ICMM
International Council
on Mining & Metals

Good Practice Guidance for Mining and Biodiversity






Good Practice Guidance for Mining and Biodiversity

Contents

Contents

Contents

Acknowledgements

This report was prepared by Sally Johnson, a private consultant. ICMM is very grateful to her for an excellent piece of work.

The first phase of work was carried out by ERM Australia, with the Australian Centre for Minerals Extension and Research (ACMER).

This project was conceived as a part of the IUCN-ICMM Dialogue. An ICMM-IUCN Advisory Group assisted ICMM in developing the Good Practice Guidance. The group consisted of Andrea Athanas (IUCN), Assheton Carter (Conservation International), Richard Cellarius (co-chair, Sierra Club), Peter Coombes (from January 2005, Anglo American), John Gardner (co-chair, Alcoa), Kristal Maze (South African National Biodiversity Institute), Andrew Parsons (ICMM), Robert Prairie (Falconbridge), Michael Rae (then at WWF Australia and now at the Council for Responsible Jewellery Practices), Dave Richards (Rio Tinto) and Phil Tanner (until December 2004, Anglo American). ICMM appreciates their guidance and support and the many hours they put into reviewing drafts.

While IUCN and some of its members assisted in the development, this Good Practice Guidance remains an ICMM product, and ICMM takes full responsibility for its content. It is designed to help ICMM members address biodiversity conservation in their policies and operations. Other business sectors are also welcome to use the guidance, as they may find it relevant and useful for their work.

It is important that management guidance be based on real experience. ICMM thanks the many reviewers and contributors who provided factual input for incorporation into this document.

Foreword

The mining and metals industry's biodiversity conservation performance is under increasing scrutiny from NGOs, commentators and financial analysts. This is due in part to a growing awareness of the importance of biodiversity conservation, but also because the industry often operates in remote and environmentally sensitive areas of the world. Demonstrating a commitment to biodiversity conservation is now an essential element of sustainable development for the mining and metals industry. ICMM members are committed to improving their performance in this area, and also to taking a role in educating governments and the public about the benefits that the mining and metals industry can play in biodiversity conservation.

Principle 7 of ICMM's Sustainable Development Framework states our commitment to "contribute to conservation of biodiversity and integrated approaches to land use planning". This document is intended to assist members (and others) to meet this commitment by providing relevant guidance to managers in corporate and site offices.

The development of this ICMM publication was undertaken as a part of the IUCN-ICMM Dialogue. A joint workshop at IUCN's Headquarters in Gland in July 2003 agreed on the need to develop it, and also the structure of the document. While the document has been developed by ICMM for its members, we are thankful to IUCN for its association and help in its development. We are also very grateful to the many individuals, and particularly the ICMM-IUCN Advisory Group and ICMM's Biodiversity Working Group for the long hours they spent in reviewing countless drafts. A two-month public consultation process during 2005 also provided very valuable input to the process.

Alongside this publication, we published two discussion papers on biodiversity offsets in 2005 as an output of the Dialogue and a contribution to efforts to improve biodiversity conservation. A set of good practice case studies was published with IUCN in 2004 to show what can be achieved and I commend that document to readers as a companion to this one.

We trust that this document will encourage and guide ICMM members to invest in the challenges of becoming positive contributors to biodiversity conservation. The return on that investment will be responsible and sustainable access to mineral resources and a role in their development.

Paul Mitchell
Secretary General

SECTION A:

Background and Overview

Chapter 1. Introduction

1.1 Background

In May 2003, the ICMM Council approved a set of sustainable development principles and committed its corporate membership to measure performance against them. One of the principles explicitly addresses the conservation of biodiversity:

Principle 7: Contribute to conservation of biodiversity and integrated approaches to land use planning.

In parallel with the development of the sustainable development principles, ICMM was engaged in dialogue with a range of stakeholders, most notably with IUCN, to understand more clearly the interfaces between mining operations and biodiversity. At the World Summit on Sustainable Development in August 2002, IUCN and ICMM launched a joint dialogue on mining and biodiversity. The objective was to provide a platform for communities, corporations, nongovernmental organizations (NGOs) and government to engage in a dialogue regarding balancing ecosystem protection with the social and economic importance of mining. Formal terms of reference for an IUCN/ICMM dialogue were agreed to in March 2003 and revised in June 2004, and the dialogue is ongoing.

Partly as a result of this engagement and exchange of ideas, an elaboration of sustainable development Principle 7 committed ICMM members to:
- respect legally designated protected areas;
- disseminate scientific data on and promote practices and experiences in biodiversity assessment and management; and
- support the development and implementation of scientifically sound, inclusive and transparent procedures for integrated approaches to land use planning, biodiversity, conservation and mining.

At a July 2003 joint IUCN/ICMM workshop in Gland, ICMM also committed to developing and promoting a library of good practice guidelines and case studies in order to support member companies implementing and measuring performance against the principles. This Good Practice Guidance (GPG) has been prepared in response to that commitment. It is aimed at providing the mining industry with the steps required to improve biodiversity management throughout the mining cycle. By implementing this guidance, mining companies should be better placed to:
- identify and evaluate biodiversity;
- understand the interfaces between their activities and biodiversity;
- assess the likelihood of their activities having negative impacts on biodiversity;
- develop mitigation measures for potential impacts on biodiversity and rehabilitation strategies for affected areas; and
- explore the potential to contribute to biodiversity enhancement or conservation.

The GPG is complemented by a companion volume prepared by IUCN and ICMM in 2004, *Integrating Mining and Biodiversity Conservation: Case Studies from Around the World.*

The GPG is aimed at mining professionals with direct experience of or responsibility for environmental aspects and other mining specialists, such as those engaged in exploration or feasibility studies. The GPG is intended to help develop knowledge and capacity, and it also signals where specialist biodiversity support may be desirable or essential. In addition, the GPG should support more constructive relationships or partnerships between mining and biodiversity professionals by promoting enhanced mutual understanding. In this respect, the GPG is not only about enhancing mining professionals' understanding of biodiversity but also about enhancing biodiversity specialists' understanding of mining.

1.2 Biodiversity and why it is valuable

1.2.1 What is biodiversity?

At the 1992 Earth Summit in Rio de Janeiro, the United Nations Convention on Biological Diversity (CBD) was signed by 157 governments; it has since been ratified by 188 countries. The CBD defines biodiversity as:
The variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

So biodiversity encompasses the variety and variability of life on Earth. It refers to the differences within and between all living organisms at their different levels of biological organization – genes, individuals, species and ecosystems. Biodiversity embraces all living organisms and their genetic diversity, a vast and complex array of ecosystems and habitats, as well as the processes that underpin and result from this diversity, such as photosynthesis, nutrient cycling or pollination. Different species – plant, animal, fungal and microbial – interact with each other in a variety of ecological processes to form ecosystems. These processes are in turn the result of the interactions between species and with their physical and chemical environments.

1.2.2 Why is biodiversity valuable?

The combination of a diversity of life forms and their interactions with each other and with the rest of the environment has made Earth a uniquely habitable place for humans. Biodiversity sustains human livelihoods and life itself. The interdependence between people and biodiversity is most apparent for some indigenous peoples, who may lead a subsistence lifestyle and be critically dependent on biodiversity, or whose culture and history are intimately associated with the natural environment and systems. In many Western cultures, although our dependence on biodiversity has becomes less tangible and apparent, it remains critically important.

At a macro-level, the balancing of atmospheric gases through photosynthesis and carbon sequestration is reliant on biodiversity, while an estimated 40 per cent of the global economy is based on biological products and processes[1]. Through a close interaction with and manipulation of biodiversity, humans have created thousands of new crop varieties and livestock breeds, with distinct development benefits. This has enabled large increases in the production of food and other natural materials, which have fed the growth and development of human societies.

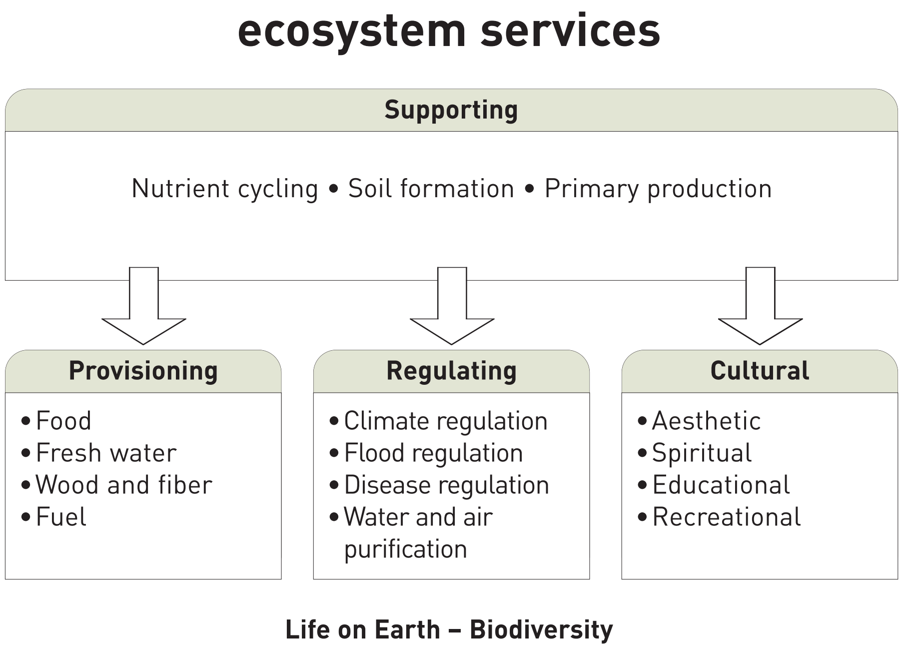
Biodiversity is also the basis of innumerable environmental services that keep us and the natural environment alive – from the provision of clean water and watershed services to the recycling of nutrients and pollination. These so-called ecosystem services include:

- soil formation and maintenance of soil fertility (through nutrient cycling);
- primary production through photosynthesis, as the supportive foundation for all life;
- provision of food, fuel and fibre;
- provision of shelter and building materials;

[1] WEHAB Working Group. 2002. "A Framework for Action on Biodiversity and Ecosystem Management." New York: United Nations. Available at ww.johannesburgsummit.org/html/documents/summit_docs/wehab_papers/wehab_biodiversity.pdf.

- regulation of water flows and the maintenance of water quality;
- regulation and purification of atmospheric gases;
- moderation of climate and weather;
- detoxification and decomposition of wastes;
- pollination of plants, including many crops;
- control of pests and diseases; and
- maintenance of genetic resources (key to crop and livestock breeding, medicines, and so on).

Figure 1.1 Categories of ecosystem services



Source: Millenium Ecosystem Assessment

In addition to these essential ecosystem services (classified as supporting, provisioning and regulating by the Millennium Ecosystem Assessment), biodiversity is also of value for aesthetic, spiritual, cultural, recreational and scientific reasons (***see Figure 1.1***). The intrinsic value of biodiversity stems from a nonutilitarian philosophy that views biodiversity as intrinsically valuable in its own right, irrespective of its contribution to human well-being. More tangibly, in some parts of the world (particularly those with low agricultural productivity), the survival of many people depends on biodiversity.

While our understanding of the value of biodiversity has improved in recent years, so too has our appreciation of significant threats to it. The current pressures on and related losses of biodiversity are threatening to undermine the ecosystem services we all depend on. Over the past 50 years, many ecosystems have been degraded more rapidly and extensively than at any time in history. As populations have grown, so has the demand for food, timber, fuel and other natural materials. While many of the world's peoples have experienced economic and social gains over this period – in which the increasing demand for minerals has played an important role – the consequences of biodiversity changes and losses have profoundly affected some of the poorest communities. The Millennium Ecosystem Assessment concluded the following:

- Approximately 60 per cent of ecosystem services are being degraded or used unsustainably.
- There is established but incomplete evidence that ecosystem changes are increasingly becoming nonlinear (accelerating, abrupt or potentially irreversible, reaching 'tipping points' or passing thresholds), with potential adverse consequences for humanity.
- The harmful effects of the degradation of ecosystem services are borne disproportionately by the poor.

In summary, the threats to biodiversity are compelling. Unless they are addressed in a holistic manner, which takes social and economic as well as scientific considerations into account, the benefits of ecosystem services will be substantially diminished for future generations. Furthermore, the next 50 years could see a further acceleration in the degradation of ecosystem services unless action is taken to reverse current trends. This is incompatible with the concept of sustainable development, which aims to meet the needs of the present without compromising the ability of future generations to meet their own needs.

The objectives of the Convention on Biological Diversity are to encourage and enable all countries to:
- conserve biodiversity;
- sustainably use the various components of biodiversity; and
- share the benefits arising from the commercial and other use of biodiversity in a fair and equitable manner.

In 2002, on the tenth anniversary of the Rio Earth Summit, the parties to the CBD committed themselves to a more effective and coherent implementation of the three objectives of the CBD. The objective was to achieve a significant reduction of the current rate of biodiversity loss at global, regional and national levels by 2010 as a contribution to poverty alleviation and to the benefit of all life on Earth. The Millennium Ecosystem Assessment illustrates the enormity of this challenge.

There is increasingly a recognition of the potential role that business has to play in concert with governments and civil society in achieving a holistic response. In 2005, meetings in London and São Paulo organized by the CBD Secretariat explored opportunities for engaging business in biodiversity issues as a means of working towards the 2010 target. This will likely become the focus of business engagement on biodiversity issues in the next five years.

1.2.3 Relevance to mining operations

Mining has the potential to affect biodiversity throughout the life cycle of a project, both directly and indirectly. Direct or primary impacts from mining can result from any activity that involves land clearance (such as access road construction, exploration drilling, overburden stripping or tailings impoundment construction) or direct discharges to water bodies (riverine tailings disposal, for instance, or tailings impoundment releases) or the air (such as dusts or smelter emissions). Direct impacts are usually readily identifiable. Indirect or secondary impacts can result from social or environmental changes induced by mining operations and are often harder to identify immediately. Cumulative impacts occur where mining projects are developed in environments that are influenced by other projects, both mining and nonmining.

The potential for significant impacts is greater when mining occurs in remote, environmentally or socially sensitive areas. Due to the continuing demand for minerals, the depletion of resources in readily accessible areas and changing technologies and economics in the mining sector, mining is increasingly being proposed in remote and biodiversity-rich ecosystems that were previously unexplored and undeveloped for minerals. This has also been made possible by the implementation of mining sector fiscal and regulatory reforms to encourage foreign direct investment in many developing countries. This trend in opening up new prospective areas to mineral resources development provides an opportunity for the mining industry to demonstrate that practices have improved, including making 'no-go' decisions. It can also represent a threat, however, and poor performance could limit access to some highly prospective areas.

Despite the significant potential for negative impacts on biodiversity from mining operations, there is a great deal that companies can do to minimize or prevent such impacts in areas identified as being appropriate for mining. There are also many opportunities for companies to enhance biodiversity conservation within their areas of operations. Being proactive in the assessment and management of biodiversity is important not only for new operations but also for those that have been operating for many years, usually under regulatory requirements that were less focused on the protection and enhancement of biodiversity.

It is also important to recognize that not all mining takes place in remote or highly sensitive areas. Some greenfield or expansion projects will be developed in relatively highly populated areas, industrial settings or regions that have been intensively farmed for many decades, where biodiversity is of limited value. This will become apparent after a modest investment of effort to establish the biodiversity context of a proposed project ***(see section 5.2.2 on screening and scoping of biodiversity issues)***. In such situations, the focus should be on developing a sufficient understanding of local biodiversity and exploring opportunities for biodiversity enhancement or creative conservation with appropriate partners.

1.3 Why mining companies should consider biodiversity

Setting aside any ethical or moral considerations, which are increasingly the subject of corporate policies, it is important for companies to address biodiversity for a variety of sound business reasons. Many mining companies have adopted an increasingly sophisticated approach to managing biodiversity as part of their commitments to establishing and maintaining a social or functional 'licence to operate' ***(see Box 1.1 on Rio Tinto)***. For example, adopting responsible practices with respect to biodiversity management is increasingly viewed as important with respect to:

- access to land, both at the initial stages of project development and for ongoing exploration to extend the lifetime of existing projects;
- reputation, which links to 'licence to operate', an intangible but significant benefit to business, and which can profoundly influence the perceptions of communities, NGOs and other stakeholders of existing or proposed mining operations; and
- access to capital, particularly where project finance is to be obtained from one of the investment banks that are signatories to the Equator Principles[2], which apply the Biodiversity Performance Standard[3] of the International Finance Corporation (IFC) to all investments in excess of $10 million (recognizing that strengthened commitments to biodiversity assessment and management are likely to be adopted).

[2] See www.equator-principles.com.
[3] In April 2006, IFC adopted Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resources Management, which replaced IFC's Operational Policy 4.04: Natural Habitats of 1998.

In addition, good biodiversity management can bring benefits to mining companies, including:

- increased investor confidence and loyalty;
- shorter and less contentious permitting cycles, as a result of better relationships with regulatory agencies;
- improved community relations;
- strong supportive partnerships with NGOs;
- improved employee motivation; and
- reduced risks and liabilities.

This Good Practice Guidance provides the mining industry with an outline of the steps required to improve biodiversity management throughout the mine cycle. Ultimately, through implementation of this GPG, mining companies should minimize the likelihood of negative impacts on biodiversity, project delays and damage to their reputations.

Box 1.1. A strategic response to biodiversity conservation – Rio Tinto

Rio Tinto has developed a strategic response to biodiversity conservation and management, designed to enable the company to meet the wide range of expectations of many different constituencies with interests in the company and its activities.

As a first step in developing a biodiversity strategy, partnerships were formed with leading conservation organisations such as Earthwatch Institute, BirdLife International, Fauna & Flora International and the Royal Botanic Gardens, Kew. These relationships provided a conservation perspective on the opportunities and challenges raised by the mining process and were an essential part of designing how to proceed. A detailed survey of the level of awareness and management of biodiversity issues at all operations was carried out. A paper setting out a strong business case for developing a biodiversity strategy was put to senior management.

The development of the strategy was managed by a Rio Tinto steering group formed in 2002 and supported by an external advisory panel. The internal steering group included senior representatives from Rio Tinto operations as well as Exploration, corporate Health, Safety and Environment, and corporate Community Relations departments. The external advisory panel consisted of six invited international experts from conservation and community development organisations, including some of Rio Tinto's biodiversity partners.

The elements of the Rio Tinto biodiversity strategy have been developed to help corporate and operational staff improve biodiversity performance through:

- Identification of biodiversity risks and opportunity
- Development and implementation of biodiversity programmes
- Recognition of synergies and challenges with sustainable communities programmes
- Identification and development of strategic and operational partnerships, and,
- Effective corporate assurance

The strategy provides a framework to bring together the interests and concerns of several groups, including indigenous landowners, affected communities, investors, employees, NGOs, regulators, scientific and finance communities. Outputs from the strategy include a Position Statement, guiding principles, a detailed guidance document and case studies.

The Strategy was launched at the World Conservation Forum in Bangkok in November 2004. It is being implemented across the Rio Tinto Group, with particular emphasis on new projects. As with the development of the strategy, the company's biodiversity partner organisations are actively involved in implementation. They are supporting Group businesses in the design and development of biodiversity programmes appropriate to local biodiversity risks and opportunities.

Working groups have been formed to continue the development of additional guidance on biodiversity indicators, metrics and targets, and on the issues surrounding the use of biodiversity offsets. Both groups have membership drawn from conservation and development organisations as well as corporate and operational staff from Rio Tinto.

1.4 The importance of stakeholder engagement

Stakeholders are groups and individuals who affect or are affected by the activities of mining companies. Depending on the scale and significance of a mining project, the stakeholders with an interest in biodiversity may include the following:

- local communities;
- a range of government and multilateral institutions with an interest in or responsibility for the management or protection of natural resources;
- investors or providers of insurance, who may impose environmental requirements or standards;
- conservation interests, including international, national or local NGOs as well as academic or research institutions; and
- employees.

Engagement of potentially affected communities and other stakeholders in biodiversity conservation is fundamental to the success of biodiversity initiatives. Engaging the community and other stakeholders with an objective of developing trust, respect and partnership, aimed at keeping the community informed of a mining company's operations, is essential to the success of a sustainable project. It should be recognized that stakeholders may have different and possibly conflicting interests in, perspectives on and priorities for biodiversity and its management. Reconciling these differences in a fair and balanced way is central to the aims of the GPG.

Stakeholder engagement has an important role to play in developing an understanding of the interfaces between mining and biodiversity and in assessing potential negative impacts. When developing mitigation measures or biodiversity conservation initiatives, attention must given to respecting cultures, customs and values; to recognizing and engaging local communities as stakeholders; to participating in the social, economic and institutional development of communities;

and to mitigating negative impacts. The importance of stakeholder engagement is a recurring theme throughout the GPG. In particular, Chapter 6 presents a discussion of stakeholder engagement tools and processes. Indeed, the GPG has its origins in the IUCN-ICMM stakeholder dialogue – a July 2003 workshop reaffirmed the commitment to producing guidance on good practice following the World Parks Congress in Durban in September 2003.

1.5 Scope and structure of the Good Practice Guidance

1.5.1 Scope

This GPG encompasses the steps required to improve biodiversity management throughout the mining cycle. It assumes the existence of a corporate commitment to the ICMM sustainable development principles and sub-elements, which may be reflected in individual members' biodiversity strategies, policies or standards. It does not address the development of policies with respect to biodiversity in any detail other than in the context of Environmental Management Systems (EMS) in Chapter 5 (***see section 5.3.1 on securing a corporate commitment***). Instead, it offers a series of practical modules that should enable companies to:

- **Understand the interfaces between their activities and biodiversity:** Help companies recognize the interfaces between their various operational activities and biodiversity, and to engage effectively with stakeholders.
- **Assess the likelihood of their activities having negative impacts on biodiversity:** Undertake practical steps to assess the potential for operational activities to negatively affect biodiversity and related stakeholders.
- **Mitigate potential impacts on biodiversity:** Identify and implement a hierarchy of measures to protect biodiversity and affected stakeholders.
- **Explore the potential to contribute to biodiversity conservation:** Beyond the mitigation of impacts, explore the potential to contribute to biodiversity conservation or protection.

The GPG has been developed to be applicable to a variety of operational contexts, encompassing a range of ecosystem types (from deserts to lowland tropical environments, for instance) and importance (such as where biodiversity may be of international importance or of very limited importance). As a consequence, the application and interpretation of the guidance will sometimes depend on specialized local knowledge or biodiversity expertise – this is flagged at various points within the GPG.

1.5.2 Structure

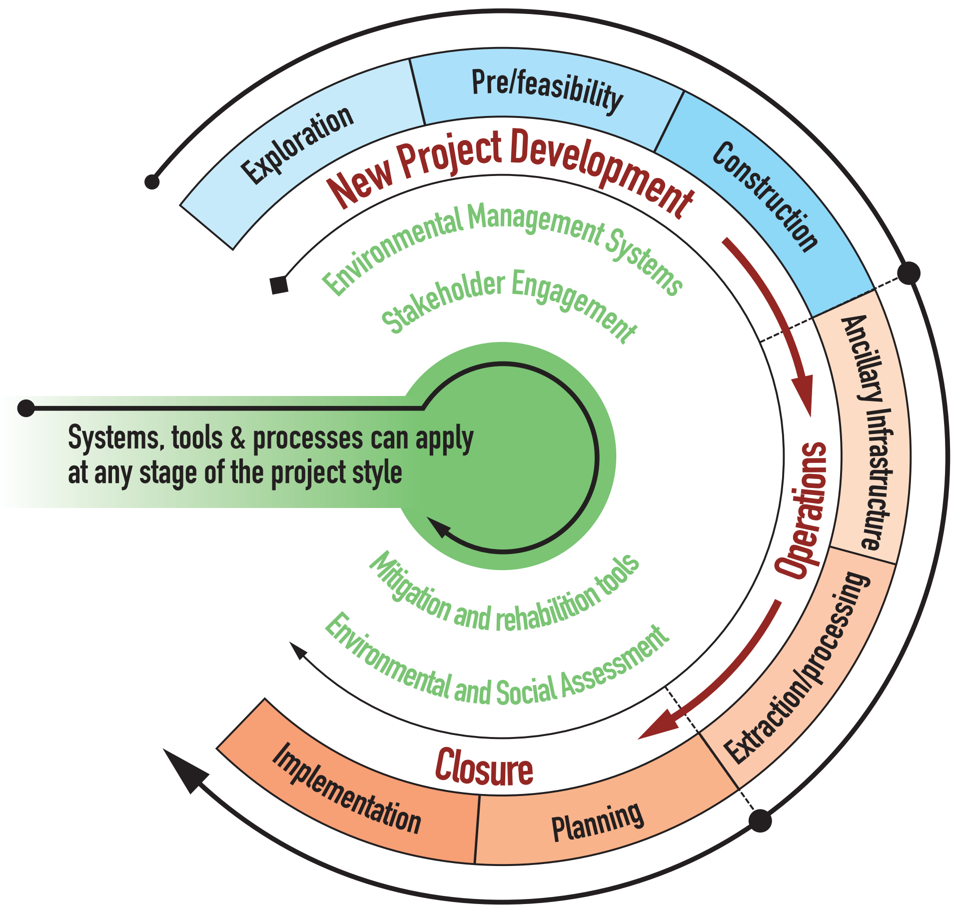
The GPG is divided into three parts. **Section A** outlines the background for ICMM developing the GPG for mining and biodiversity, highlights the importance of biodiversity and relevance to the mining sector, and emphasizes the need for stakeholder engagement in the identification, assessment, mitigation and management of biodiversity.

Section B provides guidance on managing biodiversity at various operational stages. It includes three chapters, corresponding to the three broad phases of mining projects:

- project development, which here includes exploration, pre-feasibility and feasibility studies and construction (Chapter 2);
- operations, which here includes core mining facilities and activities and ancillary infrastructure (Chapter 3); and
- closure planning and implementation (Chapter 4).

This section focuses on identifying the intersection between mining activities and biodiversity and on highlighting the systems, tools and processes that can be applied to help companies manage potential impacts on biodiversity and enhance biodiversity protection and conservation.

Figure 1.2: Integrating biodiversity into the mining project cycle



Section C describes the systems, tools and processes in greater detail and provides guidance on their practical application in the context of mining operations. It includes three clusters:

- management system and assessment tools, including Environmental Management Systems and Environmental and Social Impact Assessment (ESIA) (Chapter 5);
- stakeholder engagement tools and processes (Chapter 6); and
- mitigation, rehabilitation and enhancement tools (Chapter 7).

This structure has been designed to explicitly recognize that different operations will be at different stages of development and that many of the systems, tools and processes for biodiversity management may be applicable to all three of the operational phases outlined in section B, albeit at varying degrees of detail. Sections B and C have been designed to help users of the GPG determine the level of detail (for example, of assessment) that is appropriate, depending on the operational context. The conceptual approach adopted for the GPG is illustrated in ***Figure 1.2***.

Section D provides support materials for the rest of the document: there is a list of acronyms used, a list of key references and a set of checklists. The latter are provided as a means of ensuring adoption and implementation of the GPG by acting as an aide memoire and a way of quickly ascertaining whether one has addressed the chief requirements of a particular chapter. However the reader should beware that one size does not fit all and hence careful thought needs to go into selecting the appropriate elements that apply to a specific project. The main document should be referred to as the primary source of ideas and examples.

Throughout, the guidance includes illustrative case studies that demonstrate practical efforts by mining companies to address biodiversity challenges. In addition, the case studies provide examples of the mutual benefits that can arise for mining companies and their stakeholders through constructive engagement.

SECTION B:

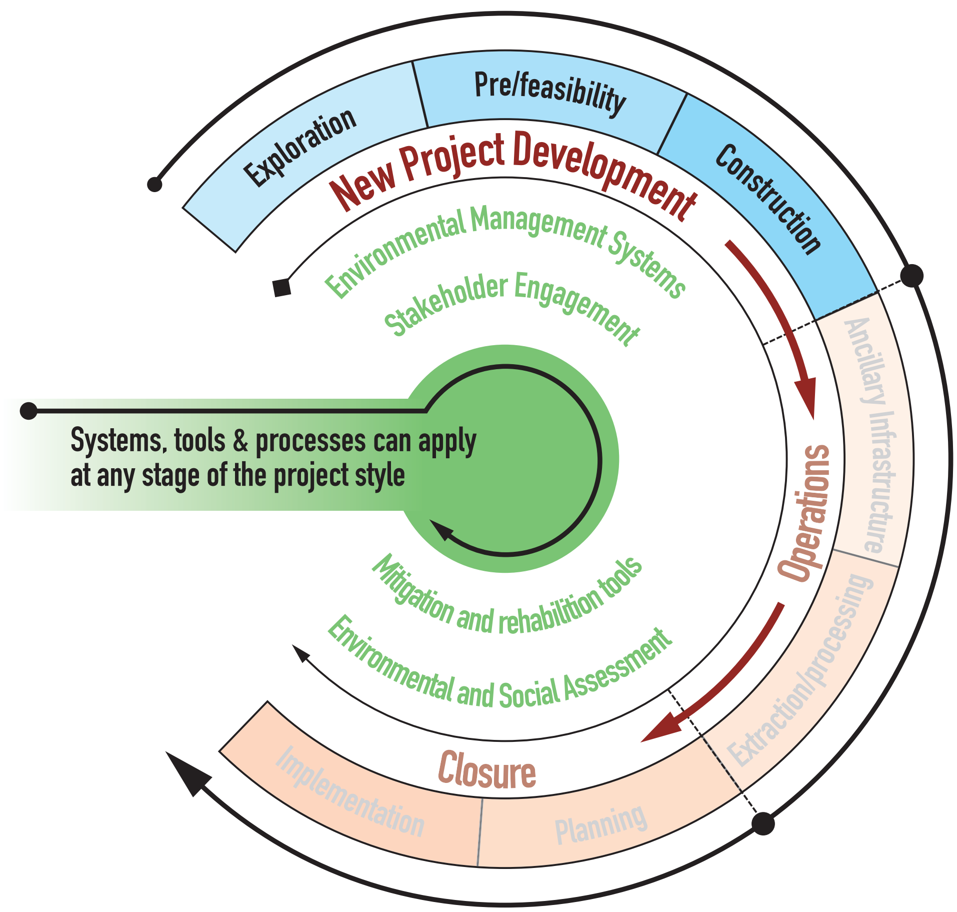
Managing Biodiversity at Different Operational Stages

Chapter 2. Integrating Biodiversity into Project Development

2.1 Introduction

For the purposes of this GPG, project development encompasses all the stages from initial exploration through to completion of construction. Individual mining companies identify somewhat different stages within project development, but here just three broad stages are included: exploration; pre-feasibility and feasibility studies; and project construction. Incremental levels of investment of time and resources, not to mention increasing confidence in the potential to recover economically viable minerals, are required to progress between each of these stages from a technical perspective.

Figure 2.1: Integrating biodiversity into project development



Similarly, incremental levels of effort are required to address environmental and social aspects in general and biodiversity in particular. This chapter reviews the three stages of mine project development and discusses the intersection between the activities undertaken by mining companies and biodiversity. It also refers to the types of systems, tools or processes that may be applied to better understand the intersections between mining and biodiversity, as well as how best to manage them. (***see Figure 2.1***.) An illustrative example of the relationships between mining activities and potential impacts on biodiversity is given in ***Figure 2.2***.

2.2 Exploration

The goal of exploration is to discover economically viable mineral deposits. The search for mineral deposits is undertaken primarily by junior mining companies, sometimes with the financial support of a major mining company, but often speculatively. Exploration is a high-risk, high-reward activity, where the probability of success is often low but the potential rewards of finding an economically viable deposit are considerable. The predominance of junior mining companies in exploration is relevant because they are less likely to have in-house capacity on environmental or social issues in general or on biodiversity issues in particular, and this GPG explicitly recognizes that lack of an in-house capacity on biodiversity issues may often be a constraint. The E3 Programme of the Prospectors and Developers Association of Canada is an excellent tool designed to support junior mining companies in addressing all environmental issues in exploration, including biodiversity.

