



Australian Government



BIODIVERSITY MANAGEMENT

*Leading Practice Sustainable Development
Program for the Mining Industry*

September 2016



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FOREWORD

The *Leading Practice Sustainable Development Program for the Mining Industry* series of handbooks has been produced to share Australia's world-leading experience and expertise in mine management and planning. The handbooks provide practical guidance on environmental, economic and social aspects through all phases of mineral extraction, from exploration to mine construction, operation and closure.

Australia is a world leader in mining, and our national expertise has been used to ensure that these handbooks provide contemporary and useful guidance on leading practice.

Australia's Department of Industry, Innovation and Science has provided technical management and coordination for the handbooks in cooperation with private industry and state government partners. Australia's overseas aid program, managed by the Department of Foreign Affairs and Trade, has co-funded the updating of the handbooks in recognition of the central role of the mining sector in driving economic growth and reducing poverty.

Mining is a global industry, and Australian companies are active investors and explorers in nearly all mining provinces around the world. The Australian Government recognises that a better mining industry means more growth, jobs, investment and trade, and that these benefits should flow through to higher living standards for all.

A strong commitment to leading practice in sustainable development is critical for mining excellence. Applying leading practice enables companies to deliver enduring value, maintain their reputation for quality in a competitive investment climate, and ensure the strong support of host communities and governments. Understanding leading practice is also essential to manage risks and ensure that the mining industry delivers its full potential.

These handbooks are designed to provide mine operators, communities and regulators with essential information. They contain case studies to assist all sectors of the mining industry, within and beyond the requirements set by legislation.

We recommend these *leading practice* handbooks to you and hope that you will find them of practical use.



Senator the Hon Matt Canavan

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1.0 INTRODUCTION

Humans are totally dependent on biodiversity for their sustenance, health and enjoyment of life. Even in Australia, we derive all of our food and many of our medicines and industrial products from wild or domesticated components of biodiversity.

Mining has the potential to affect biodiversity throughout the life cycle of a project. Such impacts, whether direct, indirect or cumulative, make many project developments potentially sensitive for regulators, local communities, investors, non-government organisations (NGOs) and employees.

This handbook addresses biodiversity management, which is one theme in the Leading Practice Sustainable Development in Mining Program. The leading practice handbooks are relevant to all stages of a mine's life—exploration, feasibility, design, construction, operation and closure—and to all facets of its operation. Leading practice biodiversity management starts at the very beginning of the mining project and continues through to mine closure and lease relinquishment. It is not limited to the immediate area affected by operations and must take account of all relevant site, local, regional, national and even international aspects.

The primary audience for this handbook is management at the operational level—those who are responsible for implementing leading practice at mining operations. It is also relevant to people with an interest in leading practice biodiversity management in the mining industry, including environmental officers, mining consultants, governments, regulators, NGOs, neighbouring and mine communities, and students. All users are encouraged to work together in partnership, taking up the challenge to continually improve the mining industry's standards of biodiversity management as part of its sustainable development performance. Improved performance can be achieved through applying the principles outlined in this handbook.

The handbook outlines the key principles and procedures now recognised as leading practice for assessing, managing and monitoring biodiversity values:

- the importance of biodiversity and its materiality for the mining sector (Section 2)
- planning to manage biodiversity through the establishment of biodiversity baselines and including biodiversity in impact assessment processes (Section 3)
- assessing biodiversity risk and impacts and setting biodiversity objectives (Section 4)
- managing biodiversity issues through the use of the mitigation hierarchy (Section 5)
- monitoring and reporting biodiversity management performance (Section 6).

The handbook has not been written in isolation and should be read in conjunction with the other leading practice handbooks, specifically those dealing with:

- rehabilitation
- acid and metalliferous drainage
- community engagement
- monitoring, in evaluating performance
- closure planning.

The handbook is intended to be an overview guide only and is neither prescriptive nor comprehensively detailed. Environmental managers and practitioners are encouraged to access and use the technical material cited in the text and listed in the 'Further reading' section for more in-depth information.

2.0 THE IMPORTANCE OF BIODIVERSITY

Key messages

- Biodiversity is critical to human wellbeing.
- Biodiversity is under significant threat from human activities.
- Australia's governments have many biodiversity conservation policies that affect the mining industry.

2.1 What is biodiversity?

The Convention on Biological Diversity (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' (CBD 2006).

The Australian Government is a signatory to the CBD and is therefore required to design and implement policies to protect biodiversity. The *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (the EPBC Act) is an example of a policy that helps Australia meet its CBD obligations.

The EPBC Act and most regulatory instruments focus on individual species, habitats (vegetation communities) and sometimes ecosystem services, rather than trying to regulate the whole of biodiversity. This is based on the assumption that good management of those components is the most practical way to deliver good outcomes for the biodiversity as a whole.

Humans are totally dependent on biodiversity for their sustenance, health and enjoyment of life. Even in Australia, we derive all of our food and many of our medicines and industrial products from wild or domesticated components of biodiversity. Biodiversity also underpins crucial ecosystem functions and processes.

Mining potentially affects biodiversity throughout the life cycle of a project (ICMM 2006). Those impacts, whether direct, indirect or cumulative¹, make many project developments potentially sensitive for regulators, local communities, investors, NGOs and employees. Long-term business success for many companies depends on their ability to understand and manage those issues.

¹ See Section 4.1 for a more detailed discussion on impact types.

