the evaluation of the process (i.e. Section 12.6), where it may, for example, be revealed that the project manager was very inexperienced and there was very little monitoring of implementation, leading to corrective actions being identified 'too late'.

The evaluation of outputs is important from a financial accountability point-of-view by checking that the work completed is commensurate with that in the plan and for which expenditure has been incurred. If, for example, only half of the structures that had been planned and paid for were physically present on the ground then this would be revealed by an evaluation of outputs.

## 12.8 Outcomes

### 12.8.1 Outcomes assessed in relation to defined objectives

Linked to each of the intended outcomes of a project (as specified in the project objectives) are indicators with specific threshold levels that were defined before the commencement of the project. In order to determine the level to which the intended outcomes of the project were achieved now requires a determining of the extent to which the indicators fall within the predefined performance thresholds, which draws directly on the results of the Level 2 monitoring.

The objectives provide a critical point of reference against which the level of success of a project is gauged. However, it must be added that if a project has not stuck rigidly to its original objectives, this does not necessarily mean that it has not been successful. Enhanced understanding of the system during the course of the rehabilitation project may have required an adjustment of the original objectives. For example, in a project with the original objective of raising the water table across 80% of the wetland, it is discovered that abstractions from the wetland's catchment have reduced available water, requiring that the area be reduced to 60%. Thus it would be against the 60%rather than the 80% that the success of the wetland project is evaluated.

### 12.8.2 Outcomes assessed in terms of returns on investment

It is important to emphasize that a project that has successfully achieved its objectives but at a relatively high cost may not necessarily be considered a successful project. It is important now to also examine the outcomes achieved against the investment costs of the project and any unintended ecological and social costs of the project.

A procedure for describing outcomes of rehabilitation is outlined in Section 11.2. This involves using *WET-Health* to describe the reinstated integrity, and *WET-EcoServices* to describe any enhancement in the delivery of ecosystem services, which are utilised to derive hectare equivalents to assist in evaluating project success.

When conducting an evaluation of returns on investment, one should ideally like to compare the costs and benefits in the same currencies. However, this is generally very difficult to achieve because there are economic, ecological and social aspects to consider. Even so, it is important that both costs and benefits are considered in the final evaluation of a project, even if in different 'currencies'. A summary table provides a useful means of doing this (Table 12.4). In the example given in Table 12.4, although the different characteristics included are not all expressed in the same currency, a comparison can be made. It can be seen that of the three projects, all having the same costs, the rehabilitation of Wetland A clearly has resulted in the greatest benefits in terms of area of intact wetland reinstated and the enhanced provision of wetland benefits. Wetland C stands out in terms of its poverty relief benefits.

For example, if the integrity of an 8 ha wetland before rehabilitation is 25% then this equates to 2 hectare equivalents (8 ha x 0.25). If the integrity after rehabilitation

is 75% (i.e. 6 hectare equivalents), then 4 hectare equivalents (6 ha – 2 ha) would have been reinstated.

When assessing the cost effectiveness of a rehabilitation project, it is useful to ask a question similar to that posed when the feasibility of the rehabilitation measures were assessed in the planning stages of the project (see *WET-RehabPlan*). The question now stands: "*Did the individual interventions in the project work well together to cost effectively produce the desired outcome?*" If a project consisted of several interventions, it is helpful here to screen each of the interventions in terms of their contribution to the rehabilitation objectives. In so doing, it may be revealed that some of the interventions contributed much less to the overall objectives than others, in some cases to the extent that they could have been omitted.

However, as indicated in *WET-RehabPlan* it is important to remember that although most interventions contribute directly, some interventions are designed to give support to other interventions and therefore contribute indirectly, but in a critical way, to the objectives (e.g. Structure A prevents erosion from undercutting of Structure B). It is important to remember also that cheaper alternatives can often carry higher risks than more costly interventions (see Section 12.5) and that their level of risk may be considered to be unacceptably high.