Figure 2.2: Examples of the intersection of project development and biodiversity

POTENTIAL IMPACTS	MINING ACTIVITIES	Exploration and construction	Early stages of exploration	Exploration drilling	Access road construction	Land clearance (for construction, etc.)	Obtaining construction materials	Construction related infrastructure	Construction of ancillary infrastructure	Roads, rail & export infrastructure	Pipelines for slurries or concentrates	Energy/power & transmission lines	Water sources, wastewater treatment	Transport of hazardous materials
Impacts on terrestrial biodiversity														
Loss of ecosystems and habitats				●	●	●	●			●	●	●		●
Loss of rare and endangered species				●	●	●	●	●		●	●	●		●
Effects on sensitive or migratory species				●	●	●	●	●		●	●	●		●
Effects of induced development on biodiversity					●	●		●		●				●
Aquatic biodiversity & impacts of discharges														
Altered hydrologic regimes					●	●	●	●		●		●	●	●
Altered hydrogeological regimes				●			●							
Increased heavy metals, acidity or pollution				●		●	●	●		●		●	●	●
Increased turbidity (suspended solids)				●	●	●	●	●		●	●	●	●	●
Risk of groundwater contamination				●			●	●		●	●		●	●
Air quality related impacts on biodiversity														
Increased ambient particulates (TSP)				●	●	●	●	●		●		●		●
Increased ambient sulfur dioxide (SO_2)								●				●		●
Increased ambient oxides of nitrogen (NO_x)								●				●		●
Increased ambient heavy metals												●		
Social interfaces with biodiversity														
Loss of access to fisheries						●	●			●	●	●		
Loss of access to fruit trees, medicinal plants						●	●	●		●	●	●		
Loss of access to forage crops or grazing					●	●	●	●		●	●	●		
Restricted access to biodiversity resources						●	●			●	●	●		
Increased hunting pressures				●	●	●	●	●		●		●		●
Induced development impacts on biodiversity					●	●	●	●		●		●		●

In the early stages of exploration, impacts on biodiversity are limited, although they can become more significant as exploration progresses. At a macro-level, however, assuming exploration efforts identify economically viable mineral deposits, the initial choice of exploration area can have a profound long-term influence on the impacts on biodiversity. Therefore even at this very early stage it is critically important to have some appreciation of likely long-term interfaces with biodiversity.

At this stage, companies should begin to develop an appreciation of the overall biodiversity importance of the area within which exploration is being undertaken by reviewing legal provisions relating to biodiversity and mapping the occurrence of protected areas. ICMM members have committed not to explore or mine in World Heritage Sites[4], which are considered to be of outstanding global value. This particular category of protected area is thus effectively 'off-limits' for exploration by ICMM members.

At one extreme, exploration might be undertaken within a protected area. At the other extreme, exploration might be undertaken in a highly regulated environment, where sophisticated land use planning has identified areas suitable for minerals exploration or exploitation based on a variety of constraints, including biodiversity, and where biodiversity may already be significantly degraded. The majority of exploration areas will fall somewhere between these two extremes. The assessment tools (***see especially section 5.2.2 on screening and scoping of biodiversity issues***) will help to establish the biodiversity context of exploration areas – and may also help to divert exploration efforts away from areas of greatest importance for biodiversity. It is important, therefore, that a limited early screening effort be undertaken (to determine regulatory restrictions such as protected areas, for instance, or regulatory requirements in terms of permitting).

The emphasis on limited early screening is responsive to the probability of exploration success – whereby perhaps only 1 in 100 regional exploration targets may proceed to the pre-feasibility stage. Consequently, it is better to flag significant biodiversity (and other environmental or social) risks at an early stage, which may have a bearing on whether a project could realistically be developed. The assessment of biodiversity and other risks should be revisited as potential projects proceed through the various stages of new project development.

2.2.1 Early stages of exploration

Exploration involves a variety of stages and techniques that require progressively greater degrees of effort and physical disturbance of land. The early stages of exploration are described below.

Geological field surveys: Collecting basic data and mapping of rock types, minerals and structures. Surface data are used to interpret the subsurface geology. The accuracy and detail of preliminary mapping can be enhanced by using aerial photography, for example to help locate outcrops and to control traverses. Field surveys generally have limited impacts on biodiversity unless sub-surface sampling is done (see below), as they involve limited disturbance of land and as access is typically obtained using existing roads and tracks or by air.

Geochemical techniques: Sampling of geological materials and testing for abnormally high or low values of elements in order to trace a path to a source of economic significance. Geochemical techniques involve collecting and analyzing

[4] World Heritage Sites are established under the World Heritage Convention of 1972 and administered by UNESCO.

various types of geological materials (such as soils, stream sediments or silt, and rocks) or certain biological materials (such as plants). As mineralization can be extremely difficult to recognize from field surveys alone, geochemical techniques assist in the discovery of ore deposits. In common with field surveys, these techniques normally have minimal impacts on biodiversity.

Geophysical survey techniques: Measuring the physical properties of minerals and rocks – in particular magnetism, electrical conductivity and density – to indicate the presence or absence of economic mineralization. For example, the magnetic properties of minerals and rocks can be used for identification, and discrepancies in Earth's magnetic field may indicate a concentration of valuable minerals. Since the properties of several minerals, rocks and rock structures overlap, the results of geophysical surveys (identified anomalies) are generally only indicative of favourable zones or targets for further physical investigation. Geophysical techniques are often undertaken from aircraft (or may be done with equipment mounted on vehicles). With air surveying, the impacts on biodiversity are very limited (as the techniques are nondestructive), with the possible exception of temporary disturbance of migratory land animals or sensitive fauna.

Ground surveying that involves no new road construction or is on lightly vegetated areas (such as grassland) also has limited impacts. Seismic lines cleared for geophone surveying can create straight lines of cleared vegetation – providing access to predators, potential weed invasion and isolation of previously intact vegetation. With modern methods of positioning and surveying, it should be possible to avoid 'line of sight' cuttings in the vast majority of cases, and low-impact methods should be possible in all other cases. The available mitigation techniques include low-pressure terrain vehicles, rubber-tyred bulldozers in a 'blade-up' condition, and helicopter access rather than cutting any lines.

Sub-surface sampling: Techniques such as pitting and trenching may be carried out to further explore anomalies identified through geophysical surveys or may sometimes be used during geological surveying. The surface of mineralization is often obscured by overburden or is weathered and leached to some depth. If the rock surface is too weathered or oxidized to allow accurate sampling, rock drills may be used to drill a pattern of shallow holes for blasting, or hand, tractor or excavator trenching may be used. The broken rock is removed and the fresh, somewhat fractured walls or trench bottom may be sampled.

Trenching and pitting involve some level of land clearance and may affect biodiversity to a greater extent than the exploration techniques described above (particularly where it requires construction of new access roads). Trenching can create large linear pits that can create 'traps' for fauna, and the removal of vegetation may be extensive. The effectiveness of trenching should be evaluated with due consideration for the potential impact on biodiversity and required rehabilitation effort. Where trenches are used, specific measures should be taken to provide barriers to access (such as fencing or other guides to divert animals), easy egress for animals that do fall in and, most important, backfilling and rehabilitation as soon as possible.

2.2.2 Exploration drilling

Exploration drilling requires the use of drill rigs to penetrate sub-surface rock layers and obtain representative materials consisting of chips or core. Drilling is the culmination of the exploration process and represents the last stage of development planning. Drill data are used to create a model of the underground geometry of mineralization. Available techniques include percussion, vacuum, reverse circulation and diamond drilling. Drilling is invasive and often requires the use of heavy equipment.

The direct impacts on biodiversity are more extensive than for other exploration techniques, as drill sites must be cleared, and new access roads are often required for equipment. Drill pads sometimes need to be established within relatively undisturbed ecosystems, and it requires intensive management to limit the associated disturbance and subsequent rehabilitation of that disturbance. Simple management measures can include minimizing the number of access roads, keeping tracks as small as possible and rehabilitating tracks as soon as practicable.

In addition, biodiversity may be affected by water abstraction for drilling fluids or by spillage or leakage of fuels, oils and drilling fluids during exploration drilling. Where exploration camps are established, surface water pollution may result from wastewater discharges, sewage disposal, and small-scale waste rock dumps (and related heavy metal and sediment drainages), which may affect aquatic biodiversity or contaminate drinking water sources for wildlife.

The latter stages of exploration can have fairly significant impacts on biodiversity, especially if exploration in remote areas facilitates access and enables other forms of natural resources extraction (removal of fuelwood or timber, hunting and so on). In some legal jurisdictions, the permitting process can require some level of environmental analyses to be undertaken at this stage (***see section 5.2.2 on screening and scoping biodiversity issues***). If not, it may still be prudent to invest earlier in a more rigorous screening to better understand the biodiversity context[5]. This could include obtaining readily available information on biodiversity within the area of exploration, reviewing legal provisions relating to biodiversity and undertaking basic surveys of biodiversity, and it normally requires the input of a trained ecologist. In addition, at this stage biodiversity stakeholders should be identified and some initial engagement undertaken (***see sections 6.2 on identification and 6.3 on engagement***). It may also be prudent to have specialist environmental personnel on site in the latter stages of exploration, to ensure that field studies (to include biodiversity as appropriate) are initiated in support of the ESIA.

Some recommended practices for limiting impacts on biodiversity during exploration include:

- limiting land clearing by using technologies and mining practices that minimize habitat disturbance;
- avoiding road building wherever possible by using helicopters or existing tracks – if roads are to be constructed, use existing corridors and build away from steep slopes or waterways;
- using lighter and more efficient equipment to reduce impacts on biodiversity;
- positioning drill holes and trenches away from sensitive areas;
- capping or plugging of drill holes to prevent small mammals from becoming trapped;
- removing and reclaiming roads and tracks that are no longer needed; and
- using native vegetation to revegetate land cleared during exploration.

[5] As acknowledged in a number of areas within the GPG, the distinctions between the stages of new project development are often fluid, so greater effort may be required depending on the project or company context. Irrespective of the provisions of the GPG, regulatory requirements with respect to biodiversity must always be adhered to.

Some of these practices were incorporated into the exploration Environmental Management Plan (EMP) developed in conjunction with stakeholders at the Skorpion Zinc Mine in Namibia (***see Box 2.1***) and for exploration within the buffer zone of the Fitzgerald River Biosphere in Western Australia (***see Box 2.2***). An innovative approach to monitoring the effectiveness of such measures to control exploration impacts was developed by Placer Exploration Limited (***see Box 2.3***).

Box 2.1. Environmental Management Plan to minimize exploration impacts and guide rehabilitation – Skorpion Zinc Mine, Namibia

In 2000, Anglo America plc commenced construction of the Skorpian zinc mine and refinery near Rosh Pinah in southern Namibia, and production began in April 2003. Ongoing exploration for zinc is being conducted in the surrounding area mainly by means of drilling on a broad grid basis and by sampling rock chips and cores.

Southern Namibia is classified by Conservation International as one of the world's top 25 biodiversity 'hotspots'. It is the only arid 'hotspot' environment, and over 10 per cent of the plant species there are found only in the Sperrgebiet area. The main concerns of the Namibia Ministry of Environment and Tourism (MET) were that the Sperrgebiet habitat was extremely sensitive and could not recover after disturbance and that the exploration might cause irreparable damage.

An EMP, including a specific Exploration EMP, was developed by company personnel in conjunction with stakeholder representatives. In addition, and in conjunction with other stakeholders, a Rosh Pinah Environmental Forum was formed in late 2000 to develop site-specific plans for exploration areas. Stakeholder involvement led to an agreement, among other actions, to restrict drill site access to single tracks on grid lines, to use wide low-pressure tyres and lightweight drill rigs, to ban camping within the Sperrgebiet, to rehabilitate all drill sites and access tracks and to monitor the drillers' environmental conduct daily.

As part of follow-up, site visits were conducted with all stakeholders, 'before and after' photographs were taken and biannual audits were conducted with full reporting. Spot checks were conducted, and all stakeholders signed off on the rehabilitation of previously affected areas.

As a consequence of the environmental management implemented, large tracts of ground have been returned to their original state at minimal cost after exploration activities. The level of environmental awareness and regard for the importance of biodiversity by all exploration staff increased considerably, and an excellent relationship of trust developed between Anglo American and MET staff.

2.3 Pre-feasibility and feasibility studies

Different companies have different terminology for the various stages of project development, but these stages typically follow promising initial results from exploration. Pre-feasibility often overlaps with the later stages of exploration work, and the boundaries between pre-feasibility and feasibility work may be blurred.

Irrespective of where the line is drawn, the results of exploration will have justified additional expenditure to determine whether a mineral deposit is economically viable and if the potential for a mining project to be developed is greater.

One distinction that is sometimes made between pre-feasibility and feasibility studies is that the former determines whether a probable mineral reserve is economically viable (and looks at a number of options), whereas the latter determines whether the proven mineral reserve can indeed be economically mined (and goes into detail on a preferred option). At this stage, the 'footprint' of mining activities often becomes more established, in terms of the exploration camp and related infrastructure, as additional drilling and other investigative work is undertaken to establish the extent and grades of the ore deposit.

Box 2.2. Specialized low-impact exploration practices – Ravensthorpe Nickel Project

The Ravensthorpe Nickel Project in Western Australia lies within an agricultural region with an established network of small towns. It is located within the Bandalup Corridor, a band of remnant vegetation adjacent to the Fitzgerald River National Park, and falls within the buffer zone of the Fitzgerald River Biosphere, a world-renowned biodiversity area. The Western Australian Department of Conservation and Land Management (CALM) manages both the national park and the biosphere. One of the allowable activities within the buffer zone of a biosphere is mining, subject to responsible environmental management.

The project's ore deposits are located in areas covered by remnant vegetation. The clearing of this vegetation associated with project development has two main impacts on biodiversity, including loss of habitat for fauna and, to a lesser extent, direct fauna impact from road traffic. The loss of fauna habitat has been compensated through the purchase of an adjacent 650-hectare 'bush block' as a conservation offset, together with the revegetation of approximately 600 hectares of existing cleared farmland to allow its incorporation back into the Bandalup Corridor. At the completion of these revegetation activities and subsequent mine rehabilitation, the width of the Bandalup Corridor will actually be increased.

During the feasibility study, detailed ecological survey work has identified over 700 individual flora species within the project leases, a number of which are endemic to the project leases and in some cases have been identified for the first time.

The project team has focused on reducing clearing of remnant vegetation by locating as much infrastructure as practicable on adjacent historically cleared land. Where clearing is unavoidable, progressive rehabilitation including backfilling of mined areas has been included in the mine development schedule. Additionally, four mining exclusion zones have been established to preserve restricted species. Results from large-scale rehabilitation trials, translocation trials for priority species, genetic studies and seed propagation studies led to the development of rehabilitation and priority species management plans.

Box 2.3. Development of an Environmental Protocol in support of responsible exploration practices – Placer Exploration Limited

In June 1994, Placer Exploration Limited implemented an Environmental Protocol to ensure its field teams followed their EMP and Environmental Checklist. The Protocol is an assessment tool that includes educational material, suggested delegations of responsibilities and two environmental performance indicators (EPIs). The protocol gives responsibility and ownership of environmental outcomes to each member of the field team. It was introduced at a seminar for field teams in January 1995 to emphasize their responsibility for minimizing environmental impacts and rehabilitation of disturbed land. To ensure field teams meet their goals, areas affected by their exploration are assessed by the Environmental Technical Officer (ETO), who then reports back to the team on their environmental performance.

For successful environmental performance, all phases of the operation must be managed properly. For exploration this involves:

- forethought and planning before the exploration activity,
- minimizing impacts during exploration,
- environmental cleanup immediately following the programmed exploration and
- rehabilitation within six months of programmed exploration.

To assist field teams, the ETO developed the Environmental Hit list. It is a robust, laminated, A5-sized, dot-point summary sheet that fits in a vehicle glove box.

Two environmental performance indicators were developed that assign a numerical value to each project, thus allowing comparison between projects. Data collected from each project are reported in a table, showing each variable in the formula and the calculated EPIs. The Environmental Performance Indicator Formulas are as follows:

- For Drilling program that has undergone an environmental cleanup immediately after drilling completed:
  EPI = no. of open holes + no. of areas with excessive tracks + no. of hydrocarbon spills + no. of areas with significant litter / Total no. of holes drilled
- For drilling program that has undergone rehabilitation no later than six months after drilling completed:
  EPI = no. of drill sumps left open + no. of drill holes not buried + no. of areas left unscarified or unripped + no. of sample bags left / Total no. of holes drilled

The results of the assessments are circulated so that everyone in the company knows which project teams are the best performers. This has led to healthy competition among field teams. The assessment outlines clearly the areas needing improvement. The performance indicators also allow comparison of the field teams and indicate the company's performance over time. While visual assessment is somewhat subjective, this is minimized by using simple variables in the EPI and by using one officer to assess the projects. As with most management tools, this approach is being modified and improved over time to enable greater feedback and to increase commitment to good environmental performance.

2.3.1 Pre-feasibility stage

From a biodiversity perspective, at the pre-feasibility stage it is important to develop a fuller understanding of the biodiversity context of the project area (***see section 5.3 on EMS***). Initially, this may not require specialist inputs, provided there is sufficient in-house capacity to apply the systems, tools and processes outlined in Section C of the GPG. However, where initial screening indicates that biodiversity is important within the project area and that more effort will be required if a project proceeds to the feasibility stage, it is advisable to contract specialist expertise on biodiversity to begin to establish a biodiversity baseline, if this has not already been done (***see section 5.2.3 on baseline studies***). This may be either a stand-alone exercise or part of an initial Environmental and Social Impact Assessment (***see section 5.2 on ESIA***).

At this stage, it will be important to undertake the following:

- identification of important areas for biodiversity, whether protected or not, and the status of protected areas and species;
- an initial review of possible mining options (underground versus open-pit, for example), processing options and likely waste products, water demands, options for waste rock or tailings storage and so on and consideration of the merits of each from a technical, economic, environmental (including biodiversity) and social perspective; and
- a preliminary assessment of potential impacts, taking into consideration possible timeframes for development.

It is critically important that the initial analysis of alternative mining options involves substantive, informed and documented environmental and social input (with specific attention to biodiversity in sensitive environments), as options become more fixed with the transition to the feasibility stage. Depending on the source of financing or regulatory requirements, if the project proceeds to the feasibility stage there may be a requirement to demonstrate a credible analysis of alternatives from an environmental and social perspective. It is important that this be based on a credible up-front analysis as opposed to a retrospective attempt to justify the preferred option.

2.3.2 Feasibility stage

During the feasibility stage, the confidence level for proceeding with mining is further increased. At this stage, detailed information will be collected on proven and probable reserves, and mine development and design options will be specified in detail. Detailed production plans will be developed, outlining the quantity of ore to be processed and waste rock to be disposed of. Layout plans showing preferred options for infrastructure, processing facilities, waste treatment and disposal sites and ancillary facilities will be developed. By the end of the feasibility studies, closure plans will also have been established and integrated into project design (***see Chapter 4***). At this stage, design parameters begin to be locked in, and subsequent changes become more difficult.

The steps just described for the pre-feasibility stage should be reviewed and updated in light of the more detailed design information, and a more in-depth assessment of biodiversity and other environmental and social issues undertaken. This is the stage at which a significant investment is made in developing a full understanding of the interfaces between the proposed project and biodiversity and of possible options to avoid adverse impacts and enhance biodiversity protection or conservation. By the end of the feasibility stage, the ESIA work should be in an advanced stage. This should include the following aspects in relation to biodiversity (***elaborated on in Chapters 5, 6 and 7***):

- confirmation of the implications of legal provisions, protected areas and species and any interfaces with the mining project;
- results of baseline studies (***see also section 5.2.3 on baseline studies***), an evaluation of the importance of biodiversity (from a technical perspective and based on in-depth consultations with a range of stakeholders) and a discussion of current threats to biodiversity;
- an assessment of the proposed mining projects' impacts on biodiversity (direct, indirect and induced) and on the users of biodiversity;
- a discussion of mitigation measures (from construction through to closure), the prospects for successful implementation and residual impacts on biodiversity and related stakeholders; and
- a discussion of options for biodiversity conservation or enhancement.

The mitigation measures to address potential impacts on biodiversity would typically be included in an EMP. These ought to specify the measures to be adopted during construction in considerable detail, with decreasing specificity for the operational and closure planning stages. However, while an EMP may often be specified as a regulatory requirement, it is essential that it be integrated into the overall EMS for the mining company and be subject to regular review and updating (***see section 5.3 on EMS***). This is particularly important as the ESIA is often completed in parallel with the feasibility studies, whereas during the detailed design, changes to the plant layout (either an increase in footprint or changes to the location of equipment) may affect biodiversity through increasing disturbance or encroaching on sensitive areas.

2.4 Construction

Construction often represents the period of greatest environmental and social disruption during the mining project cycle. Substantial areas of land may be cleared of vegetation to accommodate project facilities and related infrastructure. In other situations, indirect clearance may occur, particularly in parts of the world where in-migration is common and often unchecked. While construction planning occurs during the feasibility stage and the related impacts are predicted and addressed during the ESIA process, many stakeholders are often unprepared for the realities of construction. This section includes a brief discussion of the intersection between a number of construction elements and biodiversity. These aspects need to be addressed as part of the ESIA process (***see section 5.2 on ESIA***).

2.4.1 Access for construction and ancillary infrastructure

The construction of access roads and other linear project infrastructure (such as dedicated rail lines, pipelines for transport of slurries or concentrates or power transmission lines) can have a significant impact on biodiversity. It may result in the isolation or fragmentation of habitats, which can have a significant impact on biodiversity. Interruption to the natural linkages between populations of plants and animals can create significant, sometimes irreversible, changes. It also results in habitat fragmentation, whereby separated smaller areas are less resilient to change. Edges provide greater potential for pest plants and animals to invade, and isolated areas of land frequently become degraded (***see section 5.2.5 on impact identification and assessment***).

Linear infrastructure can disrupt surface water regimes and significantly affect wetland and groundwater systems. Changes to stream and river flows may affect adjacent habitats or riverine ecology, including fisheries on which downstream communities may be dependent. In more remote situations, where biodiversity is largely undisturbed as a result of limited access, the construction of access roads may induce significant adverse changes through the introduction of alien or invasive species and the provision of access to settlers or other 'users' of biodiversity (such as loggers or hunters).

2.4.2 Land clearance and resettlement

Land clearance has an obvious and direct impact through habitat destruction. The conduct of land clearance, however, can influence the survival of rarer plant and animal species. For example, where rare plant species have been identified during baseline or follow-up surveys (***see section 5.2.3***), these can sometimes be successfully transplanted prior to vegetation removal. Similarly, measures can be taken to improve the prospects for survival of fauna (such as by ensuring that the nesting season is avoided for important bird species (***see also Chapter 7***). Land clearance may also significantly affect the users of biodiversity, most notably through diminishing the resource base of dependent communities. Where communities may also be subject to resettlement as a result of land clearance, their displacement to alternative locations may result in additional pressures on biodiversity in the vicinity of the relocation site.

The sourcing of construction materials may also have a significant impact on biodiversity, and potential impacts and mitigation measures should be considered as part of the ESIA and detailed design. In particular, the opening up of borrow-pits or dredging of sands and gravels may have an impact on terrestrial or aquatic biodiversity.

2.4.3 Construction-related infrastructure

The large numbers of workers associated with the construction of mining projects (sometimes thousands of temporary workers or contractors' staff), along with related infrastructure, can have significant impacts on biodiversity. Of particular concern in ecologically sensitive areas is the likelihood of more permanent in-migration following the construction period. This can result in significantly increased pressures on the natural resource base in general and on biodiversity in particular. One solution is to accommodate temporary workers in construction work camps, but these present their own problems for biodiversity (along with a range of associated social impacts). For example, workers may engage in hunting or make other demands on natural resources (for temporary gardens, for example, or fuelwood). The water demands of the construction workers and related sanitation requirements may also pose a threat to aquatic biodiversity. To control the impacts on biodiversity during construction, some companies have adopted policies of no firearms or no hunting or fishing.

During the intense construction period, many contractors and subcontractors could be on-site at any given time, and the contractual pressures on contractors to deliver are often intense. In these situations, the responsibilities for mitigation measures committed to in an EMP can become diffused or forgotten. In areas of high importance for biodiversity, it is essential the these practical realities are factored into the design of mitigation measures, into the allocation of responsibilities for implementing these measures and into construction supervision to ensure that adequate protection is afforded to biodiversity and affected stakeholders.

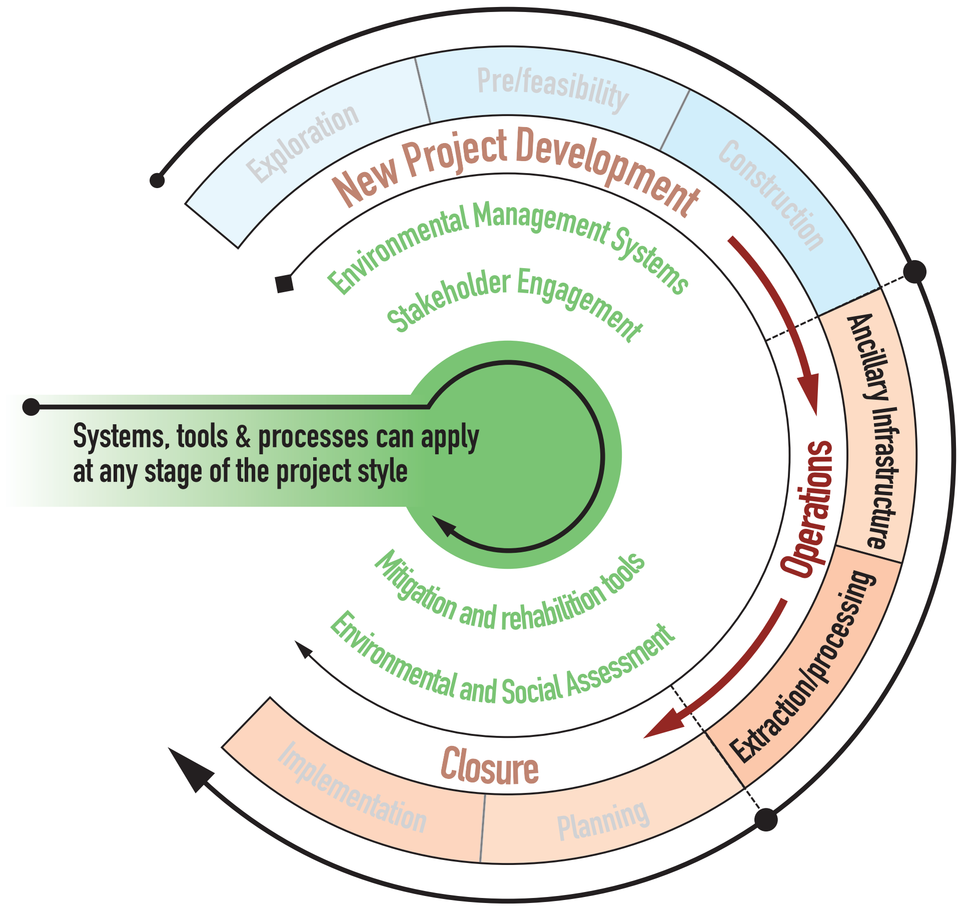
Chapter 3. Integrating Biodiversity into Operations

See checklist 3.1 on page 123

3.1 Introduction

For the purposes of this GPG, operations refers to all activities related to the extraction and processing of ore, the disposal of waste materials and the transport of products (where this is undertaken by the mining company) (***see Figure 3.1***). This is the core business of mining companies and the point at which production commences to offset the costs of construction and related expenditures. It also includes the operational issues relating to the use of ancillary infrastructure, as opposed to the construction aspects (dealt with in Chapter 2).

Figure 3.1: Integrating biodiversity into operations



While construction typically takes one to three years, operations may occur over a period of decades. Whereas the focus of efforts during new project development is almost exclusively on impact prediction and mitigation, the operational phase often provides opportunities for biodiversity protection and enhancement.

For newer mining projects, the operational impacts will have been assessed and considered in detail during the ESIA process. For existing mining operations that may have been in production for some time, and where biodiversity may have received limited consideration prior to production commencing, ***section 5.2.2*** provides guidance on how to identify the interfaces between mining operations and biodiversity and to determine whether biodiversity impacts represent "significant environmental aspects" (in EMS parlance).

A key focus of this chapter is the potential impacts on biodiversity (***see Figure 3.2 for illustrative examples***) from operational activities, but it also highlights the potential for biodiversity enhancements. It is important to recognize that many existing mining operations have active exploration programs aimed at extending probable and proven reserves. Where exploration is likely to result in significant expansion beyond that envisaged as part of the original permitting process, the provisions of Chapter 2 will also apply.

3.2 Ancillary infrastructure: operational considerations

The major potential impacts of ancillary infrastructure occur during design and construction, although a number of operational considerations are also relevant to biodiversity. The potential impacts associated with water and sanitation infrastructure are also present during operations and were dealt with earlier. While the major impacts of linear infrastructure occur during construction, the continuing presence of physical barriers can present a threat to migratory animal species. The principal risk to biodiversity from ancillary infrastructure that has not been previously discussed relates to the transport of hazardous process chemicals, hazardous waste materials (such as sulphuric acid produced from smelter flue gas desulphurization) or hazardous metals (such as mercury) that may occur in association with other metals.

In light of some high-profile hazardous materials spills in recent years (including mercury in the streets of Choropampa, Peru, and sodium cyanide in the Barskaun River, Kyrgyzstan), mining companies are increasingly conducting hazard and risk assessments that explicitly consider transportation issues. However, these are often concerned primarily with human populations as receptors, and they need to be adapted to address the risks to biodiversity. The tools outlined in Chapter 5 can be readily adapted to this purpose (***see section 5.3.2 on determining significant biodiversity aspects***).

Biodiversity may also be affected by maintenance activities on linear infrastructure, particularly weed and pest control. This can be minimized by implementing an integrated pest management or integrated vector management approach for all pest management activities. This advocates the use of alternative approaches to chemical controls in the first instance. Where the use of pesticides is essential, the selected pesticides should be low in human toxicity, effective against the target species, and have minimal effects on non-target species and the environment. Additional guidance is available in the IFC's Performance Standard 3: *Pollution Prevention and Abatement* and related Guidance Note.

3.3 Operations: ore extraction, processing and waste disposal

3.3.1 Ore extraction and processing

The clearing of overburden and pit development are often the most dramatic visual impacts of mining, but even with large mines the areal extent of the pit can be quite limited. The primary impacts on biodiversity result from land clearance for the pit, access routes, and progressive expansion into new areas. Typically, large, long-life mines undergo many expansions in area and capacity, generating a sequence of events that can be the equivalent of new mines being started, so there may also be a requirement to conduct a new Environmental and Social Impact Assessment or update the initial ESIA.

The more gradual and progressive clearing of vegetation to make way for mine facilities and access roads is illustrative of how a great number of smaller impacts can eventually leave areas of natural habitat isolated and sub-critical in size. Introduction of alien or invasive weeds and feral fauna can have secondary impacts that extend well beyond the mine, and these need to be explicitly considered within the EMS or related action plans (***see section 5.3 on EMS***).

Overburden stripping or removal and disposal of waste rock (that is, non-ore-bearing rock or noneconomic ore grades) can also occupy large areas of land and create additional potential impacts on biodiversity through contaminated runoff. This may result from erosion and particulate runoff, especially in high rainfall areas, or from sulphide-bearing wastes leading to acidic runoff and the associated leaching of metals. Standard mitigation measures may be applied to mitigate such impacts (***see section 7.3.2 on rehabilitation implementation and maintenance***).

Different mining methods present different risks and opportunities for biodiversity. Underground mines typically have a small footprint associated with ore extraction and processing. Open pit mines progressively deepen and widen, increasing the areas disturbed each year and offering few opportunities for early rehabilitation. Open cast mines usually offer opportunities for progressive rehabilitation, as the mined areas may be recontoured behind the active mining areas.

'Conventional' ore extraction involves blasting, excavating, and hauling mined ores to processing facilities. Other forms of ore extraction, however, may have acute impacts on biodiversity at the ore extraction stage. Strip mining of shallow and extensive coal deposits results in the clearing of large areas. Placer mining of alluvial deposits (of gold or titanium, for example) often involves even more extensive shallow deposits, which are frequently located in stream beds or wetlands. The presence or proximity of water creates additional challenges for managing the impacts of extraction, although the highly weathered and concentrated nature of the deposits means that the tailings are generally inert (***see section 3.3.2 on management of tailings***).

In addition to the effects on biodiversity associated with land clearance or disturbance, mining operations also have significant potential to affect aquatic, riparian or wetland biodiversity – for example, through altering hydrologic or hydrogeological regimes by mine dewatering or diversion of surface watercourses. In addition, wetland, riparian or aquatic biodiversity may be affected by activities such as effluent discharges to watercourses that either support biodiversity or lie next to wetland or riparian areas of high ecological value, migration of groundwater with low levels of acidity or high levels of metal contaminants from beneath waste rock or tailings storage areas and abstraction of surface or groundwater for minerals processing and potable usage.