2.2 Biodiversity and ecosystem services

Ecosystem services are the direct and indirect contributions of ecosystems to human wellbeing.² Ecosystem services relevant to the Australian mining industry include the provision of clean water, flood regulation, cultural services and recreational services. Biodiversity and ecosystem services are both complex concepts and there is often confusion about how they relate to each other. This is particularly true of the emerging policy field of ecosystem service assessment. This handbook does not cover the policy and science of ecosystem service assessment and management within the mining industry. However, readers should recognise that biodiversity can be a regulator of fundamental ecosystem processes, a final ecosystem service in itself, or an ecosystem service good. Many ecosystem processes, and thus the services they give rise to, are underpinned by biodiversity. Biodiversity can also directly provide people with goods and benefits (Mace et al. 2012; DEST 1993).

2.3 The materiality of biodiversity

2.3.1 Changing regulatory landscape

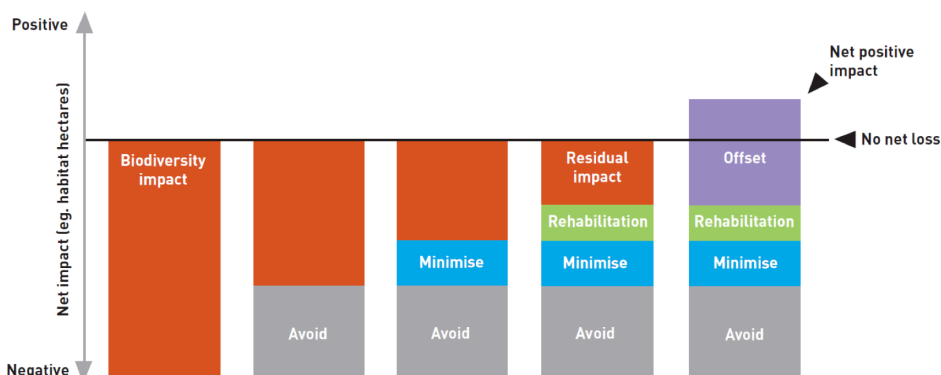
The mitigation hierarchy (Box 1 and Section 5.1), including biodiversity offsets (Section 5), has been widely adopted at both state and federal levels. This is the most significant recent development in the mining industry's management of its biodiversity impacts. Accordingly, expectations and legal compliance requirements for baseline studies, impact assessment, mitigation and offset planning, implementation and associated monitoring programs are increasingly stringent.

Australian governments have implemented biodiversity offset policies at state and federal levels. Requirements vary between jurisdictions, although there is increasing effort to harmonise regulation. Offsets are considered only after other elements of the mitigation hierarchy (avoid, minimise, rehabilitate) have been employed. They generally aim to maintain or enhance the viability of the biodiversity value or values targeted by the offset policy (for example, a particular habitat type or protected species).

² The Economics of Ecosystems and Biodiversity, www.teebweb.org.

Box 1: The mitigation hierarchy

The mitigation hierarchy is widely used by companies and industry peak and advisory groups as a practical framework for managing risks and impacts to biodiversity.



The mitigation hierarchy is a sequence of actions:

1. to anticipate and avoid project impacts on biodiversity where feasible
2. where complete avoidance is not feasible, to minimise impacts
3. when impacts occur, to rehabilitate
4. where significant residual impacts remain, to offset for them.

At the federal level, offsets have been used as conditions of approval in specific circumstances under the EPBC Act since 2001. The Act's environmental offset policy was drafted in 2007 and finalised in 2012 to guide decisions on what constitutes a suitable offset. The EPBC Act applies to all 'matters of national environmental significance'—the species, vegetation communities, aquatic and marine communities and other biodiversity features that underpin all regulatory biodiversity management. Updated definitions and lists are available online.³ State and territory offset laws apply to state significant species lists that vary among jurisdictions, are updated most years and are available online. Where biodiversity features are listed at both the federal and state levels, an increasing number of states are obtaining accreditation under the EPBC Act to undertake assessments under bilateral agreements, thus avoiding duplicate assessments.

In this rapidly changing policy landscape, companies that adopt a structured and systematic approach to biodiversity management, framed around robust implementation of the mitigation hierarchy, will be able to anticipate evolving legal requirements and engage proactively with regulators. This will help to ensure that approval processes are predictable and efficient and that new policies and legislation are developed in a way that balances the needs of business and biodiversity conservation. This kind of long-term perspective is particularly important in industries such as mining, in which project lifespans can be decades and legacy impacts of earlier poor management practices can be costly and difficult to manage.

³ Department of the Environment, *What is protected under the EPBC Act? Matters of national environmental significance*, <https://www.environment.gov.au/epbc/what-is-protected>.

2.3.2 Changing finance landscape

Since 2006, there has been a gradual but significant increase in the quantity and sophistication of the finance sector's project performance standards. For example, Performance Standard 6 (PS6) of the International Finance Corporation (IFC) explicitly requires application of the mitigation hierarchy and the offsetting of impacts on biodiversity of high value ('critical habitats') (IFC 2012a). In many project development situations, the IFC performance standards add another layer of compliance and often require a higher level of performance than government regulation.