**Table 12.4: Summary of some of the main benefits and costs of three hypothetical wetland rehabilitation projects**

| | | Wetland projects | | |
|---|---|---|---|---|
| | | A | B | C |
| Hectare Equivalents | Hectare equivalents of hydrologic integrity that have been re-instated/secured | 35 ha | 10 ha | 10 ha |
| | Hectare equivalents of geomorphic integrity that have been reinstated/secured | 0 ha | 5 ha | 0 ha |
| | Hectare equivalents of vegetation integrity that have been re-instated/secured | 8 ha | 2 ha | 2 ha |
| **Total Costs of carrying out the project** | | R1 200 000 | R1200 000 | R1200 000 |
| Cost per Hectare Equivalent | Hectare equivalents of hydrologic integrity | R34 285 | R120 000 | R120 000 |
| | Hectare equivalents of geomorphic integrity | - | R240 000 | - |
| | Hectare equivalents of vegetation integrity | R150 000 | R600 000 | R600 000 |
| Ecosystem Benefits | Improvement in the provision of benefits by the wetland: nutrient and toxicant assimilation | Intermediate increased to mod high | Intermediate increased to mod high | Intermediate increased to mod high |
| | Biotic integrity | Intermediate increased to mod high | Intermediate increased to mod high | No improvement |
| | Provision of harvestable resources | Mod low increased to Mod high | No improvement | No improvement |
| Job Creation and Employment | Wages for the unemployed | R300 000 | R300 000 | R450 000 |
| | Permanent jobs created | 0 | 0 | 2 |
| Unintended ecological and social costs of the project | | Slight reduction in area sufficiently dry to cultivate | None known | None known |

**The running example**

In order to assess the entire rehabilitation process within the Killarney wetland the information was recorded taking into consideration improvements in wetland ecosystem delivery and integrity and the cost of the interventions implemented to achieve the gain in functioning wetland area.

| Cost of Interventions | Affected area (ha) | Consolidated Hectare Equivalents Gained | Cost-effectiveness(R/ ha) |
|---|---|---|---|
| R1 785 300 | 57.5 | 8 | R233 163 |

The cost effectiveness of the project could be considered as moderate taking into consideration the following table utilised in the planning process:

| Cost of rehabilitation interventions per hectare of reinstated/ secured intact wetland | Likely cost-effectiveness |
|---|---|
| < R50 000 per ha | The cost-effectiveness of the project is likely to be high. |
| R50 000-R150 000 per ha | The cost-effectiveness of the project is likely to be intermediate to high. |
| R150 001-R300 000 per ha | The cost-effectiveness of the project is likely to be moderate but can be justified if returns in terms of ecosystem system delivery are moderate to high. |
| R300 001-R500 000 per ha | The cost-effectiveness of the project is likely to be low to intermediate, but can be justified if benefits are high. Therefore, benefits would need to be well justified. |
| >R500 000 per ha | Cost-effectiveness of the project is likely to be low. Such a project would need to be extremely well motivated such that it could only be justified if benefits are exceptionally high. |

While the return on investment may be considered to be moderate while taking into consideration the expenditure to gain the specified hectare equivalents, it is important to note that the wetland occurs within a formally protected nature reserve. Generally, the wetland rehabilitation planned within the Killarney wetland comprised activities that were attempting to restore ecosystem service delivery and ecological integrity. Observations of rehabilitation activities currently being implemented within South Africa suggest that these activities are more expensive than stabilisation of active erosion within wetlands. In those instances where the rehabilitated wetlands form part of larger protected areas, generally it is acceptable to spend additional funds, restoring rather than merely stabilising degraded wetland systems to contribute towards the maintenance of biodiversity.