Processing facilities, storage areas, ore stockpiles and office areas are reasonably limited in size, although they represent additional takings of land and loss of biodiversity. On-site storage and transport of hazardous materials are also a factor, as discussed in the previous chapter. The main potential impacts on biodiversity relate to:

- accidental releases of process chemicals and tailings disposal from hydrometallurgical processing – that is, minerals processing based on the use of solutions or solvents, primarily water combined with other process chemicals (***see section 3.3.2 on management of tailings***);

- air emissions from pyrometallurgical processes such as roasting and smelting, which include sulphur dioxide, particulates and heavy metals, which may be toxic to flora or fauna;
- disposal of slag from pyrometallurgical processes which contains toxic metals; and
- low-grade stockpiles seeping into surface and groundwaters.

Plume dispersion impact modelling of pyrometallurgical emissions will often consider impacts on human receptors, but need to be refined to address impacts on biodiversity.

Figure 3.2: Examples of the intersection of operations and biodiversity

POTENTIAL IMPACTS	MINING ACTIVITIES	Ore processing and plant site	Plant site, materials handling, etc.	Extraction and waste rock storage	Rock blasting and ore removal	Mine dewatering	Placer and dredge mining	Ore stockpiling	Pyrometallurgical processing	Hydrometallurgical processing	Use and storage of process chemicals	Tailings containment/disposals
Impacts on terrestrial biodiversity												
Loss of ecosystems and habitats			●	●			●					●
Loss of rare and endangered species			●	●			●					●
Effects on sensitive or migratory species			●	●	●				●	●		●
Effects of induced development on biodiversity												
Aquatic biodiversity & impacts of discharges												
Altered hydrologic regimes			●	●	●	●	●			●		●
Altered hydrogeological regimes				●	●	●				●		●
Increased heavy metals, acidity or pollution			●	●	●	●	●	●		●	●	●
Increased turbidity (suspended solids)			●	●	●		●	●		●		●
Risk of groundwater contamination			●	●	●	●		●		●	●	●
Air quality related impacts on biodiversity												
Increased ambient particulates (TSP)			●	●	●			●	●			●
Increased ambient sulfur dioxide (SO_2)									●			
Increased ambient oxides of nitrogen (NO_x)									●			
Increased ambient heavy metals			●	●	●			●	●			●
Social interfaces with biodiversity												
Loss of access to fisheries			●	●								●
Loss of access to fruit trees, medicinal plants			●	●								●
Loss of access to forage crops or grazing				●		●		●		●		●
Restricted access to biodiversity resources				●								●
Increased hunting pressures			●									
Induced development impacts on biodiversity												

3.3.2 Management of tailings

Tailings arise where mined ores are upgraded to concentrates or final products by physical processes such as screening, crushing and grinding or by chemical methods such as leaching. The biodiversity impacts of tailings storage chiefly occur in three different ways. First, creation of the initial footprint has unavoidable impacts, and thus site selection is the design factor with the most profound influence on operational impacts, rehabilitation costs and post-closure liability. Site choice can significantly alter the impacts on biodiversity and its users. Second, tailings may contain entrained liquors and mobile metal contaminants, and these can seep into groundwaters or emerge in surface streams, with ecological impacts. Third, accidents, which happen rarely, can have catastrophic impacts and be widely publicized. Good design and construction, along with management and monitoring systems (***see Chapter 5***), will minimize the likelihood of accidents occurring as well as the opportunity for adverse campaigning and publicity by local communities and national and international NGOs.

The waste material or tailings may be disposed of in a number of ways, with differing implications for biodiversity. Land-based storage is the most common method used. It usually involves constructing a dam across a valley and creating a tailings impoundment, except in flat areas where the 'dam' may encircle the entire impoundment. In some circumstances, it may be possible to return tailings to a mined void.

In countries where precipitation exceeds evaporation, such as Canada and Norway, water-retaining dams and diversion structures can be created around existing water bodies to allow tailings to be placed below the water surface. This method has the advantage of preventing oxidation of sulphidic tailings and related acid drainage. The potential impacts of these structures on biodiversity are usually localized, but if a breach occurs the downstream impacts can be significant and extensive.

Submarine tailings disposal (STD) is used in some cases. Modern STD systems typically involve treating tailings to remove the most harmful chemicals, de-aerating and diluting with seawater (to reduce buoyancy) and then pumping tailings through a submerged pipe prior to discharge at depths of 80 – 100 metres. The aim is to release tailings below the surface thermocline and euphotic zone, so the tailings form a 'density current' that readily descends to the depths of the ocean. While proponents argue that the somewhat uncertain impacts on bottom-dwelling (benthic) organisms are preferable to land-based impacts on biodiversity, the efficacy of STD is challenged on environmental grounds. Critics point to the risks of pipe breakages, unanticipated patterns of tailings dispersal and impacts on benthic organisms, and they challenge the acceptability of disposing of contaminants in the sea.

The final method of tailings disposal is riverine disposal, where surface waters can be used to dilute and disperse tailings or, in other cases, as a means to transport tailings to a managed deposition area where they can be stabilized and rehabilitated. The practice is not common and is used in situations where high rainfall, mountainous terrain and seismic activity rule out other options.

Irrespective of which method is used, the implications for biodiversity should be explicitly considered. Determination of the appropriateness of any particular tailings management practice must be made on a case-by-case basis. Risk assessment procedures can be used to identify potential and probable impacts and thus the appropriateness of different tailings management scenarios. The risk assessment, through the use of multiple lines of evidence, can also be used to make determinations and predictions of future risks. The appropriate tailings management method should meet the requirements set by the results of the risk assessment in conjunction with those of regulatory agencies and other stakeholders. Stakeholder engagement tools and processes are described in Chapter 6.

3.4 Opportunities for biodiversity protection or enhancement

The primary focus of the GPG up to this point has been on potential impacts or threats to biodiversity from mining. These impacts occur within a broader context of threats to biodiversity that need to be considered if mitigation or protection/enhancement efforts are to be successful. The identification of external threats is discussed further in Chapter 5 (***see section 5.4.1 on maturity of the conservation context***). However, these threats also represent opportunities to go beyond mitigating adverse impacts on biodiversity and to explore opportunities to enhance biodiversity conservation. This aspect is discussed in greater detail in section 7.5.

The assessment of threats to biodiversity and the development of conservation or enhancement proposals must not take place in isolation but with the engagement of key stakeholders. For example, stakeholders have an important role to play in identifying and establishing priorities regarding threats to areas of importance for biodiversity, as well as in developing and implementing proposals for conservation enhancement. These aspects are explored further in Chapter 6 (***see section 6.2 on stakeholder identification and analysis***). In addition, section 5.4 proposes an extension of current approaches to ESIA to include an assessment of the factors that would influence the likely success of mitigation or enhancement measures.

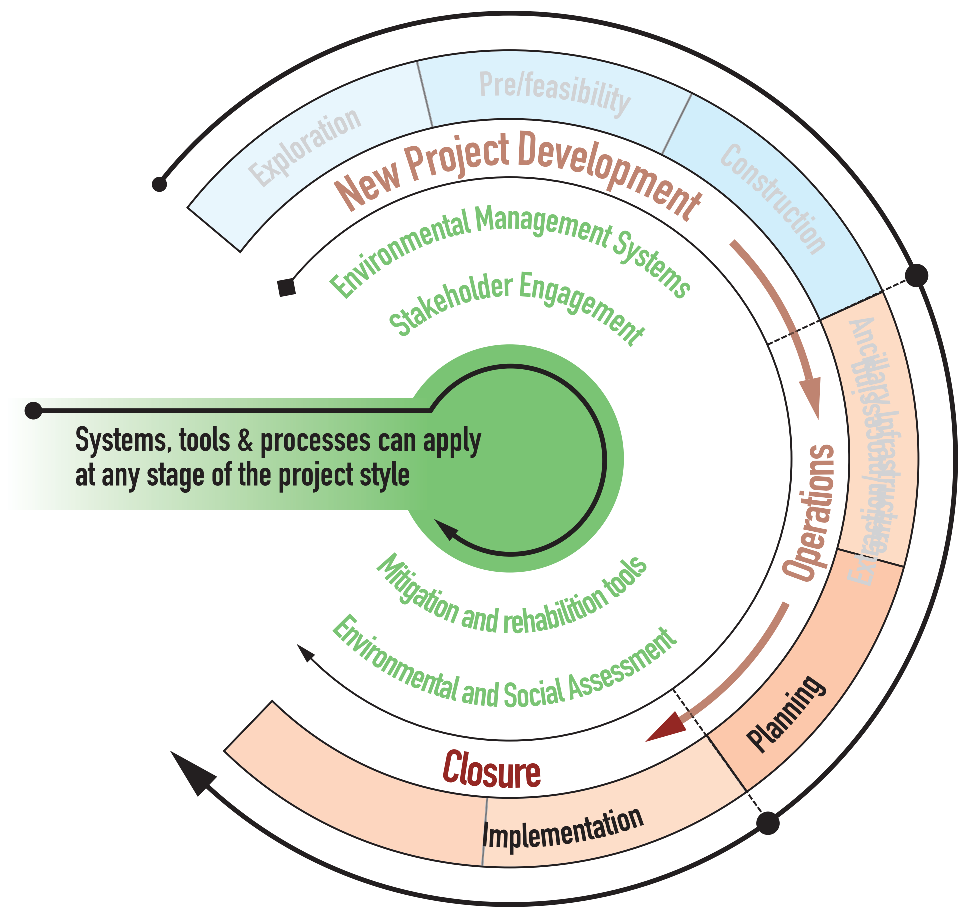
Chapter 4.
Integrating Biodiversity into Closure Planning and Implementation

See checklist 4.1 on page 124

4.1 Introduction

For the purposes of this GPG, closure planning refers to the process for ensuring that mining operations are closed in an environmentally and socially responsible manner, usually with the overarching objective of ensuring sustainable post-mining land uses. The process of planning for closure should engage stakeholders extensively on their post-closure objectives and aspirations and should attempt to reconcile any competing perspectives (such as economic post-closure land uses as opposed to biodiversity conservation land uses). It must take a whole-of-mine-life perspective and address all aspects of closure, not just those relating to biodiversity conservation and rehabilitation. Closure implementation involves rehabilitation and pollution prevention measures to ensure that post-closure objectives are achieved, as well as complementary measures to address social and economic aspects (***see Figure 4.1***).

Figure 4.1: Integrating biodiversity into closure planning



Whereas Chapters 2 and 3 primarily focused on impact identification and to some extent mitigation, closure planning is primarily about identifying and implementing opportunities for rehabilitation and conservation enhancement. Planning for closure should begin during the project development phase and be revisited periodically throughout the operational phase. The closer a mine is to closure, the more details the plans should contain. Closure planning presents an opportunity for restoration of biodiversity affected during the exploration and operational phases, at least to some extent. It should consider the findings of baseline and ongoing biodiversity surveys and monitoring. An important focus of closure planning should be the long-term sustainability of conservation, mitigation and rehabilitation measures and any related monitoring requirements.

4.2 Closure planning: Establishing objectives and targets

Achievable objectives and targets for biodiversity re-establishment are essential to give the company a framework on which to base its rehabilitation program and to provide measurable standards against which regulatory authorities and other stakeholders can determine whether the company has met all necessary requirements prior to mine closure and lease relinquishment. These targets and objectives for biodiversity should be integrated into the overall EMS for an operation (***see section 5.3 on EMS***).

The establishment of closure targets and objectives is not a one-shot desk-based exercise; it should be developed through a dynamic and iterative process involving mining stakeholders. When setting biodiversity objectives and targets, the following aspects should always be taken into account:

Relevant regulatory requirements and other guidelines: These will usually include requirements specified in the EMP to the ESIA prepared prior to project approval and construction, as well as other applicable laws, regulations, policies and guidelines (such as those pertaining to biodiversity protection and rare species conservation). The register of legal requirements developed for the operations' EMS should be checked and the requirements should be discussed with relevant government authorities. In addition, any national or regional initiatives and action plans to implement the Convention on Biological Diversity should be reviewed in the context of setting closure targets.

Effective consultation with key stakeholders: Consultations with stakeholders on matters relating to closure should commence early and initially focus on broader issues of post-closure land uses. However, as additional information becomes available on biodiversity through ongoing monitoring and surveys, rehabilitation scenarios can be developed, ideally with the involvement of stakeholders (***see section 6 on stakeholder engagement tools and processes***). This was the approach adopted at Misima Mines in Papua New Guinea (PNG) (***see Box 4.1***).

Competing interests need to be understood and reconciled: Linked to the previous point on consultation, there are likely to be competing pressures and perspectives on desirable post-closure land uses. For example, farmers may like to see land being converted to productive agricultural or forestry uses, planners may see the land as having the potential to satisfy increasing demand for housing, while conservationists may envisage post-closure land uses that promote biodiversity enhancement. Understanding and reconciling these competing interests is an essential component of the closure planning process (***see section 6 on stakeholder engagement tools and processes***).

All available information on biodiversity: Based on the pre-mining biodiversity values, closure planning will need to consider whether these can realistically be replaced, using recognized good practice rehabilitation methods with adaptive management. The information needs to be viewed from an ecosystem perspective and to take account of aspects such as floral and faunal communities, habitats, key indicator species, stakeholder aspirations and rare, threatened or uncommon species.

Technical limitations: Mining may result in significant changes to soil characteristics, microclimate, topography, and hydrology. Propagation methods for some plant species originally present may be unknown. In addition, the innate characteristics of the site – in terms of nutrient status, slopes, water availability, and so on – may also profoundly influence the types of plant and animal communities that may ultimately be supported. These and other technical limitations need to be considered so that the biodiversity objectives set are achievable.

Pre-mining land uses and the extent of biodiversity degradation: Pre-existing land uses and the extent of disturbance of biodiversity have a bearing on whether native ecosystems should be established following mining. Expectations of stakeholders will clearly be higher in cases where mining has taken place in a relatively undisturbed ecosystem rather than in an area that has been heavily degraded by other land uses.

Whether mitigation or enhancement is intended: Where biodiversity may have been degraded prior to mining, the principles of mitigation require mining companies to rehabilitate biodiversity to a comparable extent. But companies committed to excellence will often aim instead for enhancement, as part of a net biodiversity gain. For example, those mining in heavily cleared and overgrazed areas may choose to re-establish a vegetation community with significantly higher conservation values than existed before mining.

Box 4.1. Sustainable post-closure land uses – Misima Mines Limited, Papua New Guinea

Placer Dome Asia Pacific's Misima Mine is located on the island of Misima, some 600 kilometres east of the Papua New Guinea capital, Port Moresby. The climate is tropical, with high temperatures and average rainfall of 3,000 millimetres a year. The original vegetation was predominantly wet tropical rain forest, but there are now substantial areas of secondary growth consisting of regrowth forest (following logging to produce timber for early mining activities) and old 'gardens' (cleared patches that locals used for subsistence gardens). The forest and secondary vegetation are used by local villagers as a source of building timbers, wood for carving, food (edible fruits and nuts, hunting and egg collecting), flowers for decoration and medicinal and ceremonial fruits and leaves.

Although artisanal mining commenced in the 1880s, Misima Mines developed a modern open-cut mining operation in the 1980s. The mine is now in the final stages of closure and serves as a good example of how biodiversity considerations can be integrated into closure planning to meet the socioeconomic and cultural needs of the local population. The company recognized that complete restoration of the pre-impact ecosystem was not a realistic objective. Through extensive consultation with the PNG Government and the community, the company developed a rehabilitation strategy designed to meet the requirements of the local people in terms of garden land and forest products as well as environmental goals such as long-term stability, biodiversity and ecosystem resilience. The objective of the revegetation program is 'to form a stable, biologically diverse and resilient ecosystem that is productive for future generations, either as forest or subsistence agricultural land'.Revegetation of mine dumps is accomplished in three stages, using locals employed from the clan to which the land will revert. Stabilization involves the rapid establishment of grass and legume ground covers to protect the soil from erosion. These also produce organic matter and build up soil nitrogen. Phase 1 planting consists of establishing 12 rapid-growing species of shade trees that can tolerate the relatively exposed conditions. Finally, after three to four years, the trees form a dense canopy that reduces the density of groundcover plants and allows Phase 2 planting of 'climax' forest tree species to take place. Recognizing the importance of botanical diversity in the forest, the company is planting around 70 different tree species, propagated in the local nursery.

Progressive rehabilitation has meant that when milling operations ceased in May 2004, 80 per cent of disturbed areas had already been rehabilitated. Over time, colonization from unmined areas will increase the number of species present, resulting in biodiversity objectives being met and the development of a sustainable forest capable of meeting the community's needs. However, it is acknowledged that sites will not be able to be used as gardens in the near future until soil nutrients re-establish to levels suitable for supporting garden activities. A monitoring program has been implemented to assess progress towards the long-term rehabilitation objectives. Training and research programs have been established to provide the community with the knowledge and skills necessary to sustainably manage the forest in conjunction with other commercial agricultural cash crops such as coconuts, vanilla and bananas.

Note: Barrick Gold Inc. took over Placer Dome in early 2006 and now has this site under its closure department.

Post-mining land tenure and land uses: Post-mining land tenure will influence what conservation objectives are possible. Due to population pressures, some areas may not be available for conservation purposes. In these situations, objectives and targets for biodiversity conservation in mined and other leasehold areas will need to take into account other land uses and to focus on outcomes that deliver the best overall environmental, economic and social outcomes.

Integration into whole-of-lease biodiversity management: Unlike some aspects of rehabilitation, for biodiversity conservation and re-establishment it is very important to minimize impacts on the floral and faunal communities of surrounding areas over which the mining company has control. Initiatives such as reducing grazing, controlling introduced predators and herbivores, fire management, weed eradication and establishment of nest boxes can be used to enhance conservation values in unmined areas of the lease and can provide the sources of recruitment over the longer term. Local conservation groups are a good source of information on what initiatives might prove the most cost-effective.

Minimizing secondary impacts: Some rehabilitation objectives should focus on minimizing secondary impacts of the mining operation – for example, by controlling erosion that could increase downstream sediment loads, affecting aquatic biodiversity.

Other opportunities for biodiversity improvement: Discussions with stakeholders prior to the setting of rehabilitation objectives can reveal other opportunities for biodiversity improvement that the community may not have the technical or financial resources to implement. For example, the company could consider donating plants or seed to schools and community groups for local revegetation projects, providing training programs on rehabilitation and managing conservation values, communicating (through newsletters) and sponsoring species management and recovery plans.

In establishing closure targets and objectives with respect to biodiversity, estimates and provisions should be made for the costs of closure. ICMM has recently published a relevant study on financial assurance for mine closure and reclamation (***see Section D***).

Once the closure targets and objectives have been established, a strategy for closure and a detailed management plan will need to be developed, setting out the responsibilities, methods, timing and costs for implementing agreed objectives (which will include biodiversity and a range of other post-closure objectives). These aspects are the subject of a current ICMM project.

4.3 Closure implementation: Rehabilitation and pollution prevention

Mining represents a transient land use, and the aspiration should always be to restore land used for mining to some 'productive' use. In broad terms, rehabilitation refers to the measures undertaken to return land on which mining has taken place to the agreed post-closure uses. Implicitly, this requires that the rehabilitation measures are not undermined in the longer term by residual pollution (such as the presence of toxins in soils used for revegetation or of acid rock drainage). In some jurisdictions, the legal requirement is for restoration of the pre-mining land use, whereas in others the end uses are open to a process of negotiation, either with the regulatory authorities or with a broader set of stakeholders. Restoration can sometimes impose significant costs – for example, restoration costs for grazing land in Queensland were reportedly more that two orders of magnitude greater that the value of adjoining grazing land. In contrast, alternative rehabilitation options might be achieved at a lower cost but with a greater potential benefit to biodiversity.

A rehabilitation objective responsive to biodiversity might read as follows: *'To establish a sustainable native ecosystem that is as similar to the pre-existing ecosystem as can be achieved within the limits of recognized good practice rehabilitation techniques and the post-mining environment'.*

This commits the company to implementing good practice rehabilitation aimed at re-establishing pre-existing conservation values, but acknowledges that some aspects that may be unavoidable (such as altered soil, topographical and hydrological characteristics) might limit the extent to which this can be done. Progress towards achieving this objective can be measured by comparing biodiversity parameters in the rehabilitated area with those in selected unmined reference sites. Other objectives may address more specific aspects, such as the provision of habitat for rare or uncommon species.

Box 4.2. Involving communities in mine life planning – Gregory Crinum Coal Mine, Queensland, Australia

Gregory Crinum consists of two coal mines operated by the BHP Billiton Mitsubishi Alliance (BMA). These open cut and underground operations feed coal to a single wash plant and rail loadout. The mines are situated in an area that has been extensively cleared for grazing and agriculture but that also contains areas of remnant vegetation, some of which have conservation value due to their scarcity. The community consultation methods used by BMA to develop its Mine Life Plan are an example of how mining companies can involve stakeholders in helping to make key decisions on long-term land use issues.

The process commenced with a public meeting in September 2002. A Community Working Group was formed from local stakeholders. It included representatives of land care, environmental, regional planning and agricultural groups, as well as local government, the Queensland Environmental Protection Agency and Gregory Crinum mine management, environmental and community relations personnel. An independent facilitator was contracted to help the process work smoothly. Input from the group was used to help work out the best future-use options for different land units (or domains) on the whole mining lease, so that the mine could do the necessary earthworks, establish the right vegetation (trees, shrubs and grasses) and anything else required to translate the plan into reality. The group also helped develop criteria to measure whether the mines' rehabilitation efforts were successfully progressing towards agreed land uses. A review process was developed to ensure the Plan evolved over time to reflect changing community values and advances in scientific knowledge.

The Community Working Group met 16 times over eight months. Members soon reached consensus that a number of land uses were possible on the various domains. These included native vegetation conservation, grazing, agroforestry, recreation, cropping and industrial areas. Specific success measures were developed for post-mining land uses. The criteria fell into various categories, including vegetation establishment (density, composition, species richness and sustainability); management of dust, fire, weeds and feral animals; ecosystem function; connectivity (linking areas of environmental significance); post-mining land management; and sustainability of proposed post-mining land uses. Protection of remnant stands of Brigalow (and Acacia tree species) was recognized as important for the ongoing conservation of endangered ecosystems that are part of the habitat for the rare Bridled Nail-tail Wallaby.

The ongoing review process will involve the mine circulating information on any developments that may affect the mine plan. Members of the Community Working Group and invited community members and groups meet annually to review the Mine Life Plan, measure current rehabilitation progress against success measures and if necessary, make changes to the Plan. BMA is now using a similar approach to develop rehabilitation and mine closure strategies at the company's other coal mines.

It is important not to raise false expectations among stakeholders. Companies should check what other mines operating in the region have achieved and what recent research indicates is possible. Local revegetation projects carried out by volunteer groups might also provide useful information on the re-establishment of native vegetation. The experience of the Gregory Crinum coal mine illustrates the benefits of engaging communities in planning for rehabilitation and closure (***see Box 4.2***).

Box 4.3. Restoring botanical richness after bauxite mining – the Jarrah Forest, Southwestern Australia

Alcoa World Alumina Australia operates two bauxite mines at Willowdale and Huntly in the Darling Range of southwestern Australia. The Huntly mine is the largest bauxite producer in the world. The mine pits range in size from one hectare to tens of hectares. Alcoa's aim after bauxite mining is to re-establish all the pre-existing land uses of the forest. Re-establishing the jarrah forest on the mined areas that is as similar to the original forest as possible was determined to be the best way to achieve this goal.

The jarrah forest is a highly valued resource for the people of Western Australia. It is renowned for its diverse flora, being one of the most plant-species-rich forests in the world outside of tropical rain forests. Restoring botanical richness is thus seen as an important objective for re-establishing a jarrah forest.

The program started with five-year improvement milestones. The first milestone was to achieve 80 per cent of forest-species richness. When this was accomplished, a new milestone was set for 2000 – that, on average, 100 per cent of the indigenous plant species found in representative jarrah forest sites would also be found in a 15-month-old rehabilitation, with at least 20 per cent of those found being from a resistant species priority list.

Alcoa reached its goal. In 2000, the company achieved an average of 100 per cent at Huntly and Willowdale – in other words, all the rehabilitated areas had on average the same number of indigenous plant species as found in nearby jarrah forests. The goal now is to maintain this good record and thus the botanical richness of the area after mining. It is within this context that Alcoa has developed a scientifically based, best practice rehabilitation procedure. (***See also Box 7.2.***)

While many mining companies have achieved remarkable results in re-establishing native ecosystems (***see Box 4.3***), where cost or other site-limiting factors make this impractical, other objectives that still provide biodiversity values should be considered. Examples include:

- revegetation using important functional species (for erosion control, for instance, or nitrogen fixation), species with aesthetic value, and any local species important for biodiversity conservation that it is practical to establish, while guarding against the introduction of exotic/non-native species that could proliferate without adequate controls;

- situations where other land uses such as the production of foods, medicines or cultural values are a priority – in these instances, re-establishment of biodiversity values may be a secondary but compatible objective;
- re-establishment of key species, such as rare or threatened plant species, or development of habitat suitable for the recolonization of rare or threatened fauna species; and
- rehabilitation that is stable, sustainable and includes the use of native species where possible.

Examples of the latter might include the surface of a tailings dam, where soil structure and chemistry are very different from those of nearby unmined areas. Nevertheless, every effort should be made to construct a soil profile suitable for plant growth and to establish local native plant species that will replace some biodiversity while still fulfilling critical functions such as erosion protection and water uptake.

Frequently, no specific time limits are given by which rehabilitation objectives must be met. This is a matter for discussion between the company, regulators and other stakeholders. Valid reasons for the uncertainty include unpredictable weather and limited experience in relation to successional processes in the site's specific post-mining environment. The recommended approach is to establish monitoring and research programs (***see section 7.3.3 on ongoing monitoring and research***) and draft completion criteria and to agree to a series of reviews of the situation at designated time periods.

When setting rehabilitation objectives for biodiversity, mining companies should always take into account the management requirements that will be needed to sustain conservation values in the long term, responsibilities for implementation and how the costs of management will be funded.

SECTION C:

Management, Assessment, Mitigation and Rehabilitation Systems, Tools and Processes

Chapter 5. Management Systems and Assessment Tools

5.1 Introduction

This chapter outlines some of the main systems and tools used for the assessment and management of biodiversity issues. The principal tools discussed are the Environmental and Social Impact Assessment and Environmental Management Systems. ESIA is typically associated with the exploration and feasibility stages of the mining project cycle, whereas EMSs are more closely associated with operations and mine closure. As indicated in Chapter 1, however, the systems, tools and processes discussed in this and subsequent chapters are applicable at any of the three operational stages discussed in Chapters 2, 3 or 4. For example, implementation of an EMS during exploration provides a framework for identifying and managing impacts at this early stage. Similarly, the determination of significant biodiversity aspects for an EMS may require the application of the evaluation and assessment stages of ESIA. Increasingly, ESIA is viewed as a process for managing environmental and social impacts rather than an exercise solely linked to permitting requirements.

While users of this GPG will be familiar to some extent with both EMS and ESIA, the specific relevance to biodiversity assessment and management is described below. In addition, some approaches for extending the reach of conventional analyses are outlined.

5.2 Environmental and Social Impact Assessments

5.2.1 Introduction to the ESIA Framework

Environmental and Social Impact Assessment is an important tool for ensuring that biodiversity is integrated into project planning and decision-making and that relevant environmental and social interfaces are considered. The ESIA process provides a structured approach to considering the environmental, economic and social consequences of options and alternatives when developing a mining project.

Although legislative requirements and practices vary around the world, the fundamental components of an ESIA of relevance to biodiversity include the following:

- screening or scoping to identify the environmental and social aspects to be assessed and to determine the level of assessment required for a project;
- baseline studies of environmental and social aspects to determine their pre-mining status to assist in impact prediction and monitoring of actual changes;
- impact prediction and assessment of the level of impacts that may result because of the project, including an analysis of alternatives;
- mitigation and enhancement measures and the incorporation of protective measures in the design of the project and into EMPs;
- monitoring to ensure that the predictions are accurate and that any unpredicted impacts or failed mitigation measures are identified and rectified;
- follow-up audits to ensure that EMPs are implemented; and
- requirements for consultation, at a minimum, or more substantive forms of stakeholder engagement throughout the process.

In order to take into account of the various aspects of biodiversity, the ESIA should:

- assess the relevant levels of biodiversity, namely ecosystem, species and, if appropriate, genetic biodiversity;
- assess the interconnections between the levels of biodiversity by considering the structural and functional relationships and how they will be affected by the proposed project;

- collect detailed data of key biodiversity indicators;
- assess the full range of impacts, including primary, secondary, cumulative and induced impacts;
- assess the importance of community and indigenous knowledge of local biodiversity aspects and stakeholder participation;
- clarify the criteria used to assess impacts; and
- consider impacts and mitigation measures for biodiversity.

The applicability of ESIA to the stages of the mining project-cycle is illustrated in ***Figure 5.1***. It is important to recognize that the application of ESIA benefits greatly from being undertaken within an overarching strategic planning framework in which the development and conservation potential of land has been considered in an integrated manner at a regional level. This may take the form of government-sponsored strategic regional planning exercises, strategic ESIAs conducted at the sectoral or regional level, river-basin management planning or initiatives such as the UNESCO/IUCN Landscape Level Planning Initiative[6] – which ICMM participates in. Ideally, such strategic planning exercises will have been conducted with multi-stakeholder input. While increasingly commonplace in many western industrial countries, in developing countries a strategic planning context is often absent, and ESIA documents are more likely to be subject to contrary opinions concerning project impacts and acceptability. This situation is revisited in ***section 5.4***.

5.2.2 Screening and scoping of biodiversity issues

The purpose of screening and scoping is to identify the environmental and social aspects to be assessed and to determine the level of assessment required for a project. This involves an initial appraisal of the biodiversity context of an exploration site or expansion project. The following primarily desk-based steps can help to initially establish the biodiversity context:

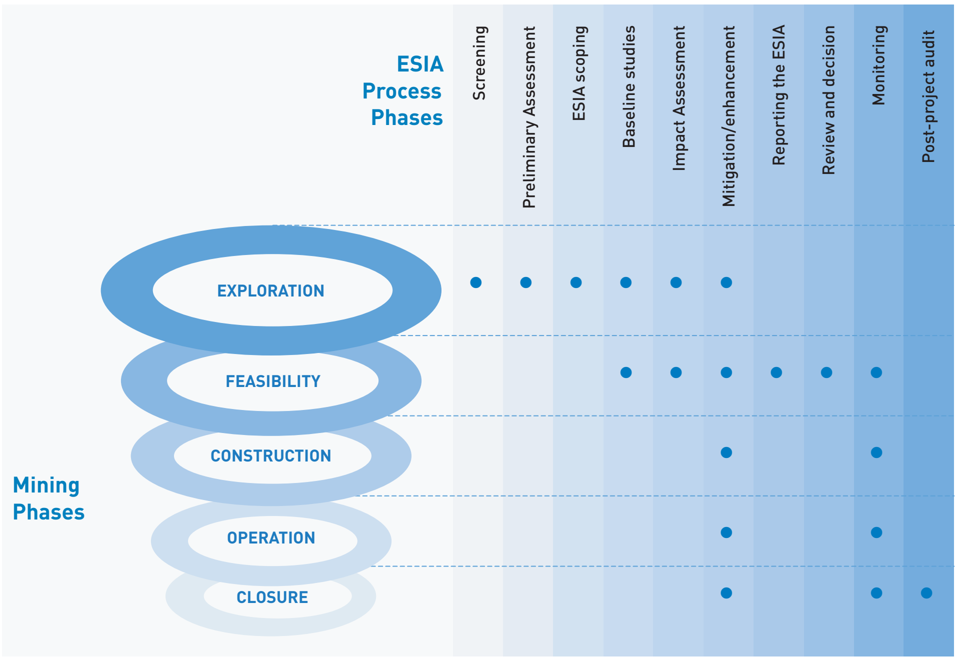
- obtaining readily available information on biodiversity through review of maps and publications available online;
- identifying whether the site or surrounding area falls within a protected area – that is, whether it is an area designated for biodiversity protection at a local, national, regional or international level (***see Section D for key sources of information on this and the next two bullet points***);
- identifying whether the site or surrounding area is not currently protected but has been identified by governments or other stakeholders as having a high biodiversity conservation priority;
- identifying whether the site or surrounding area has particular species that may be under threat (although the area may not currently be officially protected);
- reviewing legal provisions relating to biodiversity; and
- eliciting the views of stakeholders on whether the site or surrounding area has important traditional or cultural value.