PS6 has quickly become the benchmark biodiversity standard for a large number of project financing and lending institutions, including:

- commercial banks that are signatories of the Equator Principles (there are currently 79 adopting financial institutions in 35 countries covering over 70% of international project finance debt in emerging markets, including most major Australian banks)⁴
- export credit agencies (such as Australia's Export Finance and Insurance Corporation)
- multilateral finance institutions that have developed similar standards (such as the Asian Development Bank, the European Investment Bank and the Inter-American Development Bank).

Failure to meet these new performance standards in an effective and timely way can lead to delays in financial disbursement, which can result in delays to project development and even jeopardise access to capital.

The adoption of new or stricter performance standards by multilateral finance institutions is most likely to affect small and medium-sized Australian companies that have operations in Africa, South America, South-east Asia and the Middle East. Companies with Australian operations will be increasingly likely to interact with commercial lenders that are signatories to the Equator Principles. Even companies that do not typically seek project finance may be exposed to PS6 and similar standards through acquisitions and joint ventures. Moreover, PS6 is gaining traction internationally and is increasingly used as a model of leading practice by governments (some of which now make reference to PS6 in their environmental legislation) and civil society.

2.3.3 Social licence to operate

The Minerals Council of Australia (MCA) states that 'the Australian minerals industry strongly supports the role of a "social licence to operate" as a complement to a regulatory licence issued by government' (MCA 2015).

Mining often happens in remote places where local communities engage in subsistence agriculture or live through sustainable livelihoods based on surrounding natural resources. In such circumstances, the human (social and economic) dimensions of biodiversity take on critical importance. This is particularly true in the rural areas of developing countries, where entire communities are directly dependent on biodiversity and ecosystem services and therefore immediately vulnerable to their degradation.

⁴ The Equator Principles, <http://www.equator-principles.com/>.

Public concern over biodiversity loss and ecosystem damage is reflected in a growing number of initiatives. They range from civil society and local community action to international, national and local laws, and policies and regulations aimed at protecting, conserving or restoring ecosystems. To maintain their social licence to operate, mining companies are increasingly being required to:

- make ‘no go’ commitments on the basis of biodiversity values (which may include pristine, sensitive or scientifically important areas; the presence of rare or threatened species; or areas where activities pose unacceptable risks to ecological services relied upon by surrounding populations)
- alter the project development cycle where baseline information is insufficient or where scientific uncertainty mandates a precautionary approach
- mitigate (avoid, minimise, rehabilitate) and offset impacts.

Responsible management of biodiversity, in conjunction with key stakeholder groups such as regulators and indigenous peoples, is a key element of leading practice sustainable development in the mining industry.

2.3.4 Why factor biodiversity into project risk management?

Non-technical risks account for a significant proportion of delays to extractive industry projects, and social conflict over environmental resources is a major factor.⁵ Integrating biodiversity risk management into corporate decision-making from the start of a project is the key to reducing operational and financial risks downstream and therefore makes good business sense. For companies that adequately consider the environmental footprint of their projects, risks can be transformed into opportunities—improving the company’s reputational standing; gaining a competitive advantage through approval and acceptance from the public, governments and financial institutions; and securing improved access to markets.

2.3.5 What are the risks of inadequate biodiversity management?

Inadequate integration of biodiversity management into project planning and implementation may undermine a company’s operations and investments. A wide range of outcomes can affect operations, competitiveness and profitability (Table 1). Three main drivers underpin the business case for biodiversity management:

- *Regulatory and legal compliance risk*, which could restrict resource access where compliance is not achieved or result in prompt litigation where the company has adverse impacts on biodiversity.
- *Reputational risk* damage caused by association with adverse impacts on biodiversity, leading to divestments and damaging the company’s brand.
- *Competition and market risk*, including the choices of investors and customers, production costs, shareholder confidence and employee wellbeing.

⁵ A recent review showed that over half of delays to oil and gas projects were due to non-technical risks, and that social conflict over environmental resources was the single biggest factor; see Franks et al. (2014).

Table 1. The outcomes of poor biodiversity management

HOW IT IS CAUSED?	OUTCOME	IMPACTS TO THE PROJECT/COMPANY
Failure to propose adequate environmental programs to lenders in a timely manner	Regulators withholding authority to operate	Project delays
	Lenders withholding funds	Project delays
Failure to propose adequate environmental programs to the regulator in a timely manner	Regulators requiring changes to approval and/or more documentation	Project delays; capital cost overruns
		Project refused outright
		Increased rehabilitation costs
Failure to implement adequate environmental programs	Loss of social licence to operate: community outrage manifesting in strikes, blockades, protests and legal challenges	Production halted
		Renegotiation of government contributions
		Project design changes
	Loss of legal licence to operate	Construction delayed; fines; potential impact on share price or trading halt; expected production targets not met
		Exploration licences revoked
	Poor socially responsible investment index ratings	Shareholder divestments on environmental grounds
	Magnified impact of natural events	Halt in production; increased clean-up costs; damaged equipment

2.4 Key biodiversity threats and opportunities

Australia is one of the world's biologically 'megadiverse' countries. Many of Australia's species are endemic (unique) to this continent, and between 7% and 10% of all species on Earth occur here. However, there have been major declines in many components of biodiversity since European settlement, and available information indicates continuing losses at the genetic, species, ecosystem and landscape levels owing to a number of different threats linked to human activities.⁶

According to Australian Government *State of the Environment* reports⁷, the most significant past and present threats to biodiversity in Australia include:

- clearing and fragmentation of native ecosystems
- invasive species and pathogens, particularly invasive plant species, weeds, feral predators, and plant and animal diseases
- inappropriate fire regimes
- grazing pressure
- recent climate change (many areas now face decreased rainfall, more drought and associated hydrological changes).