## 13. REPORTING MONITORING AND EVALUATION RESULTS

*"It is important to implement project evaluation and monitoring in a way that will both improve the project as it proceeds and that will help improve future projects."*
(Woodhill and Robins, 1998)

The results from the various levels of monitoring and the different performance indicators must be recorded on appropriate monitoring sheets. This information should then need to be captured in the IMS to be analysed and utilised for the evaluation of each project. The IMS allows for the retrieval of monitoring reports for the various performance indicators, and the evaluation of the projects based on these reports. The results of the monitoring should be made available to the evaluator requiring the information in the form of reports. The reporting on the performance evaluation for wetland rehabilitation

projects is the final component of the wetland rehabilitation process (see Figure 3.1). This is of utmost importance, as the information collected during the monitoring and evaluation of each project would be of little use to the project implementers if it were not appropriately interpreted and presented. The method of reporting needs to be balanced so as to be appropriate for all people involved or interested in wetland rehabilitation, including project implementers, funding agents, researchers and the public. This refers to the content of the report being easy to understand and interpret with respect to the monitoring and evaluation undertaken.

The evaluation of project performance, by merely highlighting the problem areas and not providing recommendations as to how to rectify these problems, is often seen as criticism of the project and the project manager. It is therefore important to highlight problems as well as to identify both the potential cause and a potential remedy or corrective action. The recommendations would be similar to the corrective actions outlined for the project outputs, with the required actions and objectives being set and subsequently monitored themselves. In some cases those problems relating to structural integrity would require input from a technician/engineer to design appropriate solutions to the problems. This would ensure that the evaluation process is associated with learning rather than with a policing process. This process should facilitate the dissemination of the lessons learnt amongst the people involved in the implementation of wetland rehabilitation projects, improving the overall implementation of wetland rehabilitation within South Africa. This would therefore require the input of wetland specialists, engineers and project implementers to ensure the performance evaluation information is accurately represented and that recommendations are appropriate.

The process of identifying appropriate remedial action for different wetland rehabilitation sites should also include the prioritisation of different sites for the implementation of these activities. This would ensure that the sites considered to be most important or requiring urgent intervention are targeted for maintenance first. It should be noted that in some instances the corrective action required and the envisaged return on implementing these remedial measures may be of little value to the wetland system. During the prioritisation of maintenance requirements, consensus should be reached between wetland specialists, engineers and project implementers as to which sites should be focused on and which should be left to stabilise naturally.

The presentation of results should focus on the use of graphics and illustrations rather than on data or copious reporting. The use of various icons for particular characteristics of the wetland system and the representation of these in various colours, based on performance, is recommended to allow the relatively easy and rapid review of available information. This reporting technique has been successfully used for reporting wetland assessment results e.g. The Highway Methodology (US Army Corp of Engineers, 1993 and US Army Corp of Engineers, 1999) and stream condition e.g. South African River Health Programme (Water Research Commission, 2002). The icons used should be based on the objectives of the project i.e. the outputs and outcomes. Table 13.1 represents some examples that could be used to represent project performance for some outputs and outcomes.

This information could be spatially represented with each of the required icons being displayed on a map of the rehabilitated wetlands within a project area. This would allow any interested person/s to quickly review an entire

projects performance relative to its desired objectives.

The representation of the results of monitoring and evaluation in this manner would allow various stakeholders to interpret the results of the wetland rehabilitation. In many instances the provision of detailed statistical data relating to the monitoring of wetland rehabilitation indicators would only serve to complicate the interpretation of the results and be of little use to the interested parties. The spatial and graphic representation of the information allows individuals to quickly assess the performance of a particular project.

**Table 13.1: Examples of project performance, and icons, rated for different outputs/outcomes.**

| Output/Outcome | Performance | Icons |
|---|---|---|
| Structural Integrity | Fair |  |
| Ecological Outcomes | Excellent |  |
| Ecological Outcomes | Poor |  |
| Aesthetic, Social & Production Outcomes | Good |  |