Where this initial screening stage identifies areas of high importance for biodiversity, more detailed consideration should be given to possible impacts on such areas, both direct and indirect, such as the impacts related to ancillary infrastructure.

Either subsequently or in parallel, a basic survey of 'natural' areas should be undertaken, using maps and planning documents, aerial surveys or a site walkover. This is important, as biodiversity importance is closely correlated with undisturbed vegetation. Early engagement with stakeholders can also help identify the uses that people make of biodiversity and any areas of particular importance.

[6] In March 2004 UNESCO convened a meeting of several interested organizations, including IUCN and ICMM, to discuss a Landscape Level Planning initiative. The outcome of that meeting was support for the initiative from a variety of sectors, including conservation organizations and industry groups. UNESCO will thus be carrying forward the initiative together with the assistance of the Cambridge Centre for Conservation Policy. IUCN and ICMM will participate in the initiative.

Figure 5.1: Applicability of ESIA to the stages in the mining cycle



During the screening and scoping stage, it is also important to begin to map the intersection between proposed mining activities and potential impacts, bearing in mind the following:

- **Cast the net wide:** Look beyond the obvious interfaces between biodiversity and mining, such as land clearance. For example, if discharges into watercourses are likely, consider the impacts on migratory fish and downstream wetlands.
- **Include transport routes and associated infrastructure:** Consider the impacts that a spillage of process chemicals or hazardous wastes en route to or from the mining operation would have on biodiversity. In addition, ensure that ancillary infrastructure such as dedicated power supplies or product export infrastructure are considered.
- **Consider societal interfaces with biodiversity:** Biodiversity may have a variety of important uses or values to local communities or others, ranging from the aesthetic to a strong dependence for subsistence or livelihoods.

5.2.3 Baseline studies: when, how and practical considerations

Baseline studies establish a foundation for impact prediction, for monitoring predicted impacts and for evaluating the success of mitigation measures. For new projects, the collection of detailed baseline data may be important where:

- initial efforts at mapping the biodiversity context identify areas of potential but uncertain importance for biodiversity, which would benefit from additional study to establish a baseline;
- the land adjoining or affected by the operation is clearly of value for biodiversity but is subject to a range of existing threats (which might or might not include mining), and additional fieldwork could be used to characterize the nature and relative importance of threats; or

- areas of importance for biodiversity adjoin a proposed mining operation but patterns of usage are complex and not clearly understood and local communities have a high dependence on biodiversity, so that additional fieldwork could help establish usage patterns and perhaps the related values that people place on access to biodiversity.

Box 5.1. Partnership for improved biodiversity understanding – Pic de Fon Forest, Guinea

The Upper Guinea forest ecosystem, which includes portions of the West African country of Guinea, once covered an estimated 420,000 square kilometres. Centuries of human activity have resulted in the loss of nearly 70 percent of the original forest cover. The remaining Upper Guinea forest is restricted to a number of isolated patches that are refuges for the region's unique species, including the chimpanzee and pygmy hippopotamus. One of these isolated patches is the Pic de Fon classified forest in Guinea.

Rio Tinto Iron Ore Atlantic (RTIO), a division of Rio Tinto, is currently prospecting for iron ore within the Pic de Fon Forêt Classée. Given the potential for high biodiversity within the Pic de Fon, Rio Tinto entered into an agreement with Conservation International (CI) to assess the region's biodiversity, as well as the existing and potential socio-economic threats to and opportunities for conservation in the Pic de Fon. This partnership was formed in the spirit of providing significant gains for biodiversity conservation, the communities that rely on resources within the region, and the government of Guinea.

A terrestrial biological survey, conducted in partnership with CI's Rapid Assessment Program (RAP) and West Africa program, was completed in November and December 2002, to examine sites within Rio Tinto's concession in the Pic de Fon. During the RAP, nearly 800 species were recorded, including several species new to science and 11 threatened species, such as the West African chimpanzee and Sierra Leone Prinia. These findings will feed into Rio Tinto's baseline studies for its Social and Environmental Impact Assessment.

Also in December 2002, CI conducted a socio-economic threats and opportunities assessment on the region. Several threats were identified, including bushmeat hunting and unsustainable agricultural practices. Building from the findings of these assessments, an initial biodiversity action plan has been developed. From this, CI and RTIO have conducted a second RAP in adjacent Forêt Classée areas with view to developing a biodiversity database for south-east Guinea. RTIO is also working with the Royal Botanical Gardens, Kew; Birdlife International; FFI and their respective Guinean partners in implementing an integrated regional land-use planning process in Forest Guinea. This includes the Pic de Fon and surrounding areas and will benefit biodiversity conservation, industry, the communities that rely on resources within the region and the government of Guinea.

For existing projects, additional fieldwork could be undertaken where:

- an existing operation has been active for many years and the original permitting requirements contained few if any provisions relating to biodiversity and there is little or no other information readily available;
- the preferred post-closure land uses include biodiversity conservation or enhancement but there is limited information available on the current status of biodiversity; or
- an operation has had unintended and unanticipated adverse consequences on biodiversity.

Few operations will have the requisite skills in-house to undertake biodiversity surveys (or the other types of fieldwork referred to above). The main options for undertaking fieldwork include:

- **Hire consultants:** Numerous ecological consultants provide these services regarding whole ecosystems or habitats or species of interest; many of them operate independently and have a particular niche or area of focus. Where possible, personal referrals are the best means of identifying consultants.
- **Engage a conservation organization:** Some conservation groups also offer services such as biodiversity surveys and have the benefit of local knowledge. They may also be potential future partners in conservation initiatives. This was the experience of Rio Tinto Mining and Exploration Limited in Guinea (***see Box 5.1***), where an initial baseline study contribution developed into a more substantive partnership.
- **Involve a research institution or university:** These can be valuable sources of expertise and knowledge, provided that the research objectives (and time lines) of the mining company and research institution are compatible.

Whoever undertakes the fieldwork should recognize the benefits to be gained by involving the biodiversity stakeholders. They should also be clear that the objective is not just to create an inventory of the plant and animal species that are present but to evaluate the overall biodiversity importance. Often the most significant challenges of baseline assessments are to incorporate spatial and seasonal variations, as insufficient time may be available to develop an accurate assessment. This highlights the importance of starting assessments early in the mine cycle to establish pre-project trends from which changes can be measured.

The results of the baseline assessment can be shared with stakeholders through the engagement process. This will ensure that the setting of the project is in line with the stakeholders' expectations of the environment. Additionally, it demonstrates transparency and encourages cooperative relationships among interested parties.

The collection of baseline data may also reveal additional biodiversity values of the mine site that were not previously recognized. Therefore, following an evaluation of the baseline dataset, biodiversity objectives and subsequent selection of biodiversity indicators may need to be reassessed in consultation with stakeholders.

Reference areas need to be established as a benchmark against which changes in biodiversity over time can be compared (for example, through the use of the BACI approach[7]). The ecology of each project site is unique, and no two sites will be the same. Reference sites should ideally be selected before project commencement

[7] The BACI (before-after/control-impact) design is one method for assessing biodiversity impacts. Samples (for instance, of a nesting bird species) are taken before and after a disturbance in each of the disturbed (affected) areas and undisturbed (control) units. If a disturbance affects a population, it would appear as a statistical interaction between the difference in mean abundance of the sampled populations in the control and affected areas before and after the disturbance (see also Section D).

and have similar ecology, degree of disturbance and landform to the project site. Close physical proximity of the reference site to the project site is also desirable.

In some developing countries, the biodiversity knowledge base is weak, and supplementary baseline information will be required to address this shortcoming. One solution is to carefully select additional reference areas in support of supplementary 'baseline' data collection.

Where operations have already commenced and baseline information is not available on the pre-mining condition, a retrospective analysis of the pre-mining conditions will need to be made to select comparative reference sites. This should be undertaken by reviewing historical information on the nature of the landscape, disturbances, land use and biodiversity condition prior to the existence of the operations. Tools for undertaking such a review include:

- historic aerial photography of the site;
- comparison of soil types found on the site with those found on potential unmined reference sites;
- consultation with local communities and government authorities;
- database information on the flora and fauna recorded on and in close proximity to the site prior to mining; and
- topographic and geological mapping of the area.

5.2.4 Evaluating biodiversity importance

Evaluating biodiversity importance is essential to understanding the significance of potential environmental impacts and therefore the priorities for mitigation (***see Rio Tinto's 2004 Practical Guide***). For existing protected areas and species, the importance is at least partially identified. For example, World Heritage Sites or Ramsar Sites are of international importance, whereas IUCN Class II sites are of national importance. Similarly, many countries will have differentiated the biodiversity importance of their protected areas (national or local) as part of their designation.

Outside of protected areas but within areas that are clearly of value for biodiversity, the evaluation of importance is more complex. The absence of protected status should never be interpreted as low biodiversity importance – many areas of international importance for biodiversity lie outside of protected areas. The challenge for mining companies is to qualitatively evaluate the importance in the absence of clear protective designations. This involves looking at a range of criteria to determine whether the site is of local, regional, national or international importance. Over the last few decades, there have been many publications regarding nature conservation evaluation, which are a source of guidance. Although no universal standard exists, some of the common criteria include the following:

- **Species/habitat richness:** In general, the greater the diversity of habitats or species in an area, the more valuable the area is. Habitat diversity within an ecosystem can also be very valuable. Habitat mosaics are extremely valuable, as some species that depend on different types of habitat may live in the transition zone between the habitats.
- **Species endemism:** Endemic species typically occur in areas where populations of a given species have been isolated for sufficiently long to evolve distinctive species-specific characteristics, which prevent out-breeding with other species populations.
- **Keystone species:** A keystone species is one that exerts great influence on an ecosystem relative to its abundance or total biomass. For example, a keystone predator may prevent its prey from overrunning an ecosystem. Other keystone

species act as 'ecosystem engineers' and transfer nutrients between ecosystems (in the United States, for instance, bears capture salmon and disperse nutrient-rich faeces and partially eaten carcasses on land).

- **Rarity:** The concept of rarity can apply to ecosystems and habitats as well as to species. Rarity is regarded as a measure of susceptibility to extinction, and the concept is expressed in a variety of terms such as vulnerable, rare, threatened or endangered.
- **Size of the habitat:** The size of a natural area is generally considered as important. It must be big enough to be viable, which relates to the resistance of ecosystems and habitats to activities at the margins, loss of species and colonization of unwanted species. Habitat connectivity is also of related importance and refers to the extent of linkages between areas of natural habitat – high levels of connectivity between different habitats or patches of the same habitat are desirable.
- **Population size:** In international bird conservation, it has become established practice to regard 1 per cent of a species' total population as significant in terms of protective requirements. For some large predators, it is important to know whether an area is large enough to encompass the home range of several individuals and allow them to breed and be sustained.
- **Fragility:** This refers to the sensitivity of a particular ecosystem or habitat to human-induced or natural environmental changes and its resilience to such changes.
- **Value of ecosystem services:** The critical importance of ecosystem services (as highlighted in Chapter 1) is now widely appreciated. While assessment techniques are still being developed, a determined effort should be made to address this aspect.

The application of these criteria is a matter of professional judgement and requires the involvement of a trained ecologist. Evaluation can be very complex in some developing countries where there is little information to evaluate biodiversity comparatively. In such circumstances, extensive fieldwork may need to be undertaken to better understand the relative value of operational sites.

5.2.5 Impact identification and assessment

The identification and assessment of impacts involves the recognition of effects on biodiversity and on essential life-support systems (or ecosystem services). Ecosystem services may include the maintenance of hydrological systems, protection of soil, breakdown of pollutants, recycling of wastes and regulation of climate. The continued delivery of these services is dependent on biodiversity conservation and may be of greatest importance to the poorest communities.

The assessment of impacts should include:

- an assessment of the level of impact – that is, on ecosystems (and related services), species or genetic resources (***see Box 5.2***);
- an assessment of the nature of the impact (primary or secondary, long-term or short-term) – primary impacts occur where a proposed activity is directly responsible for that impact, whereas secondary impacts are an indirect consequence of the project;
- an assessment of whether the impact is positive, negative or has no effect; and
- an assessment of the magnitude of the impact in relation to species or habitat richness, population sizes, habitat sizes, sensitivity of the ecosystem, recurrent natural disturbances and so on.

When assessing biodiversity impacts, it should be recognized that the intensity of impacts varies over the life of a project, being typically low at the start, increasing markedly through the construction and operational phases and diminishing as closure is implemented. The significance of predicted impacts on biodiversity depends on the magnitude (or intensity) of the impact and the sensitivity of the affected ecosystem or species. The risk-based system outlined in Table 5.1 (***see section 5.3.2***) can be adapted to the determination of impact significance.

Box 5.2. Levels and types of impacts on biodiversity

Impacts on biodiversity may occur at any of the following levels:

- **Ecosystem level:** An ecosystem or habitat can be affected if a potential project or activity changes the size, diversity or spatial variation of the ecosystem. In addition, an impact to an ecosystem can occur if its ability to provide long-term function or services is changed.
- **Species level:** In predicting biodiversity impacts, it is also important to assess the impacts at the species level. Potential impacts to species can be assessed according to population numbers and the internal, national or local significance that a species may have to stakeholders.
- **Genetic level:** Diversity within an ecosystem is also associated with genetic diversity of populations. Genetic diversity is extremely difficult to measure. For this reason biodiversity assessment is usually carried out at the ecosystem or species level.

Additionally, when assessing biodiversity impacts, a clear distinction must be made between impacts that can be assessed quantitatively and those for which only a qualitative assessment can be made. Whenever conclusions and recommendations have been made substantially on qualitative assessments, the basis of the judgements should be well defined. A precautionary approach should be adopted in such cases where limited scientific knowledge exists.

A number of other categories of impact or types of impact are discussed briefly below.

Cumulative impacts: In situations where multiple mining projects (or other projects, such as industrial or infrastructure) are being implemented within a broad geographic area (such as a watershed, valley or airshed), it is important to consider the cumulative impacts on biodiversity (that is, the additive effects of other projects, such as multiple coal mines in a coal basin, together with any associated infrastructure). When considering cumulative impacts, attention should be given to:

- any existing or proposed activities in the area and the likely effect on biodiversity of those proposals in conjunction with the proposed mining activity;
- any synergistic effects of individual project impacts when considered in combination; and
- any known biodiversity threats in the area and the likely contribution of the proposed mining activity to increasing or decreasing those stresses.

Loss of ecosystem: Mining may result in the removal of ecosystems or habitats. This may have a permanent or temporary impact on biodiversity. Permanent habitat loss may occur due to extensive clearing for the mine location, while temporary habitat loss may occur due to limited clearing for exploration access.

Habitat fragmentation impacts: The isolation or fragmentation of ecological habitats can have significant impact on biodiversity. Interruption of the natural linkages between populations of plants and animals can create significant, sometimes irreversible, changes to the dynamics and the genetic integrity of those populations.

Fragmentation also increases the 'edge effects' of the habitats. The separated, smaller areas are less resilient to change. Long convoluted edges provide greater potential for pest plants and animals to occupy the site. The remaining isolated patches may not provide adequate habitat quality or quantity for some species. Fragmentation may disrupt ecological processes critical to the maintenance of biodiversity. Time is also a factor; the longer isolation or fragmentation exists, the greater the impacts may be. This has important implications for rehabilitation and is one of the drivers for rehabilitating areas as soon as possible and for maintaining ecological corridors wherever practicable.

Alteration of ecological processes: The alteration of ecological processes can affect the sustainability of a site's biodiversity. For example:

- The interruption of hydrological regimes may have significant impacts on wetland and groundwater systems. Changes to stream and river flows may affect the biodiversity dependent on such an ecosystem, including downstream human communities.
- The removal or disruption of a structural layer or zone will decrease the structural diversity of the site, potentially causing disruption to predator-prey relationships.
- The disruption of soil structure may cause surface crusting and erosion problems.
- Frequent burning (sometimes used for weed control) can disrupt natural ecosystem recovery processes.

Pollution impacts: Pollution can affect the air, water and soils at or around a mine site:

- Airborne pollutants such as dust and sulphur dioxide may affect biodiversity directly by suffocation or smothering or via secondary impacts such as soil and water pollution.
- Water pollution from spillages may be toxic.
- Mobile sediments from soil erosion may grossly alter in-stream habitats – filling deep pools, for example. Suspended colloidal material will create turbid conditions that may adversely affect aquatic vegetation. In aquatic systems, mobile sediments, organic matter and runoff of nutrients may cause localized algal blooms and areas of deoxygenation.

Disturbance impacts: Soil disturbance frequently provides a competitive advantage to species of plants and animals adapted to occupying a range of habitat types. Some pest plants and animals thrive in the inherently disturbed environment of mine sites. Noise, artificial lighting and vibration may also disturb wildlife, creating changes to population dynamics.

5.2.6 Monitoring and interpreting changes in biodiversity

Monitoring is the process of collecting information to determine progress against agreed biodiversity objectives. Indicators are the factors that are measured during monitoring – for example, to assess the extent of impact on biodiversity, the success of mitigation measures or the outcomes of measures to enhance biodiversity conservation. There is no simple measure for biodiversity due to its complex and dynamic nature, which presents challenges in choosing effective indicators.

As the biodiversity at a particular site has numerous components, each interacting with the other over varying periods of time, seasons and space, the framework selected will need to be readily adaptable to observed changes. At some sites, groups or associations of species of plants and animals may better reflect change than intensive assessment of individual species. For example, a species that occupies a particular development stage of an ecosystem may be monitored to provide an indication of change either positive or negative. Given that development stages are dynamic, the challenge is to determine which are positive and negative changes. Invertebrates are often used for this purpose. It is sometimes difficult to measure impacts on a single species, particularly if that species is already threatened or vulnerable or otherwise difficult to monitor.

Each mining operation should, in conjunction with government regulators and stakeholders, determine what set of indicators will be required to measure and manage impacts on biodiversity. Site indicators are to be determined based on the biodiversity context and values already identified.

Desirable characteristics of the suite of indicators are that they:
- reflect pressures (threats) to biodiversity values, the condition of biodiversity and management responses to impacts on biodiversity;
- include species-based, ecosystem structure-based and ecosystem function-based indicators of biodiversity; and
- fulfil legislative and policy requirements.

Indicators are divided into:
- condition indicators, such as species richness or composition;
- pressure indicators, such as extent of native vegetation clearance; and
- response indicators, such as area of weed control or area revegetated.

Expert assistance may be required in selecting and reviewing the most appropriate indicators of biodiversity to be measured, particularly regarding the measurability of the indicators. In addition, the initial suite of site-specific biodiversity indicators selected for the site is likely to alter during the life of the project.

Before final selection of measurable indicators, consultation with stakeholders should be undertaken to ensure the suite of indicators selected is socially acceptable. In identifying and measuring change, it will be necessary to take into account:
- the ability of an ecosystem, habitat or species to recover;
- the local value and role of biodiversity;
- interactions with natural processes; and
- the global, national or local significance of the biodiversity.

Furthermore, biodiversity assessments benefit from obtaining knowledge from indigenous and local people on biodiversity, land use and local plants and animals and their uses, including harvesting, breeding and cultivation techniques.

5.3 Environmental Management Systems

Formal Environmental Management Systems have been adopted across much of the mining industry, predominantly the ISO14001 series. Many companies require that their operations are either certified to ISO14001 or maintain systems that are compliant with ISO14001. The EMS provides the overarching framework for the management of biodiversity during operations and closure planning. This GPG describe steps and actions that can be undertaken to integrate biodiversity into the EMS.

The EMS framework provides for mining companies to address biodiversity by:

- integrating biodiversity into the environmental policy;
- documenting and assessing local biodiversity in consultation with appropriate stakeholders;
- undertaking identification and assessment of biodiversity aspects/risks;
- maintaining a register of legal and other requirements, including legally designated protected areas;
- planning and developing preventative and mitigative measures for significant biodiversity aspects;
- implementing preventative and mitigative responses to identified biodiversity aspects;
- monitoring, measuring and reporting performance on biodiversity management;
- managing the review of procedures and outcomes; and
- adopting a continuous improvement approach.

Requirements for addressing biodiversity in each of these stages are described in this section.

5.3.1 Securing a corporate commitment

A strong component of the ISO approach to management of environment, quality or other fields is that there must be strong support from senior management and that this should start with a statement of corporate policy. Reference should also be made to the company's biodiversity strategy, where one has been developed. The importance of biodiversity management to the industry now means that there should be a higher focus on, and explicit commitment to, this topic than in the past. However, care should be taken to ensure that the overall policy is clear and concise, and not too focused on details that belong in the biodiversity strategy.

A 2004 survey of 20 major extractive industry companies undertaken by ISIS Asset Management identified only 7 with published policies or position statements on biodiversity, whereas all had environment policies.

At the corporate level, biodiversity policy statements can play a key part in a company's overall corporate social responsibility strategy. Given the site-specific nature of biological diversity, however, a biodiversity policy statement may also be developed for individual project sites. Such a policy would be specific to the issues of that site. Statements may include discussion around management of all impacts, including secondary impacts, management of site-specific threatened ecological species or communities and compliance to the objectives outlined in the project ESIA.

Biodiversity policy statements might include commitments to:

- maintain natural ecosystems and manage protected areas;
- respect indigenous peoples' rights and values for natural resources and involve them in developing and deciding on appropriate management solutions for potential impacts;
- limit discharges to ecosystems below the critical level;
- raise employee awareness about making a positive contribution to the environment;
- conserve biodiversity by not destroying habitat or, where loss is unavoidable, explore mitigation options, including the use of offsets;
- comply with applicable legislation and regulations;

- apply the precautionary principle to identify situations where risk assessment and management are required;
- enhance wildlife corridors and habitats;
- consult with relevant conservation organizations;
- conduct biodiversity assessment in environmental assessments;
- focus attention on internationally recognized 'hot-spots';
- understand and manage direct and indirect impacts on biodiversity;
- make a positive contribution to biodiversity research and development;
- restore disturbed areas when activity is completed; and
- ensure that there is no overall net loss of biodiversity as a result of the company's activities.

5.3.2 Determining significant biodiversity aspects

An important early step is to identify the mining activities that have the potential to lead to significant impacts on the biodiversity. This then drives the setting of relevant objectives for the specific business or operation. Much of this information should be available through the ESIA process (***see section 5.2 on ESIA***). For existing operations that have no recent ESIA, a risk assessment should be undertaken to identify the aspects and biodiversity impacts that might occur from the identified mining activity.

The output of the risk assessment should be ranked using a risk assessment approach such as that adapted from the AS/NZ Standard 4360: 1999 (***see Table 5.1***). The output of this task will help inform the priorities and focus objectives for the EMS. Where risks are identified within the high or extreme category, and where no recent ESIA is available, further assessment of potential impacts on biodiversity may also be required, drawing on the guidance in section 5.2. This should include consultation with stakeholders to determine their knowledge of and perspectives on biodiversity, including current uses (***see also section 6.3 on engagement with stakeholders***).

Likelihood	**Magnitude of biodiversity impacts**				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	**H**	**H**	**E**	**E**	**E**
Likely	**M**	**H**	**H**	**E**	**E**
Moderate	**L**	**M**	**H**	**E**	**E**
Unlikely	**L**	**L**	**M**	**H**	**E**
Rare	**L**	**L**	**M**	**H**	**H**

L=low **M**=medium **H**=high **E**=extreme

Regular reassessment and review of potential biodiversity aspects and impacts, including primary, secondary and cumulative impacts, should be undertaken throughout the mine cycle to ensure continuous improvement. ***Table 5.2*** gives examples of some broad operational mining activities and the associated aspects and biodiversity impacts that need to be considered (***see also Figure 3.2***).

Table 5.2. Illustrative examples of mining activities, aspects and biodiversity impacts

Activity	Examples of Aspects	Examples of Biodiversity Impact
Extraction	Land clearing	Loss of habitat, introduction of plant disease, siltation of watercourses
Blasting	Dust, noise, vibration	Smothering stomata, disturbance of fauna
Digging and Hauling	Dust, noise, vibration, water pollution	Disruption of watercourses, impacts on aquatic ecosystems due to changes in hydrology and water quality
Waste Dumping	Clearing, water and soil pollution	Loss of habitat, soil and water contamination, sedimentation, acid mine drainage
Processing/ Chemical use	Toxicity	Loss of species (fish kills, for example) or reproductive impacts
Tailings Management	Land clearing, water pollution	Loss of habitat, toxicity, sedimentation, water quality and streamflow
Air emissions	Air pollution	Loss of habitat or species
Effluent discharges	Water pollution	Loss of habitat or species, reduced water quality
Building workshops and other structures	Land clearing, soil and water pollution	Loss of habitat, contamination from fuel, waste disposal
Waste disposal	Oil and water pollution	Encouragement of pests, disease transfer, contamination of groundwater and soil
Building power lines	Land clearing	Loss or fragmentation of habitat
Provision of accommodation	Land clearing, soil and water pollution, waste generation	Loss of habitat, sewage disposal and disease impacts, pets, disturbance of wildlife
Activity	Examples of Aspects	Examples of Biodiversity Impact
Roads and rail	Land clearing	Habitat loss or fragmentation, waterlogging upslope and drainage shadows down slope
Population growth	Land clearing or increased hunting	Loss of habitat or species, stress on local and regional resources, pest introduction, clearing
Water supply (potable or industrial)	Water abstraction or mine dewatering	Loss or changes in habitat or species composition

Companies should prepare a legal register identifying existing permits, licences and relevant legal and other requirements (such as policy commitments). It should be noted that legislative and regulatory requirements vary markedly across countries and regions, and each operation needs to maintain, understand and use a specific register of obligations.

Voluntary obligations also need to be considered, particularly as a number of environmental commitments with respect to biodiversity may be the result of voluntary corporate policies and industry initiatives, as opposed to legislative requirements. ICMM's sustainable development framework is such voluntary commitment.

5.3.3 Establishing targets and objectives

Clear goals for the outcomes of biodiversity management need to be set and communicated to all stakeholders. These goals and objectives should be set in consultation with the various parties who will judge the success of the work. For example, local community groups, regulators, academics and other stakeholders should be consulted. There are likely to be internal company goals related to efficiency and effectiveness, and these need to be made clear to external parties and be compatible with the objectives they set.

The objectives will depend on the biodiversity aspects identified and the requirements and opportunities to mitigate impacts. Objectives can be specific for a local issue such as a plant or animal species, or they may be general at the ecosystem level. In either case, objectives should be set in conjunction with the biodiversity values identified by the company and stakeholders, both of whom should seek opportunities to reduce negative impacts and increase positive impacts on biodiversity. Examples of goals and objectives may include:

- successful reintroduction to mined areas of key flora or fauna species;
- non-disruption to migration patterns;
- protection (non-interference) of designated high-value locations; and
- control of weeds and other pest species.

Actions to achieve the nominated objectives should be developed and then documented within the EMS.

Each operation should set targets that are specific to its operations and activities, that clearly describe what is to be achieved and by when and that link into the overall rehabilitation and mine closure strategy described in Chapter 4. Targets should be realistic and take into account availability of resources, technical limitations, engagement with landowners and the community, fulfilment of lease requirements, long-term land management requirements, and so on. The objectives, actions and targets must be consistent with the policy.

5.3.4 Biodiversity action plans

A biodiversity action plan (BAP) is a mechanism by which the objectives and targets for biodiversity conservation can be achieved. BAPs can either be stand-alone plans or be incorporated into the EMS. Numerous specific elements may be covered in a BAP.

Control of access to areas of importance for biodiversity: Access should be controlled to areas of importance for biodiversity that do not need to be disturbed during operations, to prevent inadvertent destruction of habitats or disturbance of species. In particular, corridors that allow safe movement of fauna must be protected and maintained, especially where larger animals may move through the area (such as migrating caribou in the Arctic or large mammals in Africa). In many areas where mining occurs, extensive clearing for agricultural purposes has already occurred, resulting in the fragmentation and degradation of remnant habitat. In such cases it is important that companies implement effective clearing controls to prevent further fragmentation and isolation of fauna populations and, where appropriate, that they combine this with initiatives such as construction of corridors to re-establish linkages between remaining areas of native habitat.

Clear demarcation of all protected areas is required to avoid inadvertent destruction through ignorance or carelessness: In some areas this will require fencing. In other cases, such as large areas where fencing is impractical, measures to avoid unintentional destruction of biodiversity will need to be implemented in conjunction with other landholders.

Controls on how vegetation (and associated fauna) are removed need to be specified: This helps to maximize the use of seed and other plant propagules, soil nutrients and soil biota, decaying organic matter, logs and other potential fauna habitat that can be valuable for rehabilitation. This will help ensure that clearing operations are fully integrated with the requirements of subsequent rehabilitation operations, as described in Chapter 7.

Management of pest plants and animals: Introduction of pest species in the form of weeds and feral fauna species has often accompanied expansion of mining into greenfield areas. In some cases these pests can have significant impacts on local species well beyond the mine lease area. A good example is the introduction of domestic cats into areas with no similar predators. There have also been a number of examples where rehabilitation has introduced weed species that have become pests due to their success in colonizing disturbed areas. Strict controls on employees keeping native animals as pets and vehicle washing/disinfection to control weeds and plant disease are all examples of controls that may be required.

Management of community biodiversity uses and other ecosystem services: In areas where communities are directly dependent on biodiversity for 'provisioning services', particular attention may be needed to ensure the management and maintenance of the aspects of biodiversity that communities depend on (fisheries, fuelwood, medicinal plants, and so on). More generally, other ecosystem services (such as the role of wetlands in the vicinity of the mine in regulating water quality) may need to be explicitly considered within a BAP.

Research and development programs: In the ESIA phase, gaps in knowledge of biodiversity on the site and in adjacent areas may have been identified and addressed to the extent necessary to gain project approval. In the operational phase, that knowledge base can be further developed through ongoing research. This research is usually targeted towards gaining additional knowledge that improves revegetation/rehabilitation (***Chapter 4***). However, there are likely to be other research opportunities that relate to the broader region surrounding the mine. These may include understanding the impacts of land use changes in the area (that may have resulted from secondary impacts) and the behaviour of invasive pests through to integration into species recovery programs and other detailed studies of patterns of usage of biodiversity by the local community.

Revegetation trials: These are a specific subset of research programs aimed at gaining more information on the nuances of the requirements and techniques for successful rehabilitation. Chapter 7 describes these in greater detail.

Research on aspects relevant to the wider setting of the mine: This may also be required or valuable in providing a better understanding of regional interactions. This is often the case where mines have been established in remote areas that have been poorly studied and where an ESIA may represent the only intensive study. Extending the range of that knowledge base may provide additional information relevant to the site and may extend the overall knowledge base.

5.3.5 Implementation considerations

Accountability for biodiversity management within the organization should be allocated to a senior management role, one that has the capability to ensure that biodiversity and related environmental and social interfaces are considered alongside production goals.

For each of the actions identified in the previous section, accountabilities and budgets should be assigned and documented to ensure that the necessary staffing, skills and resources are available to implement the tasks.

At the operational stage, all management procedures documented in the EMS and essential for the later implementation of successful mine rehabilitation must be carried out. These will usually include selective handling of overburden materials, topsoil management to conserve nutrients and plant propagules, construction of landforms that will control erosion and prevent any long-term impacts on biodiversity values of surrounding waterways, and progressive rehabilitation of areas as they become available.

Successful integration of the mining operations and rehabilitation stages, as described in Chapter 7, will not only result in better biodiversity outcomes, but in many cases will reduce costs by ensuring that companies complete the rehabilitation efficiently and 'get it right the first time'.

Stakeholder engagement and public reporting on biodiversity issues are essential steps to build a credible and workable BAP. Sound management of biodiversity often extends beyond the boundaries of the operation, especially where opportunities for biodiversity enhancement are pursued, and it needs effective two-way interaction and support to be successful. Companies should involve traditional landowners and other indigenous groups, NGOs and local community associations and institutions in biodiversity management, monitoring and conservation programs.

The provision of support to community education programs on biodiversity management enables companies to share sound management of biodiversity with social responsibility. Companies should avoid 'green-washing'. In addition, companies should not be reluctant to indicate problems and describe the operational challenges and dilemmas they face.

The effectiveness of any program depends on all involved having a sound understanding of the objectives and their role in the program. Induction and training programs are fundamental in this respect. All employees, contractors and visitors need to be aware of and understand the objectives of the biodiversity management plan and their role in its success.

Regular monitoring (through audits, observation, and surveys) is required to evaluate the effectiveness of awareness and training programs. At many mines, there is an excellent opportunity for involving employees with external ecologists in gathering useful data such as reporting of uncommon flora and fauna species that may not be detected in shorter duration surveys. For this to be successful, however, employees must have the necessary training, support and encouragement.