⁶ See, for example, DoE (2011).

⁷ See DoE (2011).

Steps have been taken to limit clearing of native vegetation, but it remains a significant pressure in some areas, and the legacy effects of past clearing mean that the impacts are ongoing. Pressures from invasive species, altered fire regimes and changed climate and hydrology are major and have been growing worse over the past 10 years. Despite increasing community interest in biodiversity over recent decades, the long-term commitment of resources needed for effective biodiversity research and management is often lacking. The contribution made by species and ecosystems to the wellbeing of the Australian community remains undervalued.

Despite improved industry standards and regulations, the Australian mining industry continues to have negative impacts on biodiversity. Key impacts include:

- clearance of native habitat
- degradation of terrestrial habitat
- degradation/pollution of aquatic habitat
- abstraction and contamination of freshwater
- indirect impacts (see below and Section 4.1).

Clearance of native habitat affects all species using that habitat. Clearance of high conservation value habitat is often regulated and requires rehabilitation, offsets, or both. However, rehabilitation and offsets take time to accrue benefits and can incur risks of underdelivery.

Native habitat around the mine often suffers pervasive impacts such as fragmentation; increased traffic; noise and dust pollution; increased feral pests and weeds; changed fire regimes; and altered hydrology. Many mines require the abstraction of large volumes of water. That water, plus natural surface flows and groundwater, may be significantly altered and or contaminated. Abstraction and contamination (particularly through acid mine drainage) can have long-term impacts on biodiversity, but those impacts are often poorly known.

Such impacts, especially hydrological change, can affect habitat far away from the mine. Regulations try to minimise the impacts, but mining operations often result in net losses of biodiversity values.

Traditional environmental impact assessment and regulation focus on direct impacts to the project site. Projects also have indirect impacts, such as changes in neighbouring land use owing to an altered socioeconomic environment. Indirect impacts can be serious but are not usually addressed in traditional environmental impact assessment. Climate change resulting from carbon emissions is an indirect impact of global significance to biodiversity.

There is a growing recognition of the critical role that business can play (in partnership with governments, the community and researchers) to mitigate their impacts and work towards having a net positive impact on their local environment. Through these strategic partnerships, impacts that have taken place over the past 200 years due to increasing land clearing, unsustainable land management practices, introduced species and fragmentation of the landscape can be understood, minimised and, where possible, reversed. As one of the major business groups in Australia, the mining industry has the opportunity to play a leading role in integrating biodiversity conservation and sustainable land management into business practices.

The mining industry is taking up this opportunity to support biodiversity conservation and recovery by:

- applying the mitigation hierarchy to avoid, minimise and rehabilitate impacts of mining and associated activities on biodiversity (Section 5.1)
- implementing biodiversity offsets (Section 5.5) and other compensatory measures for any residual impacts that remain after the mitigation hierarchy has been followed
- integrating biodiversity considerations into all phases of the project cycle, from exploration/acquisition through to the post-closure phase through a process of adaptive management.

A number of industry activities have the potential to support conservation efforts more broadly, including:

- supporting researchers, industry groups and consultants undertaking biodiversity studies (for example, on values, impact assessment, management of threats, and maximising the return of values in disturbed areas)
- supporting the implementation and management of conservation areas through direct or indirect resourcing
- developing human resources, skills and knowledge in areas that could assist in these complex matters
- developing partnerships with communities, conservation groups and other organisations to address these issues
- encouraging young graduates in biodiversity investigation and research through traineeships, graduate studies and partnerships
- leading in the development of best practice research and processes.

For example, the mining industry, including technical consultants, has contributed time, expertise and money to develop the Western Australian Museum's taxonomic services and its online WAMinals resource. WAMinals processes large volumes of collections from project environmental impact assessments and provides species identifications and information on species distributions (including many invertebrates new to science and not yet formally described) relevant to mining environmental impact assessments, mitigation actions and approval conditions. The industry also co-funds significant amounts of scientific research, often through ARC linkage grants.

3.0 PLANNING TO MANAGE BIODIVERSITY ISSUES

Key messages

- Biodiversity baselines underpin planning.
- Strategic planning offers improved outcomes and certainty.