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# 15. GLOSSARY

| | |
|---|---|
| **Adaptive management** | A systematic process for continually improving management policies and practices by learning from the outcomes of operational programmes. |
| **Baseline monitoring** | Activities that determine the status quo within the wetland system prior to the implementation of rehabilitation interventions and allows for comparisons to be made before and after rehabilitation. |
| **Best Management Practice (BMP)** | Guidelines for the effective and appropriate management of wetland rehabilitation projects and compliance with the requirements of existing legislation. |
| **Corrective action** | Action required to correct problems identified during the monitoring process. Major corrective actions are those that are required due to non-compliance with legislation, Occupational Health and Safety requirements, BMPs, social responsibilities or the wetland rehabilitation objectives of the programme. Minor corrective actions are those that are required due to non-compliance with the rehabilitation plan and BMPs, but are not at a level significant enough to prevent the objectives of the project from being achieved. |
| **Ecosystem integrity** | A measure of how far a system has deviated from its historical, undisturbed reference condition. |
| **Ecosystem service** | The direct and indirect benefits that people obtain from ecosystems. These benefits may derive from outputs that can be consumed directly; indirect uses which arise from the functions or attributes occurring within the ecosystem; or possible future direct outputs or indirect uses (Howe *et al.*, 1991). Synonymous with ecosystem 'goods and services'. |
| **Evaluation** | Assessment of the effectiveness of a project against pre-determined objectives, usually based on monitoring (Rutherfurd *et al.*, 2000). |
| **Execution outputs** | Outputs that involve implementation of the proposed rehabilitation activities. |
| **Hectare equivalent of healthy wetland** | The health of a wetland expressed on a scale of 0 (pristine) to 1 (critically impacted) multiplied by the size of the wetland in hectares. |
| **Information Management System** | A means of digitally storing, accessing and reporting on recorded information collected during monitoring and evaluation. |

| | |
|---|---|
| **Level 1 monitoring** | Monitoring which focuses on the assessment of the project's attainment of survival outputs of the wetland rehabilitation interventions. |
| **Level 2 monitoring** | A rapid assessment, at a coarse level, of the project's attainment of the hydro-geochemical, ecological, aesthetic and production outcomes. |
| **Level 3 monitoring** | Assessment at a fine and relatively intensive level, of the project's attainment of the outcomes of the wetland rehabilitation activities. |
| **Major and minor corrective action** | See corrective action. |
| **Monitoring** | The regular, systematic gathering of information based on observations and measurement of change in wetland characteristics in relation to a pre-defined state, in order to provide the data for evaluation (Water and Rivers Commission, 2002). |
| **Objectives** | The desired outputs or outcomes of the rehabilitation project. |
| **Outcome** | Effect on wetland health and ecosystem services of an intervention in the rehabilitation process, often explicitly set out in the objective/s of the rehabilitation project. |
| **Output** | Physical intervention and its survival objectives (flood magnitude that can be withstood by the structure) as specified in the rehabilitation plan. |
| **Performance evaluation** | A measure of whether or not the objectives (ecological, social and economic) of wetland rehabilitation are being met. |
| **Performance indicator** | Attributes that are used to evaluate the progress of the system towards meeting the rehabilitation objectives (Streever, 1999). |
| **Success standard** | An observable or measurable threshold for a particular indicator for wetland characteristics as identified by the objectives, against which the rehabilitation project can be compared. |
| **Survival output** | The minimum requirements of physical interventions and their survival objectives (flood magnitude that can be withstood by the structure) as specified in the rehabilitation plan. |

# 16. APPENDIX 1: GUIDELINES FOR FIELD DATA SHEETS FOR MONITORING

It is important that the information captured for monitoring purposes is recorded in a standardised format. Generally, datasheets exist for capturing information for specific monitoring/assessment techniques, such as SASS5 or *WET-Health*, and it is recommended that the individual/s responsible for the monitoring utilise these datasheets to record site specific information. In those instances where datasheets are not standardised the user should ensure that the datasheets include the following information:

- Site name (a description of the project site)
- Wetland name (a description of the specific wetland that is being studied)
- Date (of the monitoring event). In some instances the time may need to be recorded, for example, when sampling for fish species the time of day can influence the numbers of individuals sampled)
- Observers (record the individuals involved in the monitoring, which in some instance may require a description of their qualifications to undertake the required studies)
- GPS location (recorded as latitude and longitude in WGS 84, decimal degrees with a description of the GPS receiver's accuracy). In the event that transects are utilised for sampling the GPS position of the start and end points of the transect
- Information relating to fixed point photography should be recorded to ensure that subsequent monitoring enables easy duplication of photographs in terms of location, direction and views.