5.3.6 Checking and corrective action

Changes in biodiversity attributes need to be monitored to evaluate the success of management plans, rehabilitation trials, research projects and, equally important, the general changes in the biodiversity of the area around the site that may be influenced by non-mine factors. As long-term decisions are based on this information, the program needs to be designed soundly according to accepted statistical principles and credible to all stakeholders, and the data collection processes must be readily verifiable. In particular:

- Detailed monitoring programs are required to provide the information on which to base decisions of the success or otherwise of projects and to evaluate changes in the biodiversity resulting from both internal and external factors.
- It must be realized that in some cases impacts can extend some distance from the mine – for example, changes to water quality or hydrology. The possibility of such impacts must be taken into account in the design of the monitoring program.
- Monitoring needs to be conducted using transparent and scientifically rigorous procedures, and the use of external experts is often required. These programs need to combine cost-effectiveness with credibility to regulators, local communities and other interested parties.
- Publication in peer-reviewed journals is a means of transferring knowledge to a wider audience and evaluating the validity of the program.

The latter step can offer an objective assessment of the effectiveness of biodiversity management approaches at a mine site and is consistent with adaptive management (do-monitor-evaluate-revise). To build and maintain the necessary credibility for this component, peer review or similar external or third-party checking should be conducted. Community review groups, external advisory panels and similar approaches can provide further assurances that the information collected and analyses are considered fair and reasonable by the majority of stakeholders.

5.3.7 Monitoring and reporting

Monitoring provides a method of measuring progress against an objective. Various techniques can be used that involve repeated measurement and sampling of indicator species over time. Biodiversity monitoring can be undertaken in-house or in partnerships with various institutions such as universities and other learning centres. Biodiversity monitoring techniques are comprehensively described in the literature and are therefore not repeated here.

Reporting usually includes both formal government reporting requirements and information provided for the broader public and other stakeholders. Government reports are designed to help ensure accountability to the regulatory authorities. Public reporting on biodiversity can range from publications in the scientific literature to annual sustainability reports. The focus of public reporting is often on case studies, yet it is more valuable to provide comprehensive information on the effectiveness of actions taken to protect or enhance biodiversity. The Global Reporting Initiative (GRI) has developed a set of biodiversity-related criteria against which companies are encouraged to report. There are two core indicators in the current 2002 GRI Guidelines:

- EN6. Location and size of land owned, leased, or managed in biodiversity-rich habitats.
- EN7. Description of the major impacts on biodiversity associated with activities and/or products and services in terrestrial, freshwater, and marine environments.

Seven other indicators are also concerned with biodiversity:

- EN23. Total amount of land owned, leased, or managed for production activities or extractive use.
- EN24. Amount of impermeable surface as a percentage of land purchased or leased.
- EN25: Impacts of activities and operations on protected and sensitive areas.
- EN26: Changes to natural habitats resulting from activities and operations and percentage of habitat protected or restored.
- EN27: Objectives, programs and targets for protecting and restoring native ecosystems and species in degraded areas.
- EN28: Number of IUCN Red List species with habitats in areas affected by operations.
- EN29: Business units currently operating or planning operations in or around sensitive or protected areas.

In February 2005, a pilot version of a GRI Mining and Minerals sector supplement was released; it included the following additional biodiversity provisions:

- EN23. For mining: Total amount of land owned, leased, and managed for production activities or extractive use.
    1. total land disturbed and not yet rehabilitated (opening balance);
    2. total amount of land newly disturbed within the reporting period;
    3. total amount of land newly rehabilitated within the reporting period to agreed upon end use; and
    4. total land disturbed and not yet rehabilitated (closing balance).
    The above set of figures allows the reader to assess both the stock of land disturbed and the annual changes. Disturbance may include both physical and chemical disturbance.
- MM3. The number/percentage of sites identified as requiring biodiversity management plans, and the number/percentage of sites with plans in place. Also include criteria for deciding that a biodiversity management plan is required and the key components of a plan.

The GRI released a consultation draft on the third-generation GRI Guidelines in January 2006, which proposed two core and five additional indicators of explicit relevance to biodiversity (***see Box 5.3***), as well as a number of others that are also implicitly relevant.

One limitation of the current GRI indicators is that they are designed for corporate reporting at the aggregate or global level. Consequently, the information produced is not specific enough to determine impacts at the site level, and some indicators do not make qualitative distinctions between the value of land (in terms of biodiversity) affected by mining. The proposed indicators are also based on aggregate reporting but are clearer in terms of qualitative distinctions. As site-level information will form the basis for aggregate reporting, the emerging trend of site-level sustainability reporting should provide greater disclosure on site-level impacts as it is more widely adopted by ICMM members and other mining companies.

5.3.8 Management review and continuous improvement

The management review stage requires senior management to undertake a review of the relevance and success of the EMS. From a biodiversity perspective, this stage should include seeking input from all relevant stakeholders. Changes may be required based on the experience gained and the outcomes tracked through the monitoring stage. External factors such as increased knowledge of the ecosystems around the mine, change in the official status of a species or additional external threats to those ecosystems may also warrant a change in the objectives.

If these steps are followed, it should be possible to demonstrate continuous improvement – that is, that an operation is managing its potential impacts and learning from the results and improving performance, so that biodiversity risks are managed to ensure biodiversity conservation. Improvement may be through enhanced biodiversity outcomes or through more effective implementation of existing plans and actions, thereby ensuring reduced impacts on biodiversity and enhanced biodiversity values following rehabilitation.

Box 5.3. Draft GRI Sustainability Reporting Indicators of relevance to biodiversity

Environmental Aspect: Water

EN10 Water sources and related habitats significantly affected by withdrawal of water (additional)

Environmental Aspect: Biodiversity

EN12 Location and size of land owned, leased or managed in, or adjacent to, protected areas (core)

EN13 Description of significant impacts of activities on protected areas (core)

EN14 Area of habitats protected or restored (additional)

EN15 Programs for managing impacts on biodiversity(additional)

EN16 Number of IUCN Red List species with habitats in areas affected by operations broken down by level of extinction risk (additional)

Environmental Aspects: Emissions effluents and wastes

EN25 Water sources and related habitats significantly affected by discharges of water and runoff (additional)

5.4 Extending the reach of conventional analyses

Conventional ESIA techniques are designed to identify and assess potential impacts of mining projects, but they do not touch on some of the key factors that profoundly influence both the analysis or interpretation of baseline data and the longer-term prospects of successful outcomes for biodiversity from either mitigation or conservation efforts. In reality, biodiversity conservation and protection do not take place within a vacuum. They depend on a number of interlinked factors that contribute to and underpin the success of conservation efforts, which collectively influence the conservation context. The combination of these factors determines what may be termed the maturity of the conservation context.

Consequently, it may be important to consider extending the reach of conventional analyses to review the maturity of the conservation context before committing resources to biodiversity mitigation or enhancement initiatives. This approach has only recently been promoted[8] and has not yet gained widespread acceptance. However, it provides a structured approach to considering the factors that have a bearing on the likely success of potential biodiversity initiatives.

Having an informed understanding of the maturity of the conservation context should enable companies to 'design' biodiversity action plans (***see section 5.3.4***) and initiatives that stand a better chance of success. For example, in situations where an overarching strategic planning framework is in place (***see section 5.2.1, introduction to the ESIA framework***), biodiversity protection and conservation planning will likely have been integrated into the overall consideration of land use alternatives and development opportunities. This will not only influence whether mining can take place in the first instance, it will provide a convenient framework within which mining companies can develop biodiversity initiatives. In many developing countries, this strategic planning context will likely be absent – as a consequence, the development of successful biodiversity mitigation, protection or enhancement initiatives will depend on more sophisticated and situation-specific analyses.

5.4.1 Factors affecting the maturity of the conservation context

The maturity of the conservation context is dependent on (but not limited to) four factors, which may be considered at the national, regional or local level:

- **The state of knowledge of ecosystems and species:** A number of databases maintained by conservation groups provide details on all protected areas that are of international or national importance and on species that are threatened or endangered. So basic information on some of the most important biodiversity areas should always be available. Beyond these designated areas, the state of knowledge of ecosystems or species varies greatly from one country to another and from region to region[9]. In practical terms, this may make it difficult to interpret baseline data and determine the biodiversity value of an area. In situations where potentially important areas for biodiversity will be affected, additional scientific research may be required to reinforce gaps in the knowledge base. This may also flag opportunities for mining companies to contribute to enhancing the knowledge base of ecosystems or species, irrespective of the extent of their impacts.
- **The existence of conservation plans, initiatives and protected areas:** In considering these aspects, the objective is to get a sense of how mature or advanced conservation efforts are in a country or region (recognizing that some provincial authorities may be more progressive than others in promoting biodiversity conservation). There is currently no single easy source of such information, but over time the Earthtrends[10] database of the World Resources

[8] In Rio Tinto's internal guidance on mining and biodiversity (see Section D).

[9] The limited availability of information is likely to be improved over time by new and emerging initiatives such as the Global Biodiversity Information Facility (www.gbif.org). This is still in its infancy, but over time will serve as a comprehensive repository of the world's biodiversity data.

Institute should provide information at the national level. In practical terms, an assessment of the existence of conservation plans or initiatives can help identify either sources of information on biodiversity or potential partners for biodiversity mitigation or enhancement activities.

- **The capacity of conservation organizations (government and civil society) and the success of enforcement measures:** The capacity of conservation partners and the success of enforcement efforts are intimately linked to the status of conservation planning and vice versa, but they are treated separately for a number of reasons. First, mining companies may engage with potential conservation partners from both government and civil society (including NGOs or communities), so 'conservation partners' is more inclusive than just 'planning authorities'. Second, the success of enforcement is often unrelated to planning capacity; for example, Indonesia has developed an extensive network of protected areas covering over 10 per cent of the country, but the lack of enforcement capacity means that many such sites are severely degraded. Where capacity is lacking, mining companies can play a potentially important role in helping to support capacity development for conservation within their area of operation.
- **The intractability of biodiversity threats:** The intractability of threats to biodiversity refers to the degree of difficulty in tackling the direct and underlying causes of biodiversity loss. Of the various factors influencing the maturity of the conservation context, the intractability of biodiversity threats is perhaps the most difficult to gauge, yet perhaps the most important. In some respects, this is inversely related to the other factors discussed above. So where capacity for planning, managing and protecting biodiversity is low, it is reasonable to assume that threats to biodiversity may be high and difficult to mitigate. (One possible exception is in wilderness areas where there has been limited or no human intervention and related pressures, although such areas are increasingly rare.) The intractability of biodiversity threats can be inferred from data on demographics, poverty and inequality and control of resources (***see section 5.4.2 for additional guidance***).

The three broad stages of 'maturity' are as follows:

- **Embryonic:** the factors influencing the conservation context are absent in the initial stages of development or have significant weaknesses or inherent risks.
- **Immature:** the factors influencing the conservation context are somewhat weak or only partially established and still present risks to effective conservation.
- **Mature:** the factors influencing the conservation context are well established and provide a sound basis for effective conservation.

A tabular summary of the status of each of the four factors in each of the three stages of maturity is presented in ***Table 5.3***. A practical illustration of how this approach may be applied is outlined in Rio Tinto's biodiversity guidance document.

In practice, the status of the four factors will likely vary within a given country as well as between countries. So the maturity of the conservation context for the various factors explored in this section will likely be a continuum rather than three

[10] Earthtrends is an environmental information portal supported by organizations such as the UN Environment Programme, the UN Development Programme, the World Bank, and the Swedish International Development Agency. It currently contains useful information on the status of implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, but over time it should also have information on the status of implementation of other global biodiversity conventions. It currently has useful information on the number of protected areas made under some of the key global agreements, such as the Man and Biosphere Programme of UNESCO and the Ramsar and World Heritage Conventions.

fixed stages. Having a proper understanding of the maturity of the conservation context enables practitioners to 'design' biodiversity projects or initiatives that stand a better chance of success. For example, if threats to biodiversity within a specific area are intractable and difficult to overcome, it may be better to direct support towards other conservation initiatives. Similarly, where the assessment of significant environmental effects, as part of an EMS, identifies an operation having a significant impact on biodiversity, the success of mitigation efforts will depend heavily on the maturity of the conservation context.

This is not to suggest that conservation initiatives should only be considered in situations where the conservation context is mature. Ironically, some of the most important biodiversity areas that are immediately threatened and in urgent need of protection occur in situations where the conservation context is embryonic or immature. But the maturity of the conservation context may significantly influence the cost of biodiversity initiatives (such as the costs associated with information collection, developing capacity of conservation organizations or reinforcing enforcement measures) as well as their potential for success.

5.4.2 Assessing non-mining-related threats to biodiversity

Non-mining-related threats are perhaps the most difficult to assess. Yet understanding and responding to such risks or threats forms the basis for effective conservation action. While it may not be possible to respond effectively to all threats, conservation initiatives have the best chance of being effective when they address the most critical ones. A threats-based approach recognizes that these risks are largely caused by human activity, but that they are best addressed and mitigated if all stakeholders work together to develop mutually acceptable, feasible and sustainable alternatives.

Several conservation organizations have developed methodologies for threats-based conservation. These methodologies range from very simple lists or matrices of threats to sophisticated frameworks for designing, implementing and monitoring conservation programs. The four types of direct threats to biodiversity are:

- conversion of natural habitat to cropland, urban areas or other human-dominated ecosystems;
- overexploitation or overharvesting of commercially important species;
- introduction of invasive species, including pests and pathogens; and
- climate change, pollution and other environmental changes external to the area of interest.

Specific threats to areas of importance for biodiversity may be identified through existing information about the site and by involving stakeholders in the process of identifying and setting priorities for threats. This participatory approach ensures that the comprehensive information on threats is shared between stakeholders, who gain a common understanding of the main threats. The analysis should identify threats in specific terms, describe the impact on biodiversity and identify the underlying causes of the threat. This level of specificity is important to underpin the design of effective initiatives. Priorities for addressing threats may be set according to criteria such as:

- **The extent of the risk (overall area affected):** The smaller the area affected, the lower the overall threat. So if most of a forest area is subject to intensive illegal hunting, the area affected would be rated as very high.
- **The magnitude of the impacts from the risks:** The greater the impact, the higher

the risk rating. For example, if very little land within a protected area is being converted to agriculture and there is little population pressure, the magnitude of the impact will be negligible.
- **The urgency of risk mitigation:** The more urgent the threat is, the higher the risk rating. For example, if a protected wetland is threatened by pollution from a chemical spill, the risk rating will be very high.
- **The perceptions of threat importance by communities:** The higher the perceived level of threat, the higher the risk rating. This is independent of any objective measures of threat and is reliant on the subjective opinions of stakeholders. So stakeholders may perceive fairly benign (yet conspicuous) stack emissions as presenting a very high level of threat.
- **The political and social practicality of addressing the risks:** The lower the social and political practicality of dealing with risks, the higher the risk rating. This qualitative measure requires consideration of a number of factors and is therefore not as straightforward to apply as some other criteria. For example, while there may be strong support for land tenure reform that would support a more equitable sharing of biodiversity benefits, there may be no political support for reform. Where those in favour of reform have little or no political influence, the rating should be high. In other situations, there may be closer alignment between societal aspirations and political will.
- **The capacity of stakeholders to address the threat:** The lower the capacity to address the threats to biodiversity, the higher the risk rating. For example, if the level of water abstraction from a wetland threatens biodiversity, the responsible authorities may not have the capacity to manage the competing demands for water. Furthermore, the stakeholders may be too disparate or not sufficiently organized to self-regulate, so the risk rating would be high.

These criteria and related threats to biodiversity can be used to help identify and establish priorities on biodiversity threats for a given operation. One possible approach to identification and priority-setting of threats is outlined in Rio Tinto's biodiversity guidance document.

Table 5.3. Maturity of the conservation context

Determining factors	Stage of maturity: Embryonic	Immature	Mature
State of knowledge of ecosystems and species	Little or no information available on ecosystems or species, and no basis to support assessment of biodiversity significance.	Some information available for specific areas, but of limited value to support assessment of biodiversity significance.	Detailed information available on ecosystems and species that readily supports assessment of biodiversity significance.
Status of conservation planning	Little or no effort to meet obligations specified under CBD (such as National Biodiversity Strategy and Action Plan) or associated with internationally recognized protected areas designated under Ramsar Convention or UN List of Protected Areas. Little or no conservation planning actively undertaken either by statutory authorities or NGOs in relation to broader development planning.	Some work undertaken in support of obligations under CBD, but mainly at national level and still incomplete. Partial efforts under way to meet obligations associated with internationally recognized protected areas, but weak. Some active conservation planning undertaken, but not linked into broader development planning.	Substantive efforts in place to meet the obligations specified under the CBD at the national and lower levels of government and to fully meet obligations associated with internationally recognized protected areas. Conservation planning actively undertaken by either statutory authorities or NGOs that is formally recognised and linked to broader development planning efforts.

Table 5.3. Maturity of the conservation context

Determining factors	Stage of maturity		
	Embryonic	**Immature**	**Mature**
Capacity of conservation organizations and success of enforcement	Statutory conservation authorities have little or no capacity for conservation planning or management. International and local conservation NGOs are either absent or their capacity is very limited. Enforcement measures are largely unsuccessful, either because of lack of capacity or funding or because of the absence of rule of law.	Statutory conservation authorities have some capacity for conservation planning or management, but more is needed. Some conservation NGOs represented, but their capacity for assessment and management of biodiversity is limited. Enforcement measures are partially successful, but there is considerable scope for improvement.	Statutory conservation authorities have strong capacity for conservation planning and management. Diversity of conservation NGOs represented, some with strong local capacity for assessment and management of biodiversity. Enforcement measures are successful and supported by adequate capacity, sufficient funding and a supportive legal framework.
Intractability of threats to biodiversity	Biodiversity threats are compelling and closely aligned to pervasive poverty, population pressures and insufficient availability of land and natural resources. While intrinsic societal value placed on biodiversity may be high, pressures are such that biodiversity loss is almost inevitable.	Biodiversity threats are less compelling (may be partly linked to poverty or economic development pressures), but societal value placed on biodiversity is moderate. While biodiversity threats are not intractable, there are considerable obstacles to ensure that conservation efforts are successful.	Biodiversity threats are primarily related to economic development pressures, but are tempered by high societal value of biodiversity and low population densities. The combination of high societal value placed on biodiversity and availability of land improves the prospects for conservation of biodiversity.

Source: Developed by S. Johnson on behalf of Rio Tinto (2004)

Chapter 6. Stakeholder Engagement Tools and Processes

6.1 Introduction

Since the introduction of ESIA in the early 1970s, one of the most significant changes has been a shift from the perception of consultation as a regulatory hurdle to recognition of the critical importance of stakeholder engagement. The acceptance of the value of stakeholder engagement is now firmly established, even if the understanding of how to effectively arrange for it is less widespread. This section sets out some of the more common approaches to stakeholder engagement in the context of biodiversity identification, assessment and management.

The timing of stakeholder engagement is also important. In the early stages of exploration, when large areas of land are being traversed and the likelihood of identifying proven or probable reserves is low, stakeholder engagement is less important. As the focus of exploration becomes narrower, initial stakeholder engagement can help to establish the biodiversity context and determine the requirements for additional fieldwork in support of the environmental and social assessment. Thereafter, stakeholder engagement is a critical component of the ESIA, the identification of mitigation options, development of opportunities for conservation enhancement and related partnerships, and closure planning.

6.2 Identification and analysis of biodiversity stakeholders

Stakeholder identification is the first stage in building the constructive relationships needed for successful biodiversity identification, assessment, mitigation or enhancement. Stakeholders include any organization, community or individual with an interest in the use or management of biodiversity or that affect or are affected by conservation initiatives. This would include local users of biodiversity resources (for subsistence, recreational value, small- or large-scale commercial exploitation and so on), government agencies with responsibility for land management or conservation, and NGOs. Identifying stakeholders involves determining who makes use of or affects the management or well-being of biodiversity.

Different stakeholders will have varying interest in the biodiversity of a given area and in its conservation or continued usage. The strength and legitimacy of the claim and degree of interest of stakeholders will depend on factors such as their proximity to biodiversity resources, dependence on such resources, historical association, formal and informal rights, economic interests, and institutional mandate in the case of governmental, intergovernmental or nongovernmental organizations. The groups or individuals with the strongest and most legitimate claim may be referred to as key stakeholders.

Identifying stakeholders is often fairly straightforward. A good starting point is with government agencies, known conservation organizations or community leaders. This often leads to the identification of other relevant stakeholders. In some countries, there are a number of legally prescribed statutory consultees on conservation issues who must be included on new projects requiring an ESIA. Communities may also offer invaluable insights on biodiversity, particularly in developing countries where information may be limited, and most notably where they may have an intimate dependence on biodiversity resources. Some or all of the following stakeholders should likely be consulted:

- national and local government agencies with responsibility for management, conservation or protection of biodiversity;
- national and local NGOs with an interest in biodiversity protection (such as Wildlife Trusts, Flora and Fauna Societies and bird watching groups);
- international governmental or nongovernmental organizations (for example, where internationally important protected areas are close to an operation);

- universities and research institutes;
- local landowners and other users of natural resources in the vicinity of a project (particularly people who depend in some way on access to biodiversity resources);
- indigenous people with special ties to the land (who may be affected in many developing countries or in countries such as Canada, the United States or Australia);
- community organizations who may have an interest in biodiversity resources (such as angling clubs or fisheries or farming cooperatives); and
- other private companies with a commercial interest in biodiversity resources (such as forestry operations).

In practice, it is better to be more inclusive in the early stages than to run the risk of omitting important stakeholders. Less relevant or engaged stakeholders are more likely to opt out of consultative processes and other forms of engagement – the converse is also true, whereby the more important stakeholders are likely to remain engaged.

Once stakeholders have been identified, stakeholder analysis can help to establish their interests in biodiversity, the extent to which these interests are compatible or in conflict (such as exploitation versus conservation) and the extent to which they might like to be involved in biodiversity protection or enhancement. Stakeholder analysis involves:

- defining the characteristics of key stakeholders;
- identifying the interests of stakeholders in relation to biodiversity;
- identifying conflicts of interests between stakeholders, to help manage potential sources of tensions during the course of mine development
- identifying relations between stakeholders that may facilitate biodiversity partnerships;
- identifying the needs of stakeholders to overcome constraints to their effective participation (such as language needs or traditional consultative mechanisms);
- assessing the capacity of different stakeholder groups to participate in development activities; and
- assessing appropriate levels of engagement with different stakeholders – for example, informing, consulting or partnering – at different stages of the mining project cycle.

Stakeholder analysis can be initiated during pre-feasibility and continued throughout the lifetime of a project. It can also be applied more discretely to the development of biodiversity conservation projects or to the closure planning process. A simple matrix can be used to help with the stakeholder analysis. An example of a stakeholder analysis matrix for biodiversity conservation initiatives is given in ***Table 6.1.*** This involves considering the questions in the left-hand column for each stakeholder group and assigning them to one of the three categories of interest or impact. The result will be three lists of stakeholders, according to the assessed importance of the project to them and their likely level of interest.

Engagement encompasses a range of activities, including providing information, consultation, participatory planning or decision-making and partnership. The identified level of interest of each stakeholder helps the company decide how much time to devote to engaging with each stakeholder or group. The engagement levels revealed through this analysis may extend beyond consultation and include participatory planning or partnerships. The more mining operations understand their stakeholders and vice versa, the more successful their relationships are likely to be.

Table 6.1. Stakeholder analysis matrix for biodiversity conservation initiatives

Questions to ask stakeholders	Stakeholders (impact/interest)		
	Most	**Average**	**Least**
Who will be negatively affected by initiatives or projects aimed at biodiversity protection?			
Who will benefit from such initiatives or projects?			
Who will be responsible for implementing measures to mitigate any negative impacts?			
Whose cooperation, expertise or influence would be helpful to the success of the project?			
Who are the most vulnerable, least visible and most voiceless, for whom special consultation efforts may have to be made (such as critical dependence on ongoing access to biodiversity resources)?			
Who supports or opposes the changes that the initiatives or projects will bring?			
Whose opposition could be detrimental to the success of the biodiversity initiatives/projects?			
Who might have resources to contribute?			
Who are the key decision-makers?			

Source: Adapted from ESMAP, World Bank and ICMM (2005). Community Development Toolkit

6.3 Engagement with biodiversity stakeholders

6.3.1 Timing and scope of stakeholder engagement

Early engagement with stakeholders, in particular indigenous groups and local communities, can be helpful in making an informed preliminary assessment of the potential overall viability of a proposed mining activity. It can also assist in ensuring the ESIA is focused on matters of concern to stakeholders, which will add value to the decision-making process.

Early and effective stakeholder engagement during exploration should enable mining companies to:

- clarify the objectives of a proposed mining activity in terms of community needs and concerns and company commitments to biodiversity;
- clarify the objectives of the proposed mining activity in terms of government policy directions, strategic plans and statutory or planning constraints; and
- identify feasible alternatives and clarify their merits in terms of biodiversity values.

Box 6.1. Some key issues to consider for effective stakeholder engagement

Because stakeholder engagement in the minerals sector has been undertaken for many years, engagement has occurred in a variety of ways and lessons have been learned over time. The following strategic approach for effective stakeholder engagement is recommended:

- Go beyond compliance. Environmental legislation often contains requirements to have stakeholder consultation. While this requirement must be met, it is important that mining companies use this opportunity to build relationships with stakeholders rather than undertake the activity purely for the sake of compliance.

- Build long-term, continuing and sustainable relationships. Relationships with stakeholders should be considered as long-term investments and therefore it is important to allow the time for such relationships to develop.
- Ensure cultural differences are recognized, particularly within indigenous communities. Engaging dialogue can only occur if each party understands each other's perspective. Cross-cultural training is important to build levels of respect.
- Consider the involvement of a neutral third party. This can help to overcome actual or perceived asymmetries (in terms of power, resources, and so on) and can be instrumental in supporting the development of trust.
- Develop trust. Effective engagement occurs with trust, but trust is often absent or limited at the outset of stakeholder engagement. The previous and following two bullet points are potentially important factors in helping to develop trust.
- Ensure stakeholders are listened to and promises are fulfilled.
- Support training of community relations staff. Ensure community relations staff are given adequate status and support.

Source: Business Partners for Development (2000)

It is recognized that, at this early stage, for commercial reasons companies may be unwilling to flag what commodities or specific areas they are targeting. However, it is equally important that this stage be used to build trust and credibility. As exploration advances and where biodiversity is identified as of potentially high value, it is important to ensure that reputable agencies or individuals conduct biodiversity assessments and produce reports that are peer-reviewed to the extent practicable.

Consulting early on biodiversity is a valuable means of exchanging information, of indicating intent with respect to biodiversity, and of eliciting valuable information to help define understanding of the biodiversity context of operations. It can also help identify biodiversity threats and opportunities. It can help develop a more thorough understanding of the intersections between your operations and biodiversity, and it may reveal potential or actual impacts that had previously not been considered. It can also highlight areas of importance for biodiversity where collaborative effort could help ensure the success of conservation efforts, or it can identify complimentary interests of a range of stakeholders that could improve the prospects for biodiversity conservation or enhancement.

One area of particular relevance to consultation is 'traditional knowledge'. The value of traditional knowledge has often been underestimated as it is not presented in a 'scientific' manner that fits into formal evaluation methods. However, experience in many locations strongly indicates that this knowledge should be fully incorporated into the evaluation of biodiversity (and other) assessment and management plans. This highlights the importance of ensuring traditional rights and uses of biodiversity are recognized in impact assessment and the benefits from commercial uses of biodiversity are shared in a fair way. Additional guidance on incorporating traditional knowledge is provided in the Akwe: Kon voluntary guidelines (***see Section D***).

The effectiveness of stakeholder engagement is an important consideration. If stakeholder engagement is treated cursorily or as another 'quasi regulatory requirement', it can lead to mistrust or disaffection on the part of stakeholders. Some of the basic principles for effective stakeholder engagement are included in **Box 6.1**.

- Build long-term, continuing and sustainable relationships. Relationships with stakeholders should be considered as long-term investments and therefore it is important to allow the time for such relationships to develop.
- Ensure cultural differences are recognized, particularly within indigenous communities. Engaging dialogue can only occur if each party understands each other's perspective. Cross-cultural training is important to build levels of respect.
- Consider the involvement of a neutral third party. This can help to overcome actual or perceived asymmetries (in terms of power, resources, and so on) and can be instrumental in supporting the development of trust.
- Develop trust. Effective engagement occurs with trust, but trust is often absent or limited at the outset of stakeholder engagement. The previous and following two bullet points are potentially important factors in helping to develop trust.
- Ensure stakeholders are listened to and promises are fulfilled.
- Support training of community relations staff. Ensure community relations staff are given adequate status and support.

Source: Business Partners for Development (2000)

Once preliminary information has been gathered, it is important to consult with stakeholders to refine understanding of the site, its biodiversity and the values that stakeholders place on the biodiversity. Therefore, stakeholder engagement on biodiversity issues is central to the integration of biodiversity into the ESIA process and ought to continue throughout the process and into closure planning. The approach to involving communities in the ESIA for the Gamsberg Zinc project in South Africa is described in ***Box 6.2.***

Participatory planning and decision-making approaches become increasingly important in the choice of mitigation measures or conservation enhancement initiatives. In particular, unless post-closure land uses are narrowly prescribed by regulatory requirements, participatory planning for closure is often essential to the longer-term success and sustainability of closure in general and to measures to protect or enhance biodiversity in particular. It is at these later stages that partnerships become increasingly important.

Box 6.2. Public participation and community liaison during the ESIA process – Gamsberg Zinc Project, South Africa

Gamsberg is a large, low-grade zinc deposit in the Northern Cape Province of South Africa. It has changed hands several times since its discovery in 1971, most recently becoming wholly owned by Anglo American in 1998. A detailed feasibility study demonstrated that a viable operation could be developed to produce 300,000 tons of zinc per year. The operation would comprise an open-pit mine, concentrator and dedicated zinc refinery, all on the same site.

During the feasibility study, a detailed EIA was conducted. While the project would provide job opportunities and contribute to wealth creation, there was the potential to damage the habitat of a group of rare succulent plant species.

Extensive stakeholder consultation characterized the development of the project. Meetings were held with over 300 interested and affected parties, and the project team hosted three public open days, which included visits to the proposed mine site and detailed presentations of the proposed mining development.

Regular dialogue was established with all of the main interest groups representing the ecology, farming and local communities, the regional and local authorities and the tourism sector. Newsletters kept interested and affected parties informed of project progress and environmental issues as these emerged during the EIA. This dialogue resulted in alterations to the layout of the proposed surface facilities, including the tailings dam and the waste rock dumps, to preserve the areas that support the greatest density and diversity of plant and animal species.

6.3.2 In-depth engagement with potential partners

The more in-depth engagement envisaged would include involving stakeholders in the participatory development of closure planning and initiatives to enhance biodiversity protection or conservation. As activities progress towards developing initiatives for biodiversity conservation or enhancement, stakeholders with the strongest interest in biodiversity should be encouraged to actively participate, as they have most at stake and their support is fundamental to longer-term success.

Identifying stakeholders and their interests does not ensure that they can or will participate. Some stakeholders may either be unable or unwilling to become involved. For example, they may have differing levels of capacity for engagement in either participatory planning or partnership arrangements. Where capacity is limited, mining companies should take steps to enhance the capacity of local partners for substantive engagement. However, it should also be recognized that some NGOs are strongly opposed to engaging with business.

The sustainability of conservation initiatives in general, and particularly those involving a combination of conservation and development (such as Integrated Conservation and Development Programs), often depends on effective partnerships between government, business and civil society. No one stakeholder group has the full range of skills and resources to promote and sustain conservation partnerships in isolation. Working together enhances the prospects for more sustainable conservation outcomes that should last beyond the closure of the mining project. Successful partnerships are built on a shared commitment to address such issues. This was the impetus behind the Bushmanland Conservation Initiative in South Africa (***see Box 6.3***).

Box 6.3. The Bushmanland Conservation Initiative – Anglo American/National Biodiversity Institute, South Africa

In 1999, Anglo American proposed opening the Gamsberg Zinc Project in Bushmanland, a large open pit mine on a quartzite inselberg (an island mountain) in the heart of a pristine biodiversity hotspot. The proposed 5.5-billion-rand mine would create a hole some two by three kilometres wide and 600 metres deep – 200 metres deeper than the Kimberly hole. The mine would also create approximately 1,000 jobs in an area with few economic opportunities.