3.1 Establishing a biodiversity baseline

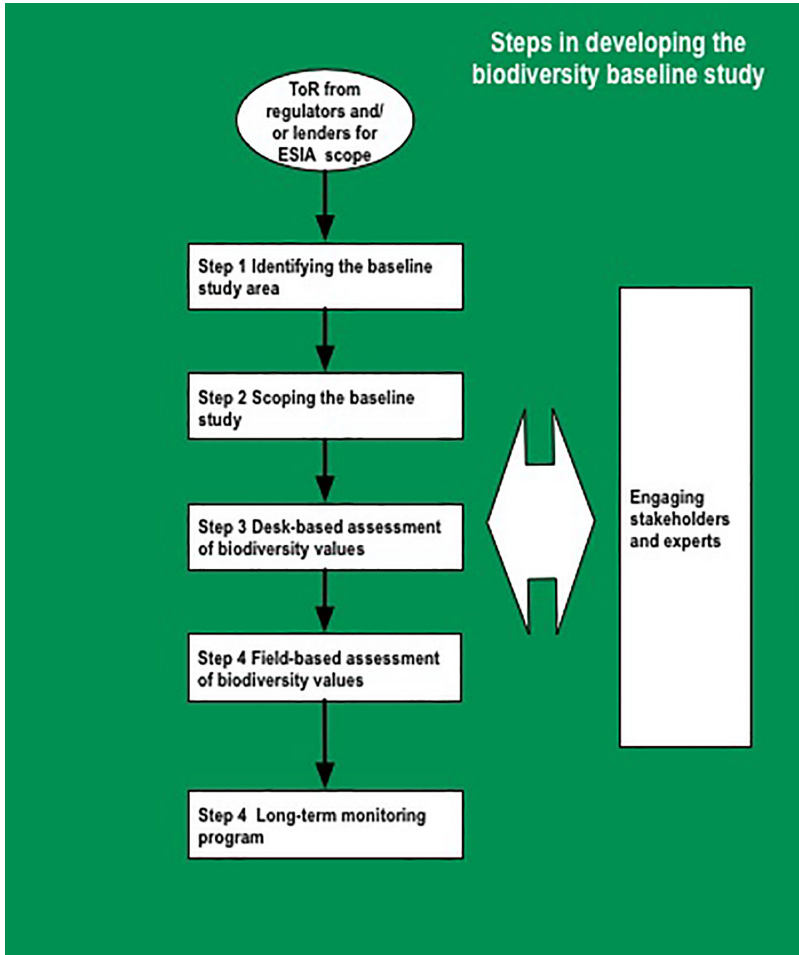
Biodiversity baselines are studies during project planning that provide information about the biological diversity of the site. Effective biodiversity baselines are important for three reasons:

- They identify and prioritise the most important biodiversity features present within the area of influence of the mining operation.
- They provide information that supports the impact assessment process.
- They provide information that supports mitigation planning.

Expectations for biodiversity baselines have increased dramatically over recent years, driven mainly by changes to regulatory requirements (including the broad adoption of biodiversity offset requirements at the state and federal levels), financial lending requirements and voluntary commitments by leading companies. Historically, the scope of biodiversity baseline studies was much narrower, often being limited to simple inventories documenting the actual or likely presence or absence of species in the project area.

Recent leading practice guidance recommends an iterative five-step process to establish a biodiversity baseline, which can then be used to develop the mining project's biodiversity risk profile and management strategy (Figure 1). Whether the project should follow all of the steps depends on the significance of the biodiversity values present at the site, as well as regulatory and financial standards and any voluntary corporate policies.

Figure 1: Steps in developing a leading practice biodiversity baseline



The following leading practice outline draws heavily from the recently published *Good practices for the collection of biodiversity baseline data* developed for the Multilateral Financing Institutions Biodiversity Working Group (Gullison et al. 2015).

3.1.1 Step 1: Identifying the baseline study area

It is leading practice to take an inclusive and comprehensive approach to defining the biodiversity baseline. When determining the boundaries of the project's biodiversity baseline study, the following categories of possible impact should be considered:

- *Direct impacts*—the physical footprint of project activities (including project infrastructure and the incremental transportation and energy infrastructure needed to support it), plus the area affected by emissions and effluents
- *Indirect impacts*—the physical footprint of non-project activities in the surrounding area that are caused or stimulated by the project, plus the area affected by their emissions and effluents
- *Cumulative impacts*—the overall impacts occurring in the project landscape caused by the project and non-project activities (related and unrelated to the project), generally including clusters of projects, land-use change trends, foreseeable developments, or a combination of those factors.

It is also important to consider the perceptions of local stakeholders when establishing the boundaries of the biodiversity baseline study area. It may be appropriate that the study area includes areas of stakeholder concern in order to confirm predictions of 'no impact on biodiversity', even if those areas are well beyond what would normally be considered the area of influence of the project.

3.1.2 Step 2: Scoping the baseline study

It is not practical for a baseline study to document and collect data for every element of biodiversity within the area of influence. Scoping the biodiversity baseline reduces the study burden while maintaining a focus on biodiversity values of importance. When defining the scope project, consider:

- regulatory and financial lenders' requirements
- corporate standards and commitments
- indigenous dependencies and knowledge
- other stakeholder dependencies and expectations
- scientific expert opinion.

The views and requirements of each stakeholder need to be assessed in the light of an understanding of the possible project impacts. Overall, the baseline study should produce enough high-quality data to allow robust biodiversity impact assessment and mitigation planning.

Which biodiversity values to include is highly specific to the region and circumstances in which the project is being developed. Biodiversity values included in baseline studies can generally be categorised as species, habitats or ecological or vegetation communities. In some cases, ecosystem services may also be included in the scope of the study.

3.1.3 Step 3: Desk-based assessment

A substantial existing body of biodiversity information has been collected over time by various specialists, organisations and governments, particularly in Australia. An initial desk-based assessment of the existing information is a cost-effective first step in collecting biodiversity baseline data. It also allows more efficient targeting of field-based surveys.

Biodiversity information is available from many sources and in many forms, such as, notably, the Australian Government's webpages on threatened species and threatened ecological communities and its protected matters search tool.⁸ Other sources of biodiversity data can be found in the scientific literature, which is far more accessible to the general public than it has been in the past because of the advent of *Google Scholar*.⁹

3.1.4 Step 4: Field-based assessment

The field-based component of a biodiversity baseline assessment is the most important part of baseline data collection. It is also generally the most significant in terms of cost and time commitment for the company. The field assessment should aim to fill the gaps and add resolution to the biodiversity information that has been collected as part of the desk-based assessment (Step 3) and the consideration of stakeholders' expectations and knowledge (Step 2).