Detailed assessments of biodiversity were undertaken, including an assessment of 14 surrounding quartzite inselbergs to place the impacts of the proposed Gamsberg mine in a regional context. This analysis showed the Gamsberg was the single most important site for biodiversity conservation in the region, as it contained 70 per cent of the unique fine quartz patch habitat, three new plant species and the largest populations of several threatened plant species. While the biodiversity studies were thorough, environmentalists were concerned that the global and national biodiversity significance of the area had not been adequately recognized in the overall EIA and that proposed mitigation measures were inadequate.

A conservation agency commissioned a fine-scale conservation plan to identify options for achieving conservation targets. This study was supposed to lay the basis for negotiation on mitigation measures to offset the impacts of the open pit, but a lack of trust between parties and the lack of precedent for such an initiative eventually led to a stalemate between Anglo and many of the conservation NGOs involved. What Anglo was offering as compensation did not have the support of the majority of NGOs and biodiversity specialists in the region. Shortly after this unsatisfactory process, the project was placed on hold due to low zinc prices.

Having the project on hold was fortuitous in retrospect. It provided some breathing space between opposing parties, and two important developments during this time facilitated constructive engagement between the conservation and mining sectors in the region.

During the Succulent Karoo Ecosystem Project planning process, the dialogue between biodiversity groups and Anglo continued, and an agreement was reached to establish a partnership project: the Bushmanland Conservation Initiative (BCI). This partnership between conservation NGOs, the mining company and local communities aimed to establish a multi-owned protected area through a variety of innovative interventions and mechanisms that drew in local landowners. The protected area will achieve conservation targets for biodiversity in this priority area through a multi-use approach. The BCI will develop local conservation management capacity through training of local community members as conservators within the project management team.

What began as a confrontation between mining and conservation interests gradually developed into a collaborative approach that included systematic conservation planning. This catalyzed Anglo Base Metals' direct involvement in implementing conservation action that meets conservation targets. Without systematic conservation planning, it would not have been possible to determine the impacts of the Gamsberg mine, suggest meaningful mitigating measures, build credibility of biodiversity goals or provide a way for the mining sector to contribute that adds directly to efforts to meet biodiversity conservation targets.

The Natural Resources Cluster of the World Bank's Business Partners for Development (BPD) initiative brought government, industry and civil society representatives together to explore opportunities for partnership around extractives projects and produced a wealth of practical guidance on how those partnerships could generate sustainable outcomes. (***See Section D*** for additional material derived from the BPD initiative.)

BPD developed a Partnership Assessment Framework that provides a structured approach to assessing the biodiversity conservation capacities and resources available within a mining project area, anticipated future capacity needs and any critical gaps. The framework can help assess the need for – or success of – capacity-building initiatives to improve conservation outcomes and can identify partners to work with in achieving those goals. It is used to assess:

- existing and future partnership capacity needs;
- anticipated benefits of biodiversity partnerships to your organization, programs or projects; and
- the sustainability of potential partner organizations.

The application of the framework involves the following steps:

- Based on the stakeholder analysis, develop a list of all possible conservation partners.
- Identify where particular partners can play a leadership role on biodiversity initiatives and where biodiversity initiatives fall outside a given partner's mandate, interest or sphere of influence.
- Identify where partners have shared mandates, interests and influence over possible biodiversity initiatives.
- List potential partners identified as having common interests and capacities with the mining operation.
- Approach potential partners with a view to reaching agreement on exploring ways of addressing priority conservation initiatives through partnership.

Additional information is available from the BPD Web site.

Chapter 7. Mitigation, Rehabilitation and Enhancement Tools

See checklist 7.1 on page 137

7.1 Introduction

Mitigation involves selecting and implementing measures to protect biodiversity, the users of biodiversity and other affected stakeholders from potentially adverse impacts as a result of mining. Such impacts may be identified during an ESIA, while determining significant environmental aspects for an EMS or as part of the routine operational or monitoring activities of mining companies. The aim is to prevent adverse impacts from happening or, where this is impractical, to limit their significance to an acceptable level.

Rehabilitation refers to the measures that are undertaken to return mined land to agreed post-closure uses. It differs from mitigation insofar as it implicitly recognizes that impacts on biodiversity have occurred. In the context of this GPG, the emphasis is on identifying post-closure land uses that maximize the benefits to biodiversity, with the support of key stakeholders.

Biodiversity enhancement refers to measures undertaken to enhance or improve biodiversity – to go beyond mitigation or rehabilitation and explore opportunities to enhance the conservation of biodiversity. Whereas mitigation and rehabilitation measures are responses to the impacts or threats to biodiversity arising from mining operations, enhancement measures are undertaken in response to external threats to biodiversity (such as overgrazing), institutional shortcomings for managing or protecting biodiversity (such as lack of enforcement) or a lack of scientific knowledge concerning biodiversity. This is a critical distinction between mitigation, rehabilitation and enhancement.

This chapter discusses the factors to consider in the selection of mitigation measures, outlines issues to consider in rehabilitation planning and implementation for biodiversity, examines the particular challenges and opportunities of offsets in greater detail, discusses the enhancement of biodiversity at various levels and considers the boundaries of responsibility of mining companies for biodiversity.

7.2 Selection of mitigation measures

Mitigation is concerned with identifying and implementing measures to safeguard biodiversity and any affected stakeholders from potentially adverse impacts of mining. Ideally, the aim is to prevent adverse impacts from occurring or, if this is not possible, to limit their significance to an acceptable level. A number of categories of mitigation and a hierarchy of their desirability are illustrated in ***Figure 7.1***. These include (in descending order of priority):

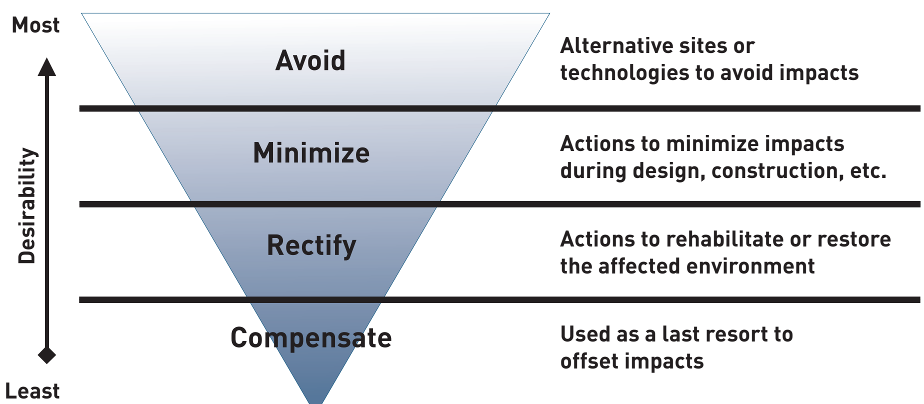
- **Avoiding** impacts by modifying a proposed mine or existing operation in order to prevent or limit a possible impact. The highest priority should always be afforded to avoidance measures. Changing the location or design of a processing plant is a simple example. A more extreme example of avoidance is not to proceed with the development. For example, if an economically attractive mineral deposit were offered to an ICMM member within a World Heritage Site, ICMM's policy on 'no go' areas would dictate that the project could not proceed.
- **Minimizing** impacts by implementing decisions or activities that are designed to reduce the undesirable impacts of a proposed activity on biodiversity. For example, installing tertiary treatment to remove phosphates from effluents that could lead to eutrophication of wetlands and changes in species composition, with resultant impacts on aquatic biodiversity.

- **Rectifying** impacts by rehabilitating or restoring the affected environment. This would include attempts at habitat re-creation, to restore the original pre-mining land uses and biodiversity values.
- **Compensating** for the impact by replacing or providing substitute resources or environments. Compensatory measures should be used as a last resort and might include so-called offsets, such as purchasing an area of equivalent habitat for longer-term protection.

The ultimate choice of mitigation measures needs to be tailored more precisely to the specific impacts, with reference to the significance of the potential impacts (***see section 5.2.5 on impact identification and assessment***). The acceptability of mitigation alternatives should be agreed with the relevant authorities. Ideally, mitigation options would first be considered in consultation with affected stakeholders and biodiversity specialists, mitigation alternatives discussed, and mitigation priorities assigned that attempt to reconcile the interests of various stakeholders.

Avoidance is the preferred option, and results in no impact on biodiversity. Actions to minimize impacts are second in terms of desirability, and might include changes in the routing of access roads or location of tailings impoundments. Measures to rectify impacts or compensate for impacts are less preferable and should be considered carefully.

Figure 7.1 Hierarchy of biodiversity mitigation measures



Source: Rio Tinto (2004)

Actions to rehabilitate or restore the affected environment, while attractive in principle, have a mixed record of success. For example, habitat recreation to mitigate impacts has a patchy record of success. Reinstatement of original communities of plants and animals is often very difficult to achieve, especially if the site has been severely degraded. Although there are some impressive examples of habitat reinstatement that have resulted in the establishment of ecologically valuable communities, there is little evidence to suggest that complex ecosystems of native vegetation can be created successfully. In general, the restoration or re-creation of areas of value for biodiversity on already cleared land takes considerably more time and energy than protecting existing native vegetation.

7.3 Rehabilitation planning and implementation

Once closure objectives and targets have been established (***see section 4.3 on rehabilitation***), a rehabilitation plan should be produced. This should be integral to the overall Mining Plan, and should clearly explain to regulators and other stakeholders how the company intends to carry out a rehabilitation program to meet agreed objectives. The plan should be developed taking into account all relevant information on pre-mining and likely post-mining landforms, soils, waste material characteristics, hydrology, land uses and other biodiversity aspects relevant to rehabilitation; any technical limitations posed by these; and pre-mining flora and fauna surveys and data from established reference monitoring sites. It should describe the final land use(s) and related objectives and targets, giving details of:

- soil and overburden materials handling, to ensure that materials favourable to plant establishment, as well as potential problem materials (such as acid-generating, high metal level, saline soils or potentially dispersive material), are placed in the correct sequence;
- topsoil handling procedures, especially those designed to conserve plant propagules, nutrients and soil biota;
- soil amelioration techniques to create conditions favourable for growth, such as the application of lime or gypsum;
- any techniques for conserving and reusing vegetation, including mulch, brush matting for erosion protection and introduction of seed and log piles for fauna habitat;
- landscaping procedures, including the construction of erosion control and water management structures;
- vegetation establishment techniques;
- weed control measures prior to and following rehabilitation;
- fertilizer application; and
- follow-up planting and maintenance programs.

The plan provisions should be time-bound and should take into account opportunities for progressive rehabilitation and closure. From a biodiversity conservation and re-establishment perspective, it is particularly important that the extent of disturbed areas is minimized at any point in time. Rehabilitation plans should be reviewed periodically as further information on site conditions becomes available and as new rehabilitation procedures are developed.

7.3.1 Site preparation

Successful rehabilitation programs are always well planned and organized and require a detailed revegetation program to guide staff who are responsible for implementing the rehabilitation plan; they need care in site preparation prior to seeding or planting to ensure optimal conditions exist for establishment of healthy diverse vegetation. The revegetation program will include details of topsoil sources, stripping depths, volumes, handling methods, placement and scheduling. Areas where soil amelioration is needed will be mapped, and details of what is required described. It will describe what plant species and vegetation communities will be established, so that the most appropriate species are used in each area, e.g. sites prone to waterlogging, tailings capping, sustainable vegetation cover to prevent erosion on tailings batters and steep slopes, and species tolerant to low pH, high salinity etc. where necessary.

The revegetation program will need to outline the methods of obtaining and introducing plant propagules. If planting of seedlings is to be used, a nursery will need to be established and seeds or cuttings collected (perhaps from adjacent areas

Box 7.1. Involving traditional owners in seed collecting and rehabilitation programs – GEMCO Manganese Mine, Northern Territory, Australia

Groote Eylandt Mining Company (GEMCO), operated by BHP Billiton, mines manganese from a number of leases on the western coastal plain of the island Groote Eylandt. The island has an area of 2,260 square kilometres and is wholly owned by the Anindilyakwa Aboriginal people. The mine is located in a part of Australia where documented knowledge of plant species is limited, and successful rehabilitation can be difficult. The company therefore looked to the traditional owners to assist in returning their land to the way it was.

In 1997, GEMCO committed to an employment and training program for the Anindilyakwan people. The Aboriginal Employment Strategy has grown to now involve 28 local people carrying out most rehabilitation tasks on site, including all seed collection, direct seeding and planting of seedlings, along with all weed control. This provides them with the skills to pursue a career with either GEMCO or the mainstream mining industry.

Rehabilitation of the open-cut mines commences with reshaping landforms, followed by fresh return of topsoil and ripping to 1.6 metres to reduce compaction. Plant establishment involves using seeding and planting procedures designed to return a variety of plant species and densities that closely represent those found in the adjoining native forests.

The mine's island location means that it is important to use locally collected seed for all revegetation work, as plants grown from these seeds are better adapted to the local conditions. Some 25 species of local trees and shrubs are collected from the leases for direct seeding or the growing of seedlings for wet season planting. The quantities of seed required each season is calculated from previous studies and available sites, and GEMCO relies on the local knowledge of employees to locate the seeds and know the optimum time for collection in a particular area.

Seed is collected most of the year, by hand from the ground or low shrubs, from taller shrubs using long-handled pickers or from trees using elevated work platforms. All seeds are cleaned to remove the husks, trash, flesh or other unwanted material that may inhibit germination. After cleaning and drying of the seeds, data are recorded on the location, weight and date of collection, the seed is treated with carbon dioxide to reduce insect attack and it is vacuum-sealed. The freshly packed seed is then placed into an air-conditioned storage room to maximize long-term viability. Significant training has been provided to allow these activities to be achieved in an efficient and professional manner.

of high biodiversity) for several years before they are actually planted out. For example, seed collection will need to commence at least a year or two before the seed is actually used, so that the volumes needed and the collection sources can be identified. Wherever possible, local species should be used, and seed should be collected locally, because it will usually be best adapted to the conditions, and this will avoid introducing different genetic provenances. After collection, seed must be cleaned and stored under conditions that will maintain maximum viability over the period of storage and that will minimize damage due to pests, fungi, and so on. The approach adopted by GEMCO in Australia illustrates the value of care in seed collection, cleaning and storage (***see Box 7.1***).

Effective site preparation refers to the procedures that take place prior to seeding or planting to help ensure that optimal conditions exist for the establishment of healthy, botanically diverse and sustainable vegetation. These procedures include soil and waste characterization, selective handling of materials, construction of stable landforms, topsoil handling, ripping, fertilizing and soil amendment and seed bed preparation (for example, scarifying).

Soil and waste characterization: The characteristics of soils and waste materials are one of the primary determinants of rehabilitation success. As early as possible during the life of the mine, soil types and horizons that should be conserved for establishing a post-mining self-sustaining vegetative cover should be identified, along with any required ameliorative treatments such as liming to adjust pH. The quality of overburden material is also important, because some of this will underlay topsoil and could affect plant roots.

Selective handling of materials: Overburden that is unsuitable for plant growth, such as acid-generating sulphidic materials, will need to be buried at a depth below the rooting zone. More favourable materials, with physical and chemical characteristics suitable for supporting plant growth, can be placed on the surface prior to covering with topsoil (if available).

Construction of stable landforms: Landform stability is essential for the long-term sustainability of rehabilitation. Poorly constructed landforms can result in erosion that severely affects both the revegetation and downstream biodiversity. Where possible, they should blend in with natural landforms or, at a minimum, be designed to limit erosion through careful design of slopes or the use of erosion control structures.

Topsoil handling: Topsoil can serve a number of important functions, such as the supply of seed and other propagules, beneficial microorganisms and nutrients, and can enable the rapid development of groundcover. The topsoil handling plan will need to address sources, collecting depth, the volumes and handling equipment needed, respreading depth and any follow-up treatment (such as scarifying prior to seeding). Where topsoil needs to be stockpiled, the structures should be built to minimize deterioration of seed, nutrients and soil biota – for example, by not collecting topsoil that is saturated following rainfall (which promotes composting), creating stockpiles of lower height (one to two metres), seeding stockpiles with a cover of native vegetation (preferably N-fixing legumes) and minimizing the duration of stockpiling. The importance of care in handling topsoil in order to ensure the longer-term re-establishment of biodiversity was evident from research conducted by Alcoa World Alumina in Australia (***see Box 7.2***).

Ripping, fertilizing and soil amendment: Ripping along contour will usually be required to facilitate root penetration through compacted spoil material and to confer protection against erosion. Fertilizing will also be required in most cases to replace the nutrients lost during mining. The types and methods of application of nutrients should be based on soil characterization studies. For some soils, amendments such as gypsum or lime will also be required.

Box 7.2. Topsoil handling to establish botanical diversity – Alcoa World Alumina Australia

Where topsoil contains a viable native seed source, it should be conserved for reuse following mining. This not only provides a cheap source of plants, it helps ensure that they establish in relative abundances that reflect pre-mining densities and it promotes establishment of species whose seed may be hard to obtain or difficult to germinate.

The bauxite mine rehabilitation program conducted by Alcoa World Alumina Australia in the jarrah forest of southwestern Australia (***see Box 4.3***) is an excellent example of how conservation of the soil seed bank can significantly enhance the botanical diversity of the post-mining vegetation community. After vegetation is cleared, the top 150 millimetres of soil, which contains most of the soil seed bank and nutrients, is stripped prior to mining and then directly returned to a pit about to be rehabilitated, wherever possible. Research has shown that the majority of native plant species (72 per cent) on rehabilitated areas comes from seed stored in topsoil. The importance of directly returning fresh topsoil has been demonstrated by trials comparing this technique with stockpiling. These have shown that disturbance associated with direct return of topsoil results in loss of less than 50 per cent of the seed contained in the pre-mining forest seed store; in contrast, stockpiling results in losses of 80–90 per cent.

Other aspects, such as the depth of re-spreading topsoil, the season when the soil is handled and the timing of seeding, are also important. Seed will not survive if buried too deep, and it persists better when the soil is moved during the dry season. Also, plant establishment from seeding is greater when the seed is applied to a freshly disturbed surface. Together, the combined use of fresh topsoil return, seeding, and planting of 'recalcitrant' (or resistant) plants have now resulted in numbers of plant species at 15 months of age equal to those recorded in equivalent-sized plots in unmined forest. For further information, see www.alcoa.com.au.

7.3.2 Rehabilitation implementation and maintenance

Good practice rehabilitation operations should include the following considerations:

- Topsoil must be handled during rehabilitation operations in a manner that will conserve plant diversity in the soil seed bank and maximize plant establishment after re-spreading. For example, topsoil should be collected at the time of year when the seed bank is likely to be highest.
- A weed control program should be implemented, where pre-mining surveys identify the presence of problem weeds, consistent with integrated pest management principles (***see also section 3.2 on ancillary infrastructure***). Similarly, a fauna management plan will be required if feral predators or grazing stock problems are likely.
- To achieve the desired botanical diversity, successional aspects must be considered when rehabilitating. Pioneer species that readily colonize disturbed areas should be included in the seed mix. Species characteristic of later successional stages should also be established early if practicable. High seeding rates of some early colonizing species may reduce overall diversity by

out-competing other species. The appropriate seeding rates for each species may be a matter of trial and error.
- Good seeding practice is critical to successful rehabilitation for many mines. To establish a diverse vegetative cover, a variety of seeding methods is often preferable – for instance, direct topsoil return, hydro-seeding, planting of seedlings or natural recolonization.
- Follow-up maintenance of plantings may be necessary and monitoring is essential to gauge the success of the methods employed. Remedial measures may be required if planting survival is low, due, for example, to drought or overgrazing.
- The use of planting to establish botanical diversity may provide good opportunities for involving other stakeholders.
- Fauna should be encouraged to return to rehabilitated areas by the provision of suitable habitat.

Additional detailed sources of guidance are included at the end of this chapter.

7.3.3 Ongoing monitoring and research

Monitoring and research are essential but often-neglected components of good-practice rehabilitation for biodiversity establishment. The principal purposes of monitoring and research are to confirm that rehabilitation operations have been carried out according to agreed procedures, to provide data in support of continuous improvement, to evaluate whether biodiversity objectives are being met and to assess long-term sustainability of rehabilitated areas.

Good rehabilitation monitoring programs have four components:
- baseline and ongoing monitoring of unmined reference areas established during pre-mining mapping and surveys, to define the values that need to be protected or replaced;
- documentation of the rehabilitation procedures carried out – details of topsoil sources and handling methods, seed mix composition, rates and application methods, densities of species planted and so on – which are all critical for interpreting the findings of later rehabilitation monitoring results;
- initial establishment monitoring, which serves as a quality control step – this is carried out soon after rehabilitation establishment operations have been completed and records whether they have been carried out as required and whether initial establishment has succeeded – followed by establishment targets and standards that, if not met, require that specified corrective actions be undertaken; and
- long-term monitoring, which commences usually two to three years later, depending on the rate of successional development in the region, and which evaluates the progress of rehabilitation towards fulfilling long-term land use objectives as well as providing the information needed to determine whether the rehabilitated ecosystem would be sustainable over the long term.

Opportunities should be sought for involving the local community in monitoring, particularly where they have an intimate relationship with and understanding of biodiversity (as in indigenous cultures). The benefits of this approach are being clearly demonstrated through a number of biodiversity management initiatives in Australia and the Canadian North West Territories.

At the research level, ecosystem development and sustainable management projects carried out as part of University projects not only provide the company with useful information, they give graduates valuable practical research experience. The benefits of long-term monitoring for successful rehabilitation (and sustainable closure) are exemplified by the approach of Richards Bay Minerals in South Africa (*see Box 7.3*).

Box 7.3. Long-term monitoring of ecosystem development – Richards Bay Minerals, South Africa

Richards Bay Minerals (RBM), a company jointly owned by Rio Tinto and BHP Billiton, began mining heavy minerals in coastal dunes northeast of Richards Bay in 1977. The natural vegetation consists of subtropical coastal dune forests. Before mining, the lease area comprised 60% plantations, 20% grassland and 20% coastal dune forest. Following discussions with the local landowner and Government, a decision was made to establish plantations for future development of a charcoal industry on the landward side of the dunes (about 66%) and indigenous coastal forests on the seaward side (33%). This would provide protection against erosion and allow for recruitment of plants and animals from an adjacent coastal strip left unmined for this purpose. The objective of RBM's dune forest rehabilitation programme is the restoration of the biodiversity and function of a typical local coastal dune forest.

The mining method is a dredging operation that progressively moves along dunes with reconstruction and revegetation of the dune behind the mining path. Rehabilitation of the reconstructed dunes is carried out by a local contractor who employs local staff. It involves respreading topsoil, the application of a seed mix containing native grass, herb, shrub and tree species as well as a cover crop followed by the construction of windbreaks for erosion protection. Assessment monitoring takes place during the initial months to confirm that rehabilitation operations have been carried out as required, and that seed is germinating and plants are establishing. Further monitoring of alien weeds is carried out and control methods used where necessary. Employees from the local communities are contracted to monitor and remove cattle from young rehabilitation areas.

Depending on the season, rainfall and aspect, the windbreaks can be removed after three to nine months. After 12 months the cover crop dies off leaving dense stands of indigenous grass. Other indigenous species come from the topsoil. Gradually, Acacia kosiensis shrubs and other species develop into a woodland, and forest plant and animal species start colonising. At around 12-18 years, Acacia kosiensis begins to senesce, and species typical of adjacent unmined areas begin to occupy the canopy gaps.

The first rehabilitation was carried out in 1978. There is therefore a long history of rehabilitation from which RBM has been able to learn a great deal in relation to the success of its methods. Monitoring and research programmes have been conducted since 1991. Much of this has work been carried out by the University of Pretoria's Conservation Ecology Research Unit (CERU), whose studies have focused on the development of plant and animal communities, and ecosystem function. Key faunal groups studied have included millipedes, birds, rodents and others. As a general rule, pioneer species of each of these groups colonise younger rehabilitation sites, whilst species typical of mature vegetation communities colonise later.

CERU have concluded that rehabilitation is likely to be successful provided source areas remain intact. This is because more than ten years of monitoring data show that, in general, the compositional and structural attributes of the regenerating flora and fauna, together with those of soil characteristics, are converging towards those typical of undisturbed forests in the region. Further time will be required for tree diversity and species composition, as well as faunal communities, to fully match those of unmined forests. However, this is expected to occur in time. The studies are continuing to provide RBM valuable feedback for the rehabilitation programme, and will prove extremely valuable in the implementation of its sustainable mine closure strategy.

For additional information see www.richardsbayminerals.co.za.

For a fuller discussion of biodiversity conservation measures, see the recent Rio Tinto and Earthwatch Institute publication on this subject (***see Section D***).

7.4 Biodiversity offsets

Where permanent destruction of a valuable ecosystem is unavoidable, other compensatory options may be considered as a last resort. These are commonly referred to as 'offsets'. The concept was first developed in the United States during the 1970s, in the context of mitigating wetlands losses. Offsets might involve funding the protection of a local nature conservation area or the purchase of an equivalent area of land for protection. A biodiversity offset amounts to a 'payment' (and possibly other forms of support) to protect biodiversity within a designated area. While offsets are simple in concept, they have attracted controversy. The ICMM proposition and briefing papers on biodiversity offsets (July 2005) provide detailed background on offsets, which provide an opportunity for integrating mitigation measures into regional conservation planning strategies.

The proponents of offsets include conservation organizations, mining companies, investors and some government agencies, who see mutual advantage in their development. For example, some conservation organizations view offsets as a legitimate means of ensuring that additional land areas are afforded long-term protection, in support of net gains for biodiversity. Companies view offsets as a mechanism to effectively mitigate impacts, secure their licence to operate and engage constructively with conservation organizations. Investors value offsets as potentially important risk mitigants, whereas governments see offsets as playing a role in helping to reconcile competing demands for development and protection of biodiversity.

Opponents, however, challenge the efficacy of the often stated objective of 'net gains' for biodiversity and the basis for such comparisons. In particular, they argue that secondary impacts are not considered in the establishment of offsets, although these can be quite significant in sectors such as mining (and to varying degrees beyond the control of companies). The critics view offsets as a convenient 'smokescreen' to enable companies to develop in areas that would otherwise be off-limits, thereby facilitating harm to biodiversity that would otherwise have been unacceptable to decision-makers.

This GPG offers only a cursory exploration of the debate around offsets, and additional information sources are provided in Section D (including ICMM's two recent contributions to the debate). At a minimum, offsets should be approached with caution and should be carefully designed to ensure their full beneficial potential is achieved in practice. The following are some basic factors that could be borne in mind:

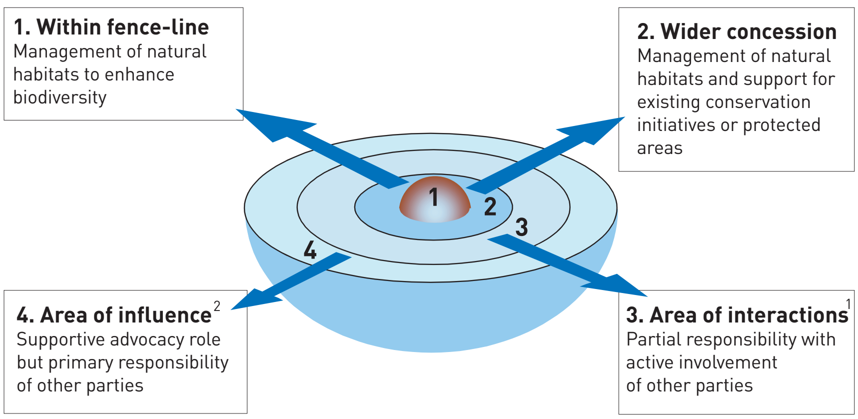
- Offsets should never be used to justify or compensate for poor environmental management practices or performance.
- The compensatory protected area(s) should preferably be ecologically similar to the original natural habitat converted or degraded by the project and be subject to fewer existing (or anticipated) threats to biodiversity.
- The compensatory protected area(s) should be of equivalent value and no smaller than the original natural habitat converted or degraded by the project. In addition, some contingency provision should be made to account for secondary impacts and unplanned future expansions.
- Where possible, offsets should complement other government/conservation partner programs and should also be responsive to conservation priorities outlines in national or regional initiatives to implement the Convention on Biological Diversity.
- Offsets should result in a net gain for biodiversity over time, bearing in mind the timeframes of ecological processes, and this should be credibly evaluated by peer-reviewed scientific studies.
- They should be enduring – they must offset the impact of the development not only for the period during which the impact occurs, but beyond.
- Offsets should be quantifiable – the impacts, limitations and benefits must be reliably estimated.
- They should be targeted – they must offset the impacts on a 'like for like or better' basis.
- Offsets should be located appropriately – ideally they should offset the impact within the same area.
- Offsets should also be supplementary – they should be in addition to existing commitments and not already be funded under a separate program.
- They should be enforceable through the development of consent conditions, licence conditions, covenants or a contract.
- In choosing offsets, biological criteria are always the primary consideration, in preference to mixing threat and biological criteria.
- The determination of acceptable offsets requires consultation with stakeholders. The offsets will of necessity be site- and project-specific.

7.5 Enhancement of biodiversity at various levels

As noted in section 7.1, biodiversity enhancement concerns measures to enhance or improve biodiversity that respond to non-mining-related threats and thereby go beyond mitigation or rehabilitation. Opportunities for biodiversity enhancement exist at various levels, which have been characterized as spheres of operational influence in Rio Tinto's guide on biodiversity (***see Figure 7.2***). Within the fence-line of an operation, natural habitats in undisturbed areas can be managed to enhance their biodiversity value, or habitats that have been subject to historical disturbance (unrelated to mining) can be improved or restored. Such management practices can also be extended to the second sphere of influence, the wider concession area, which may provide an opportunity to link into existing conservation initiatives or adjoining protected areas.

The third sphere of influence is the so-called area of interactions, which refers to the wider area of environmental or social interactions (such as wetlands that may be connected to receiving watercourses for effluents, or communities from which employees are drawn). Here the possibilities for benefiting biodiversity conservation are more diverse and might include engaging with communities and other conservation partners to address specific threats to biodiversity (***see section 5.4.2 on assessing non-mining-related threats***). The fourth area of influence is potentially very broad, and refers to the supportive or advocacy role that mining operations may play at a regional or national level in support of biodiversity conservation.

Figure 7.2 Identifying opportunities for biodiversity conservation or enhancement



Note 1: This refers to the wider area of environmental and social interactions, for example receiving waters for effluents, local communities that interact with the mine, etc.
Note 2: This refers to the advocacy role that Rio Tinto operations can play in regional environmental initiatives, support for developing the capacity of conservation organizations, etc.

Source: S. Johnson on behalf of Rio Tinto

Other than Rio Tinto's biodiversity guide, there is little or no guidance available on how mining companies can systematically identify potential opportunities to benefit biodiversity conservation. But in general terms, enhancement opportunities might be grouped under the following categories:

- managing natural habitats to enhance value;
- enhancing scientific knowledge of ecosystems or species, through ecosystem, habitat or species level studies;
- linking to existing conservation initiatives;
- supporting environmentally and socially sustainable protected areas management or creation (***see, for example, Box 7.4***);
- providing support for developing the capacity of conservation organizations, agencies or communities;
- addressing some of the underlying threats to biodiversity – for example, by engaging in alternative livelihoods initiatives to substitute for some inherently

unsustainable economic activities such as overharvesting of biodiversity resources; and
- promoting and becoming involved in integrated conservation and development initiatives, which seek to link the goal of biodiversity conservation with local social and economic development.

Box 7.4. Partnership for restoring degraded arid lands – South Australia

Arid Recovery is an ongoing ecosystem restoration partnership established in 1997 between Western Mining Corporation (subsequently acquired by BHP Billiton), the South Australian Department for Environment and Heritage, the University of Adelaide and the community group Friends of Arid Recovery. From the outset, the new partners agreed on the following as their aims:
- to facilitate the ecological restoration of arid ecosystems;
- to provide transferable knowledge, information and technology for broad-scale environmental management of Australia's arid lands; and
- to apply the principles developed to demonstrate how mining, pastoralism, tourism and conservation organizations can work together to achieve tangible benefits from sustainable ecological outcomes.

The project started small, with construction of a 14-square-kilometre fenced reserve to exclude feral cats, rabbits and foxes. Following four expansions, the protected area now covers 86 square kilometres that are fenced to exclude non-native mammals.

After thousands of hours of staff, students and volunteer labour, all feral cats, rabbits and foxes were eradicated from the entire reserve. This created an area of complete protection into which four locally extinct species were reintroduced (the Greater Stick Nest Rat, the Burrowing Bettong, the Greater Bilby and the Western Barred Bandicoot). Each of these reintroductions was successful, and all four species are now living and breeding within the reserve. A trial release of numbats has occurred and woma pythons will also soon be reintroduced to assist Arid Recovery to recreate a self-sustaining and functioning ecosystem within the reserve. The numbers of native species in the fenced area have also increased, and there are now up to ten times as many small mammals inside the reserve as there are outside. A comprehensive plant monitoring program has also demonstrated considerable recovery of the reserve's natural vegetation.

Arid Recovery demonstrates the potential for biodiversity gains from multistakeholder partnerships.

A number of illustrative examples of opportunities to enhance biodiversity conservation are presented in ***Table 7.1*** under each of the above categories and for each of the four spheres of influence highlighted in ***Figure 7.2***. These examples, originally produced for Rio Tinto, are neither exhaustive nor prescriptive, but they should help identify potential opportunities for biodiversity enhancement. In almost all situations, they require mining companies to engage with government agencies, NGOs, local and indigenous communities or a wider set of stakeholders.

This is particularly true of situations where resources for biodiversity protection are scarce and where the overall footprint of the mining development is large. In Western Australia, for example, the approval process for new mining projects requires project promoters to contribute to 'net conservation benefits' – so the expectation of net gains is enshrined in the legal approval process. If this approach becomes more prevalent, the pressure to ensure net gains to biodiversity from mining (and other) development will become more compelling. However, it is important to understand that biodiversity gains may come at a cost to some local stakeholders.

7.6 Defining boundaries of responsibility for mitigation, rehabilitation or enhancement

Irrespective of how committed or successful biodiversity mitigation, rehabilitation or enhancement efforts are within the 'fence-line', mining operations run the risk of being associated with the loss of biodiversity beyond the fence-line unless they engage in broader, more inclusive biodiversity conservation strategies. At the same time, there are limits to the extent that companies can and should assume responsibility for biodiversity protection and enhancement. This GPG proposes that operations consider the following points to help determine the boundaries of their responsibility:

- The presumption should always be that mining companies assume responsibility for all aspects of mitigation and rehabilitation. While partnership approaches are desirable in order to broaden available skills and enhance the likelihood of positive outcomes, the primary responsibility (and burden of cost) remains with the mining company, as was the case with the Greg River Mine in Alberta (***see Box 7.5***).
- For biodiversity enhancement initiatives in the concession area, the extent of the mining company's direct influence over the management of land is an important consideration, as is the involvement of other parties in land use/management/planning within the concession area. For example, does the concession area provide for a range of uses (for agriculture, cultural value, conservation or recreation), and which other parties are involved in land management or use?
- For biodiversity enhancement, the extent of environmental and social influence of the project should be considered. The areas disturbed by mining and ancillary activities, the receiving waters for effluents and the deposition zone of stack emissions from a smelter or dusts from stockpiles should all be addressed through mitigation and rehabilitation measures. But indirectly affected areas, including local communities, communities with cultural attachments to the land or communities from which employees are drawn, should also be considered in developing enhancement initiatives.
- The maturity of the conservation context and related factors (***see section 5.4***) are also important. This will have a bearing on key factors such as the intractability of biodiversity threats and the capacity of potential partners.
- The existence of and potential linkages to biodiversity initiatives at the regional or national level, where mining operations might play a supportive role, should be considered.

Within the fence-line, the overall responsibility lies with mining operations, although this does not preclude the involvement of other parties. Within the wider concession area, operations retain the main responsibility for biodiversity. Defining the boundaries of responsibility within the area of environmental and social interactions

Table 7.1. Opportunities for enhancement of biodiversity (*illustrative examples*)

Possible biodiversity interventions	Spheres of operational influence			
	Within fence-line	**Wider concession area**	**Area of interactions**	**Area of influence**
Managing natural habitats to enhance value	Manage natural grasslands to encourage diversity of flowering plants	Manage forested areas and other natural habitats as protected areas	Collaborate with local communities on management of natural habitats	Collaborate with regional authorities on management of natural habitats
Enhancing scientific knowledge of ecosystems or species	Ensure that ESIA data on biodiversity are made available to academic institutions	Ensure monitoring of biodiversity involves local NGOs or academic institutions	Support local conservation groups or academic institutions on biodiversity studies	Support scientific research into biodiversity of areas of importance for biodiversity
Linking to existing conservation initiatives	Ensure native plant species are used in any landscaping works or consider opportunities for habitat creation	Consider potential for natural habitats in concession area to be linked to existing conservation efforts	Provide technical or financial support to local conservation initiatives	Provide technical or financial support to regional conservation initiatives
Supporting management or creation of protected areas	Consider potential for natural habitats within fence-line to form part of protected areas post-closure	Link management efforts for natural habitats within concession to local protected areas management	Support local efforts to establish protected areas with relevant organizations where biodiversity value is high	Support government agencies or NGOs in establishing protected areas where biodiversity value is high
Improving capacity of conservation organizations or agencies	Actively involve conservation organizations or agencies in S&EIA work to help improve local capacity	Actively involve conservation organizations or agencies in biodiversity monitoring to help improve local capacity	Support training for conservation organizations or agencies at the local level	Support training for conservation organizations or agencies at the regional or national level
Addressing underlying threats to biodiversity (*see section 5.4*)	***See mitigation in section 7.2***	Assess biodiversity threats (***using approach outlined in section 5.4.2***) and engage stakeholders in risk mitigation	Assess biodiversity threats (***using approach outlined in section 5.4.2***) and engage stakeholders in risk mitigation	Work with relevant agencies and NGOs to support capacity development for threats assessment and management
Promoting integrated conservation and development (ICDP) initiatives	Maximize potential for conservation in parallel with operations	Consider the potential for access to natural resources within concession that are consistent with conservation	Support local efforts of NGOs or agencies to reconcile development and conservation objectives	Work with relevant agencies and NGOs to support capacity development for implementing ICDP where appropriate

Source: Developed by S. Johnson on behalf of Rio Tinto (2004) is more complex – and is likely to be shared with a combination of stakeholders that may include government, NGOs, communities or other industries. This is where an understanding of the maturity of the conservation context as well as key stakeholders is critical, not only in understanding how responsibility might be shared but in assessing the prospects for success of biodiversity conservation or enhancement initiatives.

Last, beyond the area of environmental and social interactions, the primary responsibility for biodiversity protection and enhancement resides with other parties. While in some situations the threats to biodiversity will extend far beyond a mining company's operations, there are practical limits to how actively mining companies can engage. Mining companies should limit their activities to a supportive role, such as advocating the case for biodiversity protection or linking to existing or proposed biodiversity initiatives at the regional or national level.

Box 7.5. Creating wildlife habitat – Gregg River Mine, Alberta, Canada

Luscar Limited's Gregg River Mine is adjacent to the Rocky Mountains in the Upper Foothills subregion of western Alberta. Coal mining operations commenced in 1981 and were completed in 2000, with reclamation commencing in 1982 and continuing until 2004. The reclamation process involved reshaping spoil material, covering it with 30–40 centimetres of regolith and topsoil, followed by revegetation. The post-closure land uses were identified as watershed protection, wildlife habitat and commercial forestry.

The creation of wildlife habitat has been a key objective of reclamation at both the Gregg River Mine and at the adjacent Luscar Mine, which was also partly owned by Luscar Ltd until 2003. The key to success has been to assess the area's biodiversity, develop a sound understanding of each representative faunal group's habitat requirements, incorporate this into the reclamation program and monitor species use of created habitat so that adaptive management can take place. Care must also be taken to maintain linkages to adjacent habitat, to allow for species to recolonize when the habitat reaches the stage where it meets their requirements. Seasonal variation must also be considered, as many species' habitat requirements vary significantly between winter and summer. The differences in species preferred habitats are well illustrated by ungulates (hoofed mammals).

Reclamation of habitat for bighorn sheep has been particularly successful at both the Gregg River and Luscar Mines, with the reclaimed landscape used primarily as winter range but also for lambing, rutting and summer use. Newly established grassland and subalpine meadows provide grazing areas, while retained sections of benched highwall provide escape from predators. The 2002 fall population for both mines combined was 798, one of the biggest herds in North America.

Elk have colonized the Luscar Mine and, to a lesser extent, Gregg River. They use the grassland/forest edge, and the suitability of habitat for them depends on forage quality, cover and distance from the forest. Mule deer are common at both mines and use forage/cover habitat in a similar fashion to elk.

The presence of a diverse prey base, including these ungulates and many other smaller mammal species, supports a range of predators. The gray wolf, coyote, cougar and grizzly bear are regular occupants of both mines, while wolverine, red fox, black bear and Canada lynx are occasionally recorded.Techniques used to create habitat for other fauna species include constructing rock and brush piles, selecting plants for their forage and cover value, planting trees and shrubs on the lee side of shelters, and reconstructing stream channels and wetland habitats. The techniques used range from the microhabitat scale up to broad landscape scale. Successful recolonization by a diversity of wildlife is gradually being achieved by adopting an ecosystem approach to reclamation that focuses on species' habitat requirements.

Source: Information used in this case study was provided by Beth MacCallum (Bighorn Wildlife Technologies Ltd.).

SECTION D:

Supporting Materials

Section D.
Supporting Materials

Acronyms Used

BACI	before-after/control-impact
BAP	Biodiversity Action Plan
BPD	Business Partners for Development (World Bank)
CBD	United Nations Convention on Biological Diversity
EMP(s)	Environmental Management Plan(s)
EMS	Environmental Management System
ESIA	Environmental and Social Impact Assessment
GPG	Good Practice Guidance
GRI	Global Reporting Initiative
ICMM	International Council on Mining and Metals
IFC	International Finance Corporation
ISO	International Organization for Standardization
IUCN	The World Conservation Union
NGO(s)	Non-governmental organization(s)
PNG	Papua New Guinea
STD	Submarine tailings disposal
UNESCO	United Nations Educational, Scientific and Cultural Organization

Sources of Information, by Chapter, and General References on Biodiversity

Chapter 1. Introduction

Earthwatch, IUCN and WBCSD (2002). Business and Biodiversity: A Handbook for Corporate Action.

European Comission/DfID/IUCN (2002). Biodiversity Brief 19:Biodiversity – what is it, and why is it being lost? Biodiversity in Development Monograph.

IUCN-ICMM (2003). Mining and Biodiversity: Towards Best Practice. Summary and discussion of the results of an IUCN-ICMM workshop, Mining, Protected Areas and Biodiversity Conservation: Searching and Pursuing Best Practice and Reporting in the Mining Industry. 7 – 9 July 2003.

IUCN-ICMM (2004). Integrating Mining and Biodiversity Conservation: Case Studies from Around the World

Millennium Ecosystem Assessment (2005). Ecosystems and Human Well-Being: Opportunities and Challenges for Business and Industry. World Resources Institute.

Millennium Ecosystem Assessment (2005). Ecosystems and Human Well-Being: Synthesis. Island Press.

Rio Tinto (2004). Rio Tinto's Biodiversity Strategy: Sustaining a Natural Balance.

Chapter 2. Integrating Biodiversity into Project Development

Energy and Biodiversity Initiative (2003). Framework for integrating biodiversity into the site selection process. Conservation International. Contains detailed information on site-selection for new projects in relation to protected areas.

Energy and Biodiversity Initiative (2003). Online Biodiversity Information sources. Conservation International. Contains detailed information on online sources of information on biodiversity.

Environmental Excellence in Exploration (E3) Program of the Prospectors and Development Association of Canada. At www.pdac.ca/pdac/programs/e3.html.

Chapter 3. Integrating Biodiversity into Operations

Davy, A. (1998). Environmental Assessment of Mining Projects: World Bank Environmental Assessment Sourcebook Update Number 25. Environment Department, World Bank.

Marcus, J. (ed.) (1996). Mining Environmental Handbook. Effects of Mining on the Environment and American Environmental Controls on Mining. Imperial College Press, London.

Ripley, E. et al. (1996). Environmental Effects of Mining. St. Lucie Press, Florida.

Chapter 4. Integrating Biodiversity into Closure Planning and Implementation

ICMM (2005). Financial Assurance for Mine Closure and Reclamation. London.

MMSD (2002). Mining for the Future. Appendix B: Mine Closure Working Paper. International Institute for Environment and Development and World Business Council for Sustainable Development.

Rolfe, J. (2000). Mining and Biodiversity: Rehabilitating Coal mine Sites. Feature Article in Summer 2000–2001 Policy Journal of Australia, pp. 8–12.

Chapter 5. Management Systems and Assessment Tools

Earthwatch (2002). Business and Biodiversity: Site Biodiversity Action Plans – A Guide to Managing Biodiversity on Your Site. Very useful summary of the stages involved in preparing a biodiversity action plan.

Energy and Biodiversity Initiative (2003). Biodiversity Indicators for Monitoring Impacts and Conservation Actions. Conservation International.

Energy and Biodiversity Initiative (2003). Integrating Biodiversity into Environmental Management Systems. Conservation International.

Energy and Biodiversity Initiative (2003). Integrating Biodiversity into Social and Environmental Impact Assessment. Conservation International.

Gardner, J., and Mitchell, P. (2004). Integrating Biodiversity into Environmental Management Systems and Community Development Programmes.

Global Reporting Initiative (2002). Sustainability Reporting Guidelines. Amsterdam.

Global Reporting Initiative (2004). Final Report from GRI Environment Subgroup 3: Land/Biodiversity Indicators. Amsterdam.

International Finance Corporation (2006). Performance Standard 6: Conservation of Biodiversity and Sustainable Natural Resources Management. Available online at www.ifc.org.

ISIS Asset Management (2004). Is Biodiversity a Material Risk for Companies: An Assessment of the Exposure of FTSE Sectors to Biodiversity Risk. ISIS Asset Management, London.

Morrison, M.L., et al. (2001). Wildlife Study Design. Springer-Verlag, New York. Contains details on the practical application of BACI (before-after/control-impact).

Rio Tinto (2004). Sustaining a Natural Balance: A Practical Guide to Integrating Biodiversity into Rio Tinto's Operational Activities.

United Nations Environmental Programme (1995). Global Biodiversity Assessment. Cambridge University Press.

United States Agency for International Development (2002). Biodiversity Conservation Program Design and Management: A Guide for USAID Staff.

World Wide Fund for Nature (2000). The Root Causes of Biodiversity Loss. Earthscan.

Chapter 6. Stakeholder Engagement Tools and Processes

Business Partners for Development (2000). Working Paper No. 2: Tri-Sector Partnerships for Social Investment within the Oil, Gas and Mining Sectors: An Analytical Framework. BPD Natural Resources Cluster secretariat, London.

CBD Secretariat (2004). Akwe: Kon Guidelines: Voluntary Guidelines for the Conduct of Cultural, Environmental and Social Impact Assessments regarding Developments Proposed to Take Place on, or Which are Likely to Impact on, Sacred Sites and on Lands and Waters Traditionally Occupied or Used by Indigenous and Local Communities. Convention on Biological Diversity Secretariat.

Energy Sector Management Assistance Program, World Bank and ICMM (2005). Community Development Toolkit. Pioneering New Approaches in Support of Sustainable Development in the Extractive Sector.

International Finance Corporation (1998). Doing Better Business through Effective Public Consultation and Disclosure: A Good Practice Manual.

Natural Resources Cluster of the Business Partners for Development initiative, at www.bpd-naturalresources.org.

World Wildlife Fund (2000). Stakeholder Collaboration: Building Bridges for Conservation. Washington DC.

Chapter 7. Mitigation, Rehabilitation and Enhancement Tools

Australian Centre for Mining Environmental Research (2002). Managing the Impacts of the Australian Minerals Industry on Biodiversity. Final report to the MMSD.

Energy and Biodiversity Initiative (2003). Opportunities for Benefiting Biodiversity Conservation. Conservation International.

Environment Australia (1995). Rehabilitation and revegetation. Module in series on Best Practice Environmental Management in Mining.

ICMM (2005). Biodiversity Offsets – A Briefing Paper for the Mining Industry.

ICMM (2005). Biodiversity Offsets: A Proposition Paper.

Minerals Council of Australia (1998). Mine Rehabilitation Handbook.

Nichols, O.G., and Foot, P. (2002). Designing a vegetation monitoring programme to achieve continual improvement and assess the long-term sustainability of mine rehabilitation. Proceedings of the Minerals Council of Australia Sustainable

Development Conference and 27th Annual Environmental Workshop, November 2002, pp 79–88.

Rio Tinto (2004). Sustaining a Natural Balance: A Practical Guide to Integrating Biodiversity into Rio Tinto's Operational Activities.

Rio Tinto and Earthwatch Institute (2006). A Review of Biodiversity Performance Measures.

Ten Kate, K. et al. (2004). Biodiversity Offsets: Views, Experience and the Business Case. IUCN and Insight Investment.

General References Relevant to Mine Rehabilitation and Closure

Australian and New Zealand Minerals and Energy Council and the Minerals Council of Australia (2000). Strategic Framework for Mine Closure. Canberra, ACT, Australia. See: http://www.doir.wa.gov.au/documents/safetyhealthandenvironment/Shed_env_guide_closure.pdf.

Bell, L.C. (2001). Establishment of Native Ecosystems after Mining – Australian Experience across Diverse Biogeographic Zones. Ecological Engineering 17: 179-186.

Brearley, D.R., and Osborne, J.M. (2000). Developing Completion Criteria for Minesites in Arid and Semi-arid Western Australia. In Proceedings Workshop on Environmental Management in Arid and Semi-Arid Areas (Goldfields Land Rehabilitation Group: Boulder, WA). pp. 11–21.

Burger, J., and Zipper, C.E. (2002). How to Restore Forests on Surface Mined Land. Powell River Project – Reclamation Guidelines for Surface-mined Land in Southwest Virginia. Virginia Cooperative Extension. Accessed at http://www.ext.vt.edu/pubs/mines/460-123/460-123.html.

Department of Mineral Resources (1999). Synoptic Plan Integrated Landscapes for Coal Mine Rehabilitation in the Hunter Valley of NSW. Sydney, New South Wales.

Duggin, J.A., Grant, C.D., and Meek, I.K. (2003). Rehabilitation Success Criteria for Open-cut Mining. In EPA Workshop – Mining and Post Mining Landscapes. 23–24 June 2003. Rockhampton, Australia.

Elliott, P., Gardner, J., Allen, D., and Butcher, G. (1996). Completion Criteria for Alcoa of Australia Limited's Bauxite Mine Rehabilitation. 3rd International 21st Annual Minerals Council of Australia Environmental Workshop. Pp. 79–89.

Best Practice Environmental Management in Mining Booklets, particularly: Rehabilitation and Revegetation, Landform Design for Rehabilitation, and Mine Decommissioning, at http://www.industry.gov.au/content/itrinternet/cmscontent.cfm?objectID=BF645BCB-964A-B247-A9E94E25110BDA2E

Fox, H.R., Moore, H.M., and McIntosh, A.D. (eds.) (1998) Land Reclamation: Achieving Sustainable Benefits. Proceedings of the Fourth International Conference of the International Affiliation of Land Reclamationists, Nottingham, United Kingdom, 7–11 September 1998. A.A. Balkema, Rotterdam.

Gardner, J. (2001). Rehabilitating Mines to Meet Land Use Objectives: Bauxite Mining in the Jarrah Forest of Western Australia. Unasylva 207 (52).

Grant, C., Duggin, J., Meek, I., and Lord, M. (2001). End Point Criteria and Successional Pathways for Manganese Mining Rehabilitation on Groote Eylandt, Northern Territory. 26th Annual Minerals Council of Australia Environmental Workshop. pp. 129-152.

Grigg, A.H., Murray, M-A., and Mulligan, D.R. (2000). Ecologically-based Criteria for Evaluating the Success of Rehabilitation Efforts: A Case Study from Weipa, Australia. In Proceedings of the 25th Annual Canadian Land Reclamation Association and the 4th Annual International Affiliation of Land Reclamation Meetings. September 17–20, 2000. Edmonton, Alberta.

Hannan, J.C. (1984). Mine Rehabilitation – A Handbook for the Coal Mining Industry. New South Wales Coal Association, Sydney, NSW, Australia.

Hannan, J.C., and Bell, L.C. (1993). Surface Rehabilitation. In Australasian Coal Mining Practice. A.J. Hargraves and C.H. Martin, eds., pp. 260-280. *The Australasian Institute of Mining and Metallurgy: Melbourne.*

Holl, K.D. (2002). Long-term Vegetation Recovery on Reclaimed Coal Surface Mines in the Eastern USA. Journal of Applied Ecology 39:960-970.

Holl, K.D., Zipper, C.E., and Burger, J.A. (2002). Recovery of Native Plant Communities after Mining. Virginia Cooperative Extension. Accessed at http://www.ext.vt.edu/pubs/mines/460-140/460-140.html.

Lloyd, M.V., Barnett, G., Doherty, M.D., Jeffree, R.A., John, J., Majer, J.D., Osborne, J.M., and Nichols, O.G. (2001). Managing the Impacts of the Australian Minerals Industry on Biodiversity. Report prepared for AMEEF as part of the Mining, Minerals and Sustainable Development Project.

Nichols, O.G. (1998). The Development of a Rehabilitation Programme Designed to Restore a Jarrah Forest Ecosystem Following Bauxite Mining in South-western Australia. In: Land Reclamation. Achieving Sustainable Benefits. H.R. Fox, H.M. Moore, and A.D. McIntosh, eds., Proceedings of the Fourth International Conference of the International Affiliation of Land Reclamationists, Nottingham, United Kingdom, 7–11 September 1998. A.A. Balkema, Rotterdam. pp 315–325.

Nichols, O.G. (2003). Establishing Functional Native Ecosystems Following Mining – Minimising Risk by Doing the Job Right. In EPA Workshop – Mining and Post Mining Landscapes. 23–24 June 2003. Rockhampton, Australia.

Nichols, O.G. (2004). Development of Rehabilitation Completion Criteria for Native Ecosystem Establishment on Coal Mines in the Bowen Basin. Project C12045. Australian Coal Association Research Programme, Brisbane, Australia.

Nichols, O.G., and Nichols, F.M. (2003). Long-term Trends in Fauna Recolonisation Following Bauxite Mining in the Jarrah Forest of South-western Australia. Restoration Ecology 11(3): 1–12.

Queensland Resource Council. Guidelines for Mine Closure Planning in Queensland

Rosenfeld Sweeting, A. and Clarke, A. (2000). Lightening the Lode: A Guide to Responsible Large-Scale Mining. Conservation International.

UK Office of the Deputy Prime Minister (Accessed 3 September 2004). Minerals Planning Guidance 7: Reclamation of Mineral Workings. See http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_606885.hcsp. Note Annex B Reclamation for different after-uses.

Checklist No. 2.1 Biodiversity Protection during Exploration

Objective: To conduct an initial screening exercise to develop an overall appreciation of the biodiversity importance of an area and ensure that impacts on biodiversity are minimized.

Issues to consider	Action	
Have biodiversity constraints to exploration already been identified by the regulatory authorities in-country?	**YES:**	Determine whether exploration or mining is compatible with designated land uses. If not, pursue alternative exploration targets (***see section 2.2***).
	NO:	Review any legal provisions relating to mining (or other types of development) and biodiversity that might influence exploration or mining (***see section 2.2***).
Have protected areas within the area of exploration been identified?	**YES:**	Consider implications for exploration or mining, e.g. World Heritage Sites off-limits to ICMM members (***see section 2.2***).
	NO:	Undertake mapping exercise to identify the occurrence or absence of protected areas, and consider implications for mining (***see section 2.2***).
Will the early stages of exploration involve sub-surface sampling?	**YES:**	Ensure that barriers to access (and means of egress) are provided to protect wildlife and backfill promptly (***see section 2.2.1***).
	NO:	If geophysical techniques are used, try to avoid air surveying when migratory animals may be disturbed and avoid 'line of sight' cuttings wherever practicable (***see section 2.2.1***).
Will new access roads be required for exploration drilling	**YES:**	Ensure tracks follow natural contours to prevent erosion, are kept as small as practical, and are rehabilitated as early as possible (***see section 2.2.2***)
	NO:	No specific action required.
Has exploration identified probable mineral reserves that justify the conduct of pre-feasibility studies?	**YES:**	Proceed to pre-feasibility studies and refer to ***checklist 2.2.***
	NO:	Ensure that the impacts of exploration are rehabilitated as soon as practicable (***see section 2.2.2 and Box 2.3***).

Checklist No. 2.2 Biodiversity Protection during Pre-Feasibility and Feasibility Studies

Objective: To develop a fuller understanding of the biodiversity importance of an area both to satisfy regulatory requirements and to ensure that impacts on biodiversity are minimized.

Issues to consider	Action	
Has the initial screening (***see checklist 2.1***) identified biodiversity as important within the project area?	**YES:**	Contract specialist expertise on biodiversity to help begin to establish a biodiversity baseline (***see checklist 5.1***).
	NO:	If in-house personnel can apply the tools outlined in section C of the GPG, rely on internal resources to initiate a biodiversity baseline (***see checklist 5.1***).
Are any important areas for biodiversity likely to be affected by mining, either protected areas or not, and could protected areas or species present a constraint to mining?	**YES:**	Consider in greater depth the possible implications for mining of the presence of important areas or species (***see also checklist 5.1***).
	NO:	Begin to identify possible interfaces between mining and biodiversity for areas and species of lesser importance (***see checklist 2.3***).
Is sufficient information available to conduct a preliminary assessment of potential impacts on biodiversity (in terms of both alternative mining options and the biodiversity importance of the area)?	**YES:**	Refine understanding of possible interfaces between mining and biodiversity (***see checklist 2.3***).
	NO:	Obtain additional information on either alternative mining options[1] or on biodiversity importance of the area and revisit preliminary assessment (***see section 2.3.1***).
Has the project proceeded to the stage of detailed feasibility studies on whether the proven mineral reserve can be economically mined?	**YES:**	Conduct detailed assessments of biodiversity and other environmental and social issues, consistent with the requirements of regulators or financiers, and begin to integrate biodiversity into closure planning (***see checklists 5.1 and 4.1***).
	NO:	If not already addressed, ensure that the impacts of exploration are rehabilitated as soon as practicable (***see section 2.2.2 and Box 2.3***).

[1] Depending on the source of financing or regulatory requirements, if the project proceeds to the feasibility stage, there may be a need to credibly document an analysis of alternatives from an environmental and social perspective.

Checklist No. 2.3 Mapping Possible Interfaces between Mining and Biodiversity at Various Operational Stages

Objective: To provide a practical tool to support an initial mapping of the interfaces between biodiversity and mining activities at various operational stages.

During the pre-feasibility stage (***see section 2.3.1***), when the screening and scoping stage of Environmental and Social Impact Assessment (ESIA) takes place (***see section 5.2.2 and checklist 5.1***), it is important to begin to map the intersection between proposed mining activities and potential impacts. The matrix below provides a practical tool for beginning to identify potential interfaces between mining and biodiversity at various operational stages. In mapping possible interfaces, bear in mind the following:

- **Cast the net wide:** Look beyond the obvious interfaces between biodiversity and mining, such as land clearance. For example, if discharges into watercourses are likely, consider the impacts on migratory fish and downstream wetlands.
- **Include transport routes and associated infrastructure:** Consider the impacts that a spillage of process chemicals or hazardous wastes en route to or from the mining operation would have on biodiversity. In addition, ensure that ancillary infrastructure such as dedicated power supplies or product export infrastructure are considered.
- **Consider societal interfaces with biodiversity:** Biodiversity may have a variety of important uses or values to local communities or others, ranging from the aesthetic to a strong dependence for subsistence or livelihoods.

POTENTIAL IMPACTS	**MINING ACTIVITIES**	**Exploration and construction**	Early stages of exploration	Exploration drilling	Access road construction	Land clearance (for construction, etc.)	Obtaining construction materials	Construction related infrastructure	**Construction of ancillary infrastructure**	Roads, rail & export infrastructure	Pipelines for slurries or concentrates	Energy/power & transmission lines	Water sources, wastewater treatment	Transport of hazardous materials	**MINING ACTIVITIES**	**Ore processing and plant site**	Plant site, materials handling, etc.	Extraction and waste rock storage	Rock blasting and ore removal	Mine dewatering	Placer and dredge mining	Ore stockpiling	Pyrometallurgical processing	Hydrometallurgical processing	Use and storage of process chemicals	Tailings containment/disposals
Impacts on terrestrial biodiversity																										
Loss of ecosystems and habitats																										
Loss of rare and endangered species																										
Effects on sensitive or migratory species																										
Effects of induced development on biodiversity																										
Aquatic biodiversity & impacts of discharges																										
Altered hydrologic regimes																										
Altered hydrogeological regimes																										
Increased heavy metals, acidity or pollution																										
Increased turbidity (suspended solids)																										
Risk of groundwater contamination																										
Air quality related impacts on biodiversity																										
Increased ambient particulates (TSP)																										
Increased ambient sulfur dioxide (SO_2)																										
Increased ambient oxides of nitrogen (NO_x)																										
Increased ambient heavy metals																										
Social interfaces with biodiversity																										
Loss of access to fisheries																										
Loss of access to fruit trees, medicinal plants																										
Loss of access to forage crops or grazing																										
Restricted access to biodiversity resources																										
Increased hunting pressures																										
Induced development impacts on biodiversity																										

Checklist No. 2.4 Biodiversity Protection during Construction

Objective: To ensure that impacts on biodiversity during construction are minimized.

Issues to consider	Action
Will new access roads or upgrades to existing roads be required to enable construction, or will linear ancillary infrastructure be constructed, e.g. rail lines, pipelines, transmission lines (***see section 2.4.1***)?	**YES:** Identify and assess potential impacts (***see section 5.2.5***). Ensure that alignment avoids isolation or fragmentation of habitats and disruption of streams and rivers (***see mitigation hierarchy in Figure 7.1***). **NO:** Consider risks to biodiversity adjacent to existing roads from accidental spillages, e.g. of fuel oil or other hazardous construction materials (***see section 2.4.1***).
Are areas of importance for biodiversity dependent on 'limited access' and will construction facilitate wider access and induce potential adverse changes by other third-party users?	**YES:** Consider alternative options for construction access (e.g. via air or water) and other mechanisms of control (***see section 2.4***). **NO:** Begin to identify possible interfaces between mining and biodiversity, both direct and indirect (***see checklist 2.3***).
Does land clearance have the potential to adversely impact rare or otherwise important plant and animal species (e.g. of importance to natural resource dependent communities)?	**YES:** Ensure that rare and important plant and animal species are identified during the conduct of baseline or follow-up surveys (***see checklist 5.1***) and that appropriate mitigation measures are adopted (***see checklist 7.1***). **NO:** Ensure that basic measures are undertaken to ensure that natural habitats are avoided to the extent possible through the design and location of construction facilities, storage areas, etc. (***see checklist 7.1***).
Does the sourcing of construction materials (such as dredging of sands and gravels) have potentially significant impacts on biodiversity?	**YES:** Ensure that these aspects are fully addressed as part of the ESIA (***see checklist 5.1***). **NO:** Where practical, ensure that construction materials have been obtained from approved sources (***see section 2.4.2***).
Is the proposed mine in an area which will require in-migration of a large temporary construction workforce, and has a risk of longer-term post-construction in-migration?	**YES:** Ensure that these aspects are fully addressed in the ESIA (***see checklist 5.1***) and that appropriate controls are implemented (***see section 2.4.3***). **NO:** Ensure that more limited impacts from construction related infrastructure (especially water and sanitation) are effectively managed (***see section 2.4.3***).

Checklist No. 3.1
Biodiversity Protection during Operations

Objective: To ensure that impacts on biodiversity related to the extraction and processing of ore, disposal of waste materials and transport of products are managed throughout operations.