The methodologies and procedures for field-based assessments differ considerably depending on the focus of the assessment and the region where it is being conducted, so a detailed discussion of methodologies is beyond the scope of this handbook. The Australian Government and most state governments have written guidance on survey methodologies for some terrestrial vegetation and fauna, and further guidance is available in the scientific literature. The most practical advice on methodologies is likely to come from professional consultants who have done similar fieldwork and analyses. However, a number of generic considerations should be considered when planning and implementing field-based biodiversity assessments:

- Are there any specific regulatory or lenders' requirements that dictate a particular survey methodology or level of sampling intensity?
- Are the proposed survey methodologies scientifically credible?
- Will the survey methodology generate data comparable with that obtained for control reference sites and possible biodiversity offset sites?
- Is the proposed survey methodology fit for purpose and cost-effective?
- Does the company have adequate in-house expertise, or should it seek independent third-party advice?

⁸ Protected Matters Search Tool, Department of the Environment, <http://www.environment.gov.au/epbc/protected-matters-search-tool>.

⁹ Google Scholar, <https://scholar.google.com.au/>.

3.1.5 Step 5: Long-term monitoring

Long-term monitoring is an essential element of biodiversity baseline data collection. The monitoring will serve one or a number of purposes, including:

- determining whether actual and/or predicted impacts on biodiversity values trigger thresholds requiring mitigation action to reduce or eliminate the impacts
- identifying whether unanticipated impacts on biodiversity values are occurring
- determining the effectiveness of biodiversity mitigation actions, including rehabilitation and offsets.

Long-term monitoring plans should build upon the baseline study as part of the environmental and social impact assessment (ESIA) process. Where possible, the operation should aim for a seamless integration between the baseline study and any longer term biodiversity monitoring programs that are established as part of the implementation of the mitigation hierarchy. This should include the use of the same survey and control sites, the same metrics and the same monitoring methodologies.¹⁰

3.2 The baseline and project development

Biodiversity risks and their respective management requirements vary according to the project. Irrespective of the context and complexity of the project, the biodiversity baseline plays a vital role in the development of the project's ESIA and the later application of the project's biodiversity mitigation hierarchy.

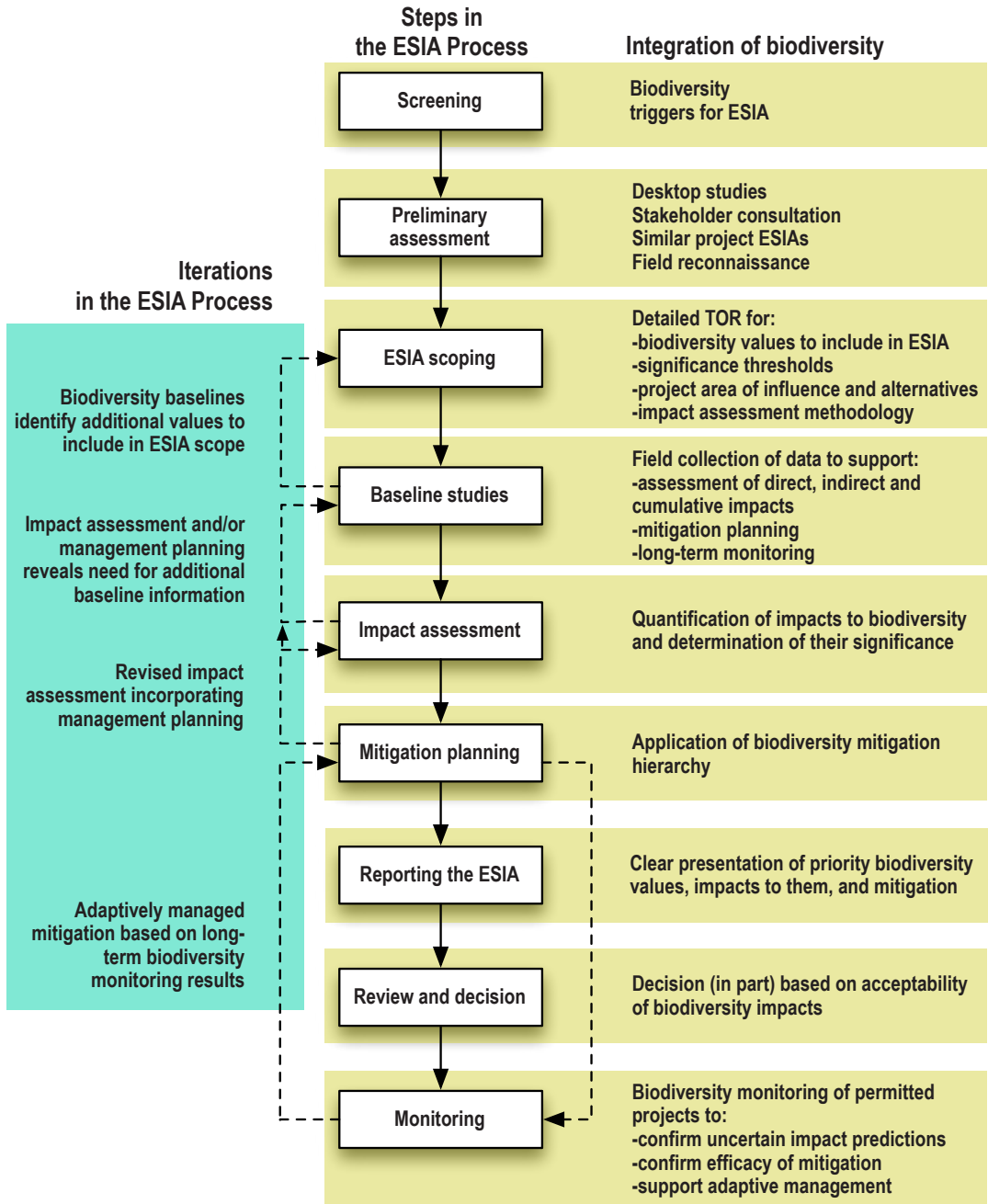
Effective biodiversity impact assessments and management plans largely rely on a solid foundation of:

- information on biodiversity (for example, taxonomic descriptions of species, conservation status assessments of species and ecosystems, and distribution maps of species and habitats at a scale that is appropriate for project planning)
- an understanding of direct, indirect and in some cases cumulative impacts (Section 3.1.1)
- the identification of priorities for biodiversity conservation (for example, existing and planned protected areas; national biodiversity strategies and action plans; and state and federal threatened species lists)
- demonstrated methods to manage biodiversity impacts.

Biodiversity considerations often need to be integrated into multiple stages of a project's ESIA process (Figure 2).

¹⁰ Biodiversity monitoring requirements, such as metrics and control sites, are discussed in more detail in sections 6.1 and 6.2.

Figure 2: Integration of biodiversity baseline and impact assessment data into the ESIA process



Source: adapted from Gullison et al. (2015).

Early integration of biodiversity information is essential for cost-effective mitigation. The development of a good biodiversity baseline and ESIA is an inherently iterative process. The levels of certainty for the presence or absence of biodiversity values and the operation's potential impacts on them are refined over time in most cases. Starting the process as early as possible in the project's life cycle helps to ensure that key decisions are made in an informed and educated way.

3.3 Strategic planning

Landscapes are often complex and increasingly have to support many different land uses and objectives for development. Biodiversity is an important element in the sustainable development of a landscape, providing ecosystem services and potential opportunities for investment and ventures. It is important to identify the areas most significant for biodiversity conservation and those with the greatest opportunities for or constraints on linking biodiversity and socioeconomic development.

The current management approach of project-by-project assessment, permitting and mitigation can potentially increase fragmentation of the landscape, further compounding biodiversity loss. In addition, conservation efforts by companies might not be directed at areas where biodiversity is most threatened and the value of the conservation activity is maximised.

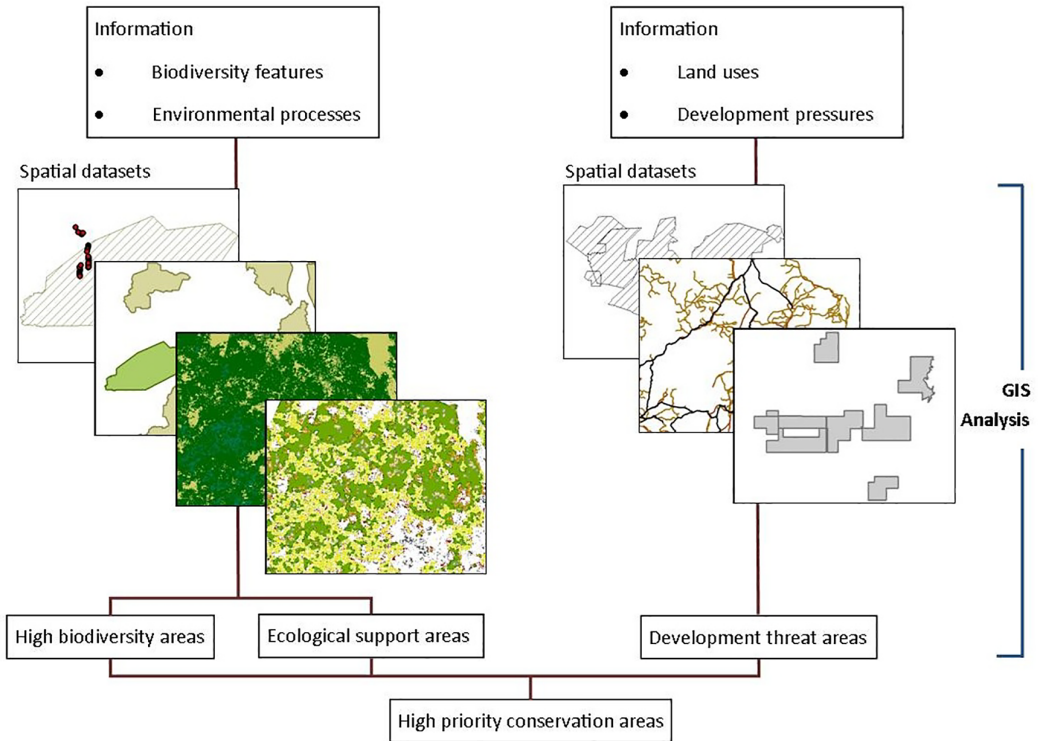
Strategic (or regional or landscape level) assessments potentially help in assessing change in biodiversity indicators over time through the comparison of baseline and current habitat and land-use parameters. Their main strength is in taking a wide view of direct, indirect and cumulative impacts of multiple developments in the landscape. A strategic plan is an effective framework for monitoring conservation effectiveness and the changes due to increasing developments in a region.