Issues to consider	Action
Could the transport of process chemicals, products or waste materials by road or ancillary infrastructure (e.g. rail or pipeline) result in accidental releases to the environment which may impact biodiversity?	**YES:** Ensure that Hazard and risk assessments are extended to include biodiversity as a receptor (***see checklist 5.2***), to include potential impacts of weed or pest control. **NO:** Ensure that the impacts on biodiversity of maintaining linear infrastructure, particularly weed and pest control, are also considered (***see section 3.2***).
Could ongoing clearing of vegetation for mine facilities and access roads result in habitat fragmentation and related impacts on biodiversity (***see checklist 5.1***)?	**YES:** Ensure that these risks are recognized and managed through the EMS (***see checklist 5.2***). **NO:** No specific action.
Does the method of mining result in large quantities of overburden or waste rock removal, which may either occupy land of importance for biodiversity or cause secondary impacts such as acidic runoff?	**YES:** Ensure that mitigation measures are applied to avoid or otherwise manage potential impacts (***see checklist 7.1***). **NO:** No specific action.
Do mining operations have the potential to adversely impact aquatic, riparian or wetland biodiversity (e.g. through altering hydrologic or hydrogeological regimes)?	**YES:** Ensure that these aspects are carefully monitored as part of the EMS for the mine or related EMP (***see checklist 5.2***). **NO:** No specific action.
Have the potential impacts on (and risks to) biodiversity from tailings management been fully considered?	**YES:** Ensure that these aspects are carefully monitored as part of the EMS for the mine or related EMP (***see checklist 5.2***). **NO:** Ensure that these aspects are carefully assessed and integrated into the EMS for the mine or related EMP (***see checklist 5.2***).
Have opportunities for biodiversity protection or enhancement been explored with the engagement of key stakeholders, and an assessment made of external threats to biodiversity?	**YES:** Ensure that these aspects are carefully monitored as part of the EMS for the mine or related EMP (***see checklist 5.2***). **NO:** Ensure that opportunities for protection and enhancement are explored, supported by an assessment of external threats to biodiversity (***see checklists 5.1, 6.2 and 7.1***).

Checklist No. 4.1 Ensuring that Biodiversity Protection and Enhancement are Factored into Closure

Objective: To ensure that opportunities for re-establishing biodiversity or conservation enhancement are realized during closure planning and implementation.

Issues to consider	Y/N	Comment
Establishing closure objectives and targets: Have the following been addressed		
Have all regulatory requirements, including provisions to implement the Convention on Biological Diversity (CBD[1]) been considered (***see Section D***)?		
Has effective consultation with stakeholders taken place (***see section 6.2***)?		
Through the process of consultation and ongoing engagement, have competing interests been understood and reconciled (***see section 6.2***)?		
Has the available information on biodiversity been considered from an ecosystem perspective (***see section 5.2.5***)?		
Have technical constraints (such as ability to propagate plant species originally present) been factored into the establishment of biodiversity objectives (***see section 4.2***)?		
Have the pre-mining land uses (and value of biodiversity) and the extent of biodiversity degradation been considered (***see sections 4.2 and 5.2.5***)?		
Are the objectives and targets clear on whether the intention is to rehabilitate biodiversity to pre-mining conditions or enhance biodiversity (***see section 5.3.3***)?		
Have the constraints imposed by pre-mining (and post-mining) land tenure been considered (***see section 4.2***)?		
Has control of secondary impacts been explicitly considered (***see section 5.2.5***)?		
Have complimentary opportunities for biodiversity improvement been identified, where the company can leverage the commitment and resources of other biodiversity stakeholders to achieve a broader biodiversity benefit (***see sections 4.2 and 5.4.1***)?		
Rehabilitation and pollution prevention during closure implementation		
Have the potential benefits to biodiversity of alternative post-closure land uses been explicitly considered (***see section 4.3***)?		
Have realistic rehabilitation options been identified that do not raise false expectations amongst stakeholders (***see section 4.3***)?		
Where re-establishment of native ecosystems through rehabilitation is impractical, have alternative post-closure land uses explicitly considered the potential for compatible measures to enhance biodiversity (***see section 4.3***)?		
Have the following been adequately considered: management requirements to sustain conservation values in the longer term; responsibilities for implementation; and funding arrangements (***see section 4.3***)?		

[1] The CBD requires signatory governments to develop national biodiversity strategies and action plans, and to integrate these into broader national plans for environment and development.

Checklist No. 5.1
Ensuring Biodiversity is Adequately Addressed in Environmental & Social Impact Assessments (ESIA)

Objective: To ensure that Environmental and Social Impact Assessment (ESIA) of projects adequately address biodiversity issues.

Issues to consider	Y/N	Comment
Key aspects to be addressed in the ESIA overall (*see section 5.2.1*)		
Have the relevant levels of biodiversity – i.e. ecosystem, species and, if appropriate, genetic biodiversity – been assessed?		
Have the interconnections between the levels of biodiversity been assessed by considering the structural and functional relationships and how they will be affected by the proposed project?		
Have sufficiently detailed data been collected for key biodiversity indicators?		
Have the full range of impacts been assessed, including primary, secondary, cumulative and induced impacts?		
Has the importance of community and indigenous knowledge of local biodiversity aspects been assessed, and has stakeholder participation been adequate (e.g. during the various stages of the ESIA process from initial screening through to public comment on draft reports?		
Have the criteria that have been used to assess impacts been clearly explained?		
Have the range of potential impacts on biodiversity and related mitigation measures been adequately considered?		
Screening and scoping of biodiversity issues in ESIA (*see section 5.2.2*)		
Has readily available information on biodiversity been obtained through a review of maps and publications available online?		
Does the site or surrounding area fall within a protected area – i.e. is it an area designated for biodiversity protection at a local, national, regional or international level (***see Section D for key sources of information on this and the next two bullet points***)?		
If the site or surrounding area is not currently protected, has it been identified by governments or other stakeholders as having a high biodiversity conservation priority?		
Does the site or surrounding area have particular species that may be under threat (although the area may not currently be officially protected)?		
Have the legal provisions relating to biodiversity been reviewed?		
Have the views of stakeholders on whether the site or surrounding area has important traditional or cultural value been obtained?		
Where the initial screening stage identified areas of potentially high importance for biodiversity, was more detailed consideration given to possible impacts on such areas, both direct and indirect, such as the impacts related to ancillary infrastructure.		

Issues to consider	Y/N	Comment
Has a basic survey of 'natural' areas been undertaken, using maps and planning documents, aerial surveys or a site walkover?		
Has initial engagement with stakeholders taken place to help identify the uses that people make of biodiversity and any areas of particular importance?		
Determining whether baseline studies or additional fieldwork is required (*see section 5.2.3*)		
For new projects, have detailed baseline data been collected where: • initial efforts at mapping the biodiversity context identify areas of potential but uncertain importance for biodiversity, which would benefit from additional study to establish a baseline? • the land adjoining or affected by the operation is clearly of value for biodiversity but is subject to a range of existing threats (which might or might not include mining), and additional fieldwork could be used to characterize the nature and relative importance of threats? • areas of importance for biodiversity adjoin a proposed mining operation but patterns of usage are complex and not clearly understood and local communities have a high dependence on biodiversity, so that additional fieldwork could help establish usage patterns and perhaps the related values that people place on access to biodiversity?		
For existing projects, has additional fieldwork been undertaken where: • an existing operation has been active for many years and the original permitting requirements contained few if any provisions relating to biodiversity and there was little or no other information readily available? • the preferred post-closure land uses included biodiversity conservation or enhancement but there was limited information available on the current status of biodiversity? • an operation has had unintended and unanticipated adverse consequences on biodiversity?		
Evaluating biodiversity importance (*see section 5.2.4*)		
For protected areas and species, is their biodiversity importance clear as part of their designation, or is additional information required?		
Outside of protected areas but within areas that are clearly of value for biodiversity, has there been any attempt to qualitatively evaluate biodiversity importance in the absence of clear protective designations?		
Has the process of evaluating biodiversity importance considered common criteria including: species/habitat richness; species endemism; keystone species; rarity; size of the habitat; population size; fragility; or the value of ecosystem services?		
Has the application of these criteria involved a trained ecologist, particularly in more complex situations – e.g. in some developing countries where there is little information to evaluate biodiversity comparatively, extensive fieldwork may be required to better understand the relative value of operational sites?		

Issues to consider	Y/N	Comment
Impact identification and assessment (*see section 5.2.5*)		
Did the assessment of impacts include an assessment of the level of impact – i.e. on ecosystems (and related services), species or genetic resources?		
Did the assessment of impacts include an assessment of the nature of the impact (primary or secondary, long-term or short-term) – primary impacts occur where a proposed activity is directly responsible for that impact, whereas secondary impacts are an indirect consequence of the project?		
Did the assessment of impacts include an assessment of whether the impact was positive, negative or had no effect?		
Did the assessment of impacts include an assessment of the magnitude of the impact in relation to species or habitat richness, population sizes, habitat sizes, sensitivity of the ecosystem, recurrent natural disturbances, etc.?		
Did the assessment of impacts explicitly recognize that the intensity of impacts varies over the life of a project, being typically low at the start, increasing markedly through the construction and operational phases and diminishing as closure is implemented?		
Was the significance of predicted impacts on biodiversity determined by assessing the magnitude (or intensity) of the impact and the sensitivity of the affected ecosystem or species (***see section 5.3.2***)?		
Were clear distinctions made between impacts that could be assessed quantitatively and those for which only a qualitative assessment could be made?		
Were cumulative impacts considered in situations where multiple mining projects (or other projects) were being implemented within a broad geographic area (such as a watershed, valley or airshed), with reference to: • any existing or proposed activities in the area and the likely effect on biodiversity of those proposals in conjunction with the proposed mining activity? • any synergistic effects of individual project impacts when considered in combination? • any known biodiversity threats in the area and the likely contribution of the proposed mining activity to increasing or decreasing those stresses?		
Did the assessment of impacts consider adverse affects such as: loss of ecosystems or habitats; habitat fragmentation and increases in the 'edge effect'; alteration of ecological processes; pollution impacts; and disturbance impacts?		
Monitoring and interpreting changes in biodiversity (*see section 5.2.6*)		
Were indicators monitored to determine progress against agreed biodiversity objectives – for example, to assess the extent of impact on biodiversity, the success of mitigation measures or the outcomes of measures to enhance biodiversity conservation?		

Issues to consider	Y/N	Comment
Were a set of indicators agreed with key stakeholders to measure and manage impacts on biodiversity?		
Was expert assistance sought in selecting and reviewing the most appropriate indicators of biodiversity to be measured?		
Where appropriate, was knowledge obtained from indigenous and local people on biodiversity and its uses?		

Checklist No. 5.2
Ensuring Biodiversity is Adequately Addressed in Environmental Management Systems (EMS)

Objective: To ensure that Environmental Management Systems adequately address the management of biodiversity.

Issues to consider	Y/N	Comments
Key aspects to be addressed in the EMS (*see section 5.3*)		
Has biodiversity been explicitly integrated into the environmental policy?		
Has local biodiversity been documented and assessed in consultation with appropriate stakeholders?		
Has an identification and assessment of biodiversity aspects/risks been undertaken?		
Is a register of legal and other requirements maintained, including legally designated protected areas?		
Have preventative and mitigative measures for significant biodiversity aspects been developed?		
Have preventative and mitigative responses to identified biodiversity aspects been implemented?		
Does the EMS include monitoring, measuring and reporting performance on biodiversity management?		
Does the EMS provide for a review of procedures to manage biodiversity and outcomes been undertaken?		
Does the EMS adopt a continuous improvement approach to managing biodiversity?		
Securing a corporate commitment (*see section 5.3.1*)		
Did the company biodiversity policy statement include commitments to some or all of the following: • maintain natural ecosystems and manage protected areas? • respect indigenous peoples' rights and values for natural resources and involve them in developing and deciding on appropriate management solutions for potential impacts? • limit discharges to ecosystems below the critical level? • raise employee awareness about making a positive contribution to the environment? • conserve biodiversity by not destroying habitat or, where loss is unavoidable, explore mitigation options, including the use of offsets? • comply with applicable legislation and regulations? • apply the precautionary principle to identify situations where risk assessment and management are required? • enhance wildlife corridors and habitats? • consult with relevant conservation organizations? • conduct biodiversity assessment in environmental assessments? • focus attention on internationally recognized 'hot-spots'? • understand and manage direct and indirect impacts on biodiversity? • make a positive contribution to biodiversity research and development? • restore disturbed areas when activity is completed? • ensure that there is no overall net loss of biodiversity as a result of the company's activities?		

Issues to consider	Y/N	Comment
Determining significant biodiversity aspects (*see also section 5.3.2*)		
For new operations, was the potential for mining activities to lead to significant impacts on the biodiversity assessed (***see section 5.2.5***)?		
For existing operations with no recent ESIA, was a risk assessment undertaken to identify the aspects and biodiversity impacts that might occur from mining activities?		
Was the output of the biodiversity risk assessment process ranked to help inform the priorities and focus the objectives for the EMS?		
Where risks were identified within the high or extreme category, and where no recent ESIA was available, was further assessment of potential impacts on biodiversity undertaken in accordance with sections 5.2 and 6.3?		
Does the EMS provide for regular reassessment and review of potential biodiversity aspects and impacts, including primary, secondary and cumulative impacts, throughout the mine cycle to ensure continuous improvement?		
Was a legal register prepared identifying existing permits, licences and relevant legal and other requirements for biodiversity (such as policy commitments)?		
Does the EMS also consider voluntary obligations, as a number of commitments with respect to biodiversity may be the result of voluntary corporate policies and industry initiatives, as opposed to legislative requirements?		
Establishing targets and objectives (*see section 5.3.3*)		
Were clear goals or objectives set for the outcomes of biodiversity management and communicated to all stakeholders, and were these consistent with the company's policy?		
Were these goals and objectives set in consultation with the various parties who will judge the success of the work (e.g. local community groups, regulators)?		
Were the objectives responsive to the biodiversity aspects identified and the requirements and opportunities to mitigate impacts?		
Were specific actions to achieve agreed objectives developed and documented within the EMS?		
Were the targets: specific to the operation and activities; clear in terms of what was to be achieved and by when; and linked into the overall rehabilitation and mine closure strategy?		
Were targets realistic and did they take account of the availability of resources, technical limitations, engagement with landowners and the community, fulfilment of lease requirements, long-term land management requirements, etc.?		

Issues to consider	Y/N	Comment
Biodiversity Action Plans (*see section 5.3.4*)		
Was a biodiversity action plan (BAP) prepared which set out how objectives and targets for biodiversity conservation would be achieved, either as a stand-alone plan or incorporated into the EMS?		
Did the BAP provide for control of access to areas of importance for biodiversity that do not need to be disturbed during operations, to prevent destruction or disturbance of habitats or species?		
Did the BAP provide for protected areas to be clearly demarcated to avoid inadvertent destruction through ignorance or carelessness?		
Did the BAP specify controls on how vegetation (and associated fauna) were to be removed, to maximize the use of seed and other plant propagules, etc.?		
Did the BAP provide for management of pest plants and animals to control impacts on local species within and beyond the mine lease area?		
Did the BAP consider the management of community biodiversity uses and other ecosystem services?		
Did the BAP specify measures to address biodiversity knowledge gaps in order to gain additional knowledge to improve revegetation/rehabilitation outcomes, or to improve the understanding of biodiversity more broadly?		
Implementation considerations (*see section 5.3.5*)		
Was accountability for biodiversity management within the organization allocated to a senior manager, with the ability to ensure that biodiversity and related environmental and social interfaces were considered alongside production goals?		
For each of the actions addressed in the BAP, were accountabilities and budgets assigned and documented to ensure the necessary staffing, skills and resources were made available for implementation?		
Were all management procedures documented in the EMS and essential for the later implementation of successful mine rehabilitation carried out during operations (e.g. selective handling of overburden materials)?		
Did stakeholder engagement and public reporting on biodiversity issues help to build a credible and workable BAP?		
Were complimentary activities undertaken, such as the provision of support to community education programs on biodiversity management?		
Did all involved parties have a sound understanding of the objectives for biodiversity and their role in achieving these objectives?		
Was regular monitoring undertaken to evaluate the effectiveness of awareness and training program?		
Checking and corrective action (*see section 5.3.6*)		
Were changes in biodiversity attributes monitored to evaluate the success of management plans, rehabilitation trials, research projects and, equally important, the general changes in the biodiversity of the area around the site that may be influenced by non-mine factors?		

Issues to consider	Y/N	Comment
Was the program designed soundly according to accepted statistical principles, was it credible to stakeholders, and were the data collection processes readily verifiable? In particular: • Did detailed monitoring programs provide information on which to base decisions of the success or otherwise of projects and to evaluate changes in biodiversity? • Was the potential for some impacts to extend some distance from the mine taken into account in the design of the monitoring program? Was monitoring conducted using transparent and scientifically rigorous procedures, and were external experts used where required?		
Was third-party checking implemented to help build and maintain the necessary credibility for this aspect?		
Monitoring and reporting (*see section 5.3.7*)		
Was monitoring undertaken to measure progress against stated objectives?		
Were formal government reporting requirements adhered to and did these help to ensure accountability to the regulatory authorities?		
Did any public reporting of biodiversity take place, and did it include the two core indicators specified in the Global Reporting Initiative (GRI), i.e. location and size of land owned, leased, or managed in biodiversity-rich habitats (EN6); and a description of the major impacts on biodiversity associated with activities and/or products and services in terrestrial, freshwater, and marine environments.?		
Were any other GRI indicators of relevance to biodiversity (***see Box 5.3***) reported on?		
Management review and continuous improvement (*see section 5.3.8*)		
During the management review stage, was input sought from all relevant biodiversity stakeholders?		
Were any changes implemented based on the experience gained and the outcomes tracked through the monitoring stage?		
Was it possible to demonstrate continuous improvement – that the operation was managing its potential impacts on biodiversity and learning from the results and improving performance, so that biodiversity risks were managed to ensure biodiversity conservation?		

Checklist No. 5.3
Extending the Reach of Conventional Analyses to Better Understand the Conservation Context

Objective: To obtain a better understanding of the factors that can either contribute to, underpin, or undermine biodiversity conservation or enhancement measures.

Issues to consider	Y/N	Comment
Factors affecting the maturity of the conservation context (*see section 5.4.1*)		
Was an assessment made of the state of knowledge of ecosystems and species, based on a review of information sources?		
Were the existence and status of conservation plans, initiatives and protected areas reviewed?		
Were the capacity of conservation organizations (government and civil society) and the success of enforcement measures reviewed?		
Was an assessment made of the intractability of biodiversity threats, i.e. the degree of difficulty in tackling the direct and underlying causes of biodiversity loss?		
Based on the above, was it possible to make an overall appraisal of the maturity of the conservation context?		
Did an understanding of the maturity of the conservation context help to better estimate the cost of potential biodiversity initiatives as well as assess their potential for success?		
Assessing non-mining related threats to biodiversity (*see section 5.4.2*)		
Was an assessment made of non-mining-related threats to biodiversity, to provide a better basis for effective conservation action?		
Did the threats assessment consider the following four categories of direct threats to biodiversity: • conversion of natural habitat to cropland, urban areas or other human-dominated ecosystems? • overexploitation of commercially important species? • introduction of invasive species, including pests and pathogens? • climate change, pollution and other environmental changes external to the area of interest?		
Was a participatory approach adopted involving stakeholders, to help ensure that comprehensive information on threats was shared between stakeholders and thereby develop a common understanding of the main threats?		
Did the analysis identify threats in specific terms, describe the impact on biodiversity and identify the underlying causes of the threat?		
Were priorities for addressing threats identified based on criteria such as: the extent of the risk (overall area affected); the magnitude of the impacts from the risks; the perceptions of threat importance by communities; the political and social practicality of addressing the risks; and the capacity of stakeholders to address the threat?		

Checklist No. 6.1 Stakeholder Analysis Matrix in Support of Biodiversity Protection and Enhancement

Objective: To obtain a better understanding of how to effectively engage with stakeholders in the context of biodiversity identification, assessment and management.

Stakeholder analysis matrix for biodiversity (*see Table 6.1*)

Questions to ask stakeholders	Stakeholders (impact/interest)		
	Most	**Average**	**Least**
Who will be negatively affected by initiatives or projects aimed at biodiversity protection?			
Who will benefit from such initiatives or projects?			
Who will be responsible for implementing measures to mitigate any negative impacts?			
Whose cooperation, expertise or influence would be helpful to the success of the project?			
Who are the most vulnerable, least visible and most voiceless, for whom special consultation efforts may have to be made (such as critical dependence on ongoing access to biodiversity resources)?			
Who supports or opposes the changes that the initiatives or projects will bring?			
Whose opposition could be detrimental to the success of the biodiversity initiatives/projects?			
Who might have resources to contribute?			
Who are the key decision-makers?			

Source: Adapted from ESMAP, World Bank and ICMM (2005). Community Development Toolkit

Note: This application of the matrix involves considering the questions in the left-hand column for each stakeholder group and assigning them to one of the three categories of interest or impact. The result will be three lists of stakeholders, according to the assessed importance of the project to them and their likely level of interest.

Engagement encompasses a range of activities, including providing information, consultation, participatory planning or decision-making and partnership. The identified level of interest of each stakeholder helps the company decide how much time to devote to engaging with each stakeholder or group. The engagement levels revealed through this analysis may extend beyond consultation and include participatory planning or partnerships. The more mining operations understand their stakeholders and vice versa, the more successful their relationships are likely to be.

Checklist No. 6.2
Stakeholder Engagement Tools and Processes in Support of Biodiversity Protection and Enhancement

Objective: To obtain a better understanding of how to effectively engage with stakeholders in the context of biodiversity identification, assessment and management.

Issues to consider	Y/N	Comments
Identification and analysis of biodiversity stakeholders (*see section 6.2*)		
Has a systematic attempt been made to identify stakeholders, i.e. to determine who makes use of or affects the management or well-being of biodiversity?		
Have some or all of the following stakeholders been considered/consulted: • national and local government agencies with responsibility for management, conservation or protection of biodiversity? • national and local NGOs with an interest in biodiversity protection (such as Wildlife Trusts, Flora and Fauna Societies and bird watching groups)? • international governmental or nongovernmental organizations (for example, where internationally important protected areas are close to an operation)? • universities and research institutes? • local landowners and other users of natural resources in the vicinity of a project (particularly people who depend in some way on access to biodiversity resources)? • indigenous people with special ties to the land (who may be affected in many developing countries or in countries such as Canada, the United States or Australia)? • community organizations who may have an interest in biodiversity resources (such as angling clubs or fisheries or farming cooperatives)? • other private companies with a commercial interest in biodiversity resources (such as forestry operations)?		
Has an analysis of stakeholders been undertaken to help establish their interests in biodiversity, the extent to which these interests are compatible or in conflict, and the extent to which they might like to be involved in biodiversity protection or enhancement?		
Did the stakeholder analysis (***see checklist 6.2***) include: • defining the characteristics of key stakeholders? • identifying the interests of stakeholders in relation to biodiversity? • identifying conflicts of interests between stakeholders, to help manage potential sources of tensions during the course of mine development? • identifying relations between stakeholders that may facilitate biodiversity partnerships? • identifying the needs of stakeholders to overcome constraints to their effective participation (such as language needs or traditional consultative mechanisms)? • assessing the capacity of different stakeholder groups to participate in development activities? • assessing appropriate levels of engagement with different stakeholders – for example, informing, consulting or partnering – at different stages of the mining project cycle?		

Issues to consider	Y/N	Comments
Did the stakeholder analysis identify their interests in the biodiversity of an area and in its conservation or continued usage, and identify the groups or individuals with the strongest and most legitimate claim (key stakeholders)?		
Engagement with biodiversity stakeholders (*see section 6.3*)		
Was engagement with biodiversity stakeholders initiated early, in particular with indigenous groups and local communities?		
Did early and effective stakeholder engagement take place during exploration and enable mining companies to: • clarify the objectives of a proposed mining activity in terms of community needs and concerns and company commitments to biodiversity? • clarify the objectives of the proposed mining activity in terms of government policy directions, strategic plans and statutory or planning constraints? • identify feasible alternatives and clarify their merits in terms of biodiversity values?		
Did early stakeholder engagement help to ensure the ESIA was focused on matters of concern to stakeholders?		
Did early stakeholder consultation help to elicit valuable information to help develop an understanding of the biodiversity context of operation, or help identify biodiversity threats and opportunities?		
Once preliminary information was gathered, were stakeholders consulted in greater depth to help refine the understanding of biodiversity and the values that stakeholders place on it?		
Were stakeholders involved in participatory planning and decision-making approaches to the choice of mitigation measures or conservation enhancement initiatives?		
Did more in-depth engagement involve stakeholders in the participatory development of closure plans and initiatives to enhance biodiversity protection or conservation?		
As activities progressed towards developing initiatives for biodiversity conservation or enhancement, were stakeholders with the strongest interest in biodiversity encouraged to actively participate?		
Where capacity for engagement in either participatory planning or partnership arrangements was limited, were steps taken to enhance the capacity of local partners for substantive engagement?		
Was a structured approach adopted to assessing the biodiversity conservation capacities and resources available within a mining project area, anticipated future capacity needs and any critical gaps (***see section 6.3.2***)?		

Checklist No. 7.1 Biodiversity Mitigation, Rehabilitation and Enhancement Tools

Objective: To obtain a better understanding of the distinctions between, and practical tools in support of, biodiversity mitigation, rehabilitation and enhancement[1].

Issues to consider	Y/N	Comments
Selection of mitigation measures (*see section 7.2*)		
Were mitigation identified and implemented to safeguard biodiversity and any affected stakeholders from potentially adverse impacts of mining, to prevent adverse impacts from occurring or to limit their significance to an acceptable level?		
Did mitigation measures follow the following hierarchy (in descending order of priority): • **Avoiding** impacts by modifying a proposed mine or existing operation in order to prevent or limit a possible impact? • **Minimizing** impacts by implementing decisions or activities that are designed to reduce the undesirable impacts of a proposed activity on biodiversity? • **Rectifying** impacts by rehabilitating or restoring the affected environment? • **Compensating** for the impact by replacing or providing substitute resources or environments (which should be used as a last resort and might include offsets?		
Were the mitigation measures adopted responsive to and commensurate with the significance of potential impacts identified through impact identification and assessment (***see checklist 5.2***)?		
Were mitigation options considered in consultation with affected stakeholders and biodiversity specialists, and did agreed mitigation measures attempt to reconcile the interests of various stakeholders?		
Was the acceptability of mitigation alternatives agreed with the relevant authorities?		
Rehabilitation planning and implementation (*see section 7.3*)		
Was a rehabilitation plan prepared that was responsive to established closure objectives and targets (see checklist 4.1), and integral to the overall Mining Plan?		
Did the rehabilitation plan clearly explain to regulators and other stakeholders how the company intended to carry out a rehabilitation program to meet agreed objectives?		

[1] **Mitigation** involves selecting and implementing measures to protect biodiversity, the users of biodiversity and other affected stakeholders from the impacts of mining. **Rehabilitation** refers to measures undertaken to return mined land to agreed post-closure uses and differs from mitigation as it implicitly recognizes that biodiversity impacts have occurred. Biodiversity enhancement refers to measures that go beyond mitigation or rehabilitation and explore opportunities to enhance the conservation of biodiversity. So while mitigation and rehabilitation measures are responses to impacts or threats to biodiversity arising from mining operations, enhancement measures are undertaken in response to external threats to biodiversity, institutional shortcomings for managing or protecting biodiversity or a lack of scientific knowledge concerning biodiversity. This is a critical distinction.

Issues to consider	Y/N	Comments
Did the rehabilitation plan take into account all relevant information on pre-mining and likely post-mining landforms, soils, waste material characteristics, hydrology, land uses; any technical limitations posed by these; and pre-mining flora and fauna surveys and data from established reference monitoring sites?		
Did the rehabilitation plan describe the final land use(s) and related objectives and targets, giving details of: • soil and overburden materials handling, to ensure that materials favourable to plant establishment, as well as potential problem materials (such as acid-generating, high metal level, saline soils or potentially dispersive material), are placed in the correct sequence? • topsoil handling procedures, especially those designed to conserve plant propagules, nutrients and soil biota? • soil amelioration techniques to create conditions favourable for growth, such as the application of lime or gypsum? • any techniques for conserving and reusing vegetation, including mulch, brush matting for erosion protection and introduction of seed and log piles for fauna habitat? • landscaping procedures, including the construction of erosion control and water management structures? • vegetation establishment techniques? • weed control measures prior to and following rehabilitation? • fertilizer application? • follow-up planting and maintenance programs?		
Were the rehabilitation plan provisions time-bound and did they take into account opportunities for progressive rehabilitation and closure?		
Was the rehabilitation plan reviewed periodically as further information on site conditions became available and as new rehabilitation procedures were developed?		
Biodiversity offsets (*see section 7.4*)		
Where permanent destruction of a valuable ecosystem was unavoidable, were offsets considered only as a last resort?		
Were any compensatory protected areas established and were they ecologically similar to the original natural habitat converted or degraded by the project and subject to fewer existing (or anticipated) threats to biodiversity?		
Were compensatory protected areas of equivalent value and no smaller than the original natural habitat converted or degraded by the project?		
Did offsets complement other government/conservation partner programs and were they responsive to conservation priorities outlined in national or regional initiatives to implement the Convention on Biological Diversity?		
Did offsets result in a net gain for biodiversity over time, bearing in mind the timeframes of ecological processes, and was this credibly evaluated by peer-reviewed scientific studies?		

Issues to consider	Y/N	Comments
Were the offsets enduring – did they offset the impact of the development not only for the period during which the impact occurred, but beyond?		
Were the offsets quantifiable – were the impacts, limitations and benefits reliably estimated?		
Were the offsets targeted – did they offset the impacts on a 'like for like or better' basis?		
Were the offsets located appropriately – ideally they should offset impacts within the same area?		
Were the offsets supplementary – were they in addition to existing commitments and not already funded under a separate program?		
Were the offsets enforceable through the development of consent conditions, licence conditions, covenants or a contract?		
In choosing offsets, were biological criteria the primary consideration in preference to mixing threat and biological criteria?		
Were the offsets determined in consultation with stakeholders?		
Biodiversity offsets (*see section 7.5*)		
Were any biodiversity enhancement measures implemented to enhance or improve biodiversity and respond to non-mining-related threats?		
Within the fence-line of an operation, were natural habitats in undisturbed areas managed to enhance their biodiversity value, or habitats that were subject to historical disturbance (unrelated to mining) improved or restored?		
Within the wider concession area, were any similar management approaches pursued and were these linked into existing conservation initiatives or adjoining protected areas?		
Within the area of environmental or social interactions (such as wetlands that may be connected to receiving watercourses for effluents, or communities from which employees are drawn) were possibilities for benefiting biodiversity conservation identified to address non-mining threats to biodiversity (***see section 5.4.2***)?		
Were any practical or advocacy efforts undertaken at a regional or national level in support of biodiversity conservation (e.g. enhancing scientific knowledge of ecosystems or species through ecosystem, habitat or species level studies)?		
Where opportunities for biodiversity enhancement were pursued, were the potential costs of biodiversity gains to stakeholders considered?		
Defining boundaries of responsibility (*see section 7.6*)		
Was an attempt made to define the boundaries of responsibility for mitigation rehabilitation or enhancement?		
Did the company assume responsibility for all aspects of mitigation and rehabilitation within the fence-line, although this does not preclude the involvement of other parties?		

Issues to consider	Y/N	Comments
For biodiversity enhancement initiatives in the concession area, was the company's responsibility commensurate with its direct influence over the management of land?		
For biodiversity enhancement measures within the area of environmental and social interactions, was the extent of environmental and social influence of the project considered (including indirectly affected areas)?		
Linked to the previous point, was the maturity of the conservation context and related factors (***see section 5.4***) considered and its influence on key factors such as the intractability of biodiversity threats and the capacity of potential partners?		
Beyond the area of environmental and social interactions, did the company ensure that the primary responsibility for biodiversity protection and enhancement resided with other parties?		
At this wider level, did mining companies limit their activities to a supportive role, such as advocating the case for biodiversity protection or linking to existing or proposed biodiversity initiatives at the regional or national level?		

Published by International Council on Mining and Metals (ICMM), London, UK

ISBN: 0-9549954-8-1

Edited by: Linda Starke
Design: Magenta
Print: Pennington Fine Colour

Available from: ICMM, www.icmm.com, info@icmm.com

This book is printed on Challenger Offset 120gsm and 250gsm paper. A great proportion of the raw material used is the by-product from other processes i.e. saw mill waste and waste which results from forest thinning. The mill holds not only ISO 2002 but also ISO 14001 accreditation for their environmental management systems, which include an active policy on sustainable forestry management.

ICMM – International Council on Mining and Metals

The International Council on Mining and Metals (ICMM) is a CEO-led organisation comprising many of the world's leading mining and metals companies as well as regional, national and commodity associations, all of which are committed to improving their sustainable development performance and to the responsible production of the mineral and metal resources society needs.

ICMM's vision is a viable mining, minerals and metals industry that is widely recognised as essential for modern living and a key contributor to sustainable development.

Our library at www.goodpracticemining.com has case studies and other examples of leading practices.

www.icmm.com

ICMM
19 Stratford Place
London W1C 1BQ
United Kingdom

Telephone: +44 (0) 20 7290 4920
Fax: +44 (0) 20 7290 4921
Email: info@icmm.com