A landscape-level view helps to guide conservation priorities, and understanding landscape-level features and processes is also a requirement of many lenders under IFC Performance Standard 6 (IFC 2012a). Aspects requiring consideration at landscape scale include the identification of natural habitat through connected habitat patches, the identification of critical habitat supporting priority species and habitats, and the management of habitat essential to the provisioning of ecosystem services, such as hydrological processes.

A strategic assessment generally follows a series of systematic steps in order to identify high-value areas and assess the potential conflicting or competing issues. This can be based on a high-level desktop approach. However, the levels of stakeholder interaction and dataset resolution can be scaled up to offer more detailed and reliable outputs.

To assess the landscape features and processes, spatial information and data are combined in a GIS (Geographic Information System). A spatial assessment is an important approach, as biodiversity and landscape processes are usually not evenly distributed across the landscape, while development often occurs within specific areas. By analysing these features in the GIS, variation in biodiversity features and processes can be identified across the landscape and compared against development that may affect those areas. Figure 3 shows an overview of the systematic steps in the strategic assessment.

Figure 3: Overview of the systematic order of the strategic biodiversity assessment



Once the important and indicator biodiversity features and environmental processes have been identified, data is sourced and attributed. By analysing those features and landscape processes in the GIS, areas in the landscape that are important for biodiversity can be efficiently and effectively identified. Datasets on mining developments, infrastructure and habitat loss are vital to understand current threats and trends that may affect biodiversity. Overlaying the development features with high-biodiversity areas can identify possible conflicts between biodiversity and current or potential development. The outputs are translated into conservation priorities, indicating those areas where biodiversity may potentially be threatened by impacts or areas that require conservation management to protect and maintain high-biodiversity levels.

Strategic assessments consider the cumulative impacts of developments across landscapes and the need for alternative development options to ensure the effective application of the mitigation hierarchy. A strategic plan needs to demonstrate the full application of the mitigation hierarchy, with step-by-step demonstrations of the efforts and actions taken by the company to avoid impacts where possible.

Strategic assessment is increasingly being led by government in regions of multiple and/or large-scale development proposals, such as in the Namib Naukluft region of Namibia and in the Hunter Valley in Australia (Box 2). With appropriate stakeholder engagement, strategic assessments offer the best solutions for addressing all perspectives over the long term. Most importantly, they offer certainty and a level playing field for all proponents. The Australian Government manages landscape-scale strategic assessments under the EPBC Act, which fast track subsequent EPBC Act referrals (DoE n.d. a).

Box 2: The Hunter Valley strategic assessment

The Upper Hunter Strategic Assessment of Biodiversity has been undertaken by the NSW government and mining companies to meet Australian government guidelines. It started in 2012 and aims to identify and address important biodiversity issues before mine applications are lodged. This should improve environmental outcomes, streamline the assessment process and offer greater certainty for the community, industry and government.

Environmental outcomes can be improved by:

- informing and directing avoidance
- offering standardised mitigation actions
- addressing cumulative impacts
- offering standardised restoration
- creating a pooled offset fund.

3.4 Stakeholder engagement

Effective and timely engagement with appropriate stakeholders is a critical aspect of leading practice biodiversity management. Stakeholders are all those with an interest in, or concern about, the project and its impacts (positive or negative) on biodiversity. They are not a homogeneous group and have varying importance and relevance to biodiversity management. In some situations, the number and types of stakeholders an operation might potentially need to consult on biodiversity matters can appear daunting.

The first step in engagement is to map potentially relevant stakeholders. Their proximity to the operation may vary considerably and is not necessarily a good indicator of importance.

Stakeholder engagement on biodiversity issues was once considered a regulatory burden on project development. It is better viewed as a valuable part of biodiversity risk management, especially (but not only) during the ESIA process (ICMM 2006). Many recent examples of mining projects incurring costs and delays can be traced to poor stakeholder engagement as part of the project's risk management.

Engagement with stakeholders can take many forms and serve a number of purposes, including in stakeholders' roles:

- as sources of biodiversity baseline information and data, including biodiversity monitoring
 - landholders
 - indigenous communities
 - universities and other researchers
 - state environment departments
 - environmental NGOs

- as groups potentially affected by the operation's impacts on biodiversity
 - indigenous communities
 - local communities
 - regulators (federal, state and local government)
 - individuals and organisations (at the local, state, national or international level) with an interest in the region's biodiversity
- as land management partners
 - indigenous communities
 - NGOs.

3.4.1 Stakeholders as a source of biodiversity information

External input will generally be required to develop an accurate and up to date biodiversity baseline, as mining operations in Australia rarely have the necessary resources in house. This is particularly relevant in regions of Australia where biodiversity is complex and/or poorly documented. Leading practice companies allocate resources and time to build relationships with the stakeholders that can best support the operation in biodiversity baseline development and subsequent management of biodiversity issues. They also give appropriate consideration to the mix of traditional knowledge and scientific datasets.

3.4.2 Potentially affected stakeholders

A comprehensive program of community engagement is an essential component of the modern mining and minerals processing operation, which serves to maintain and enhance the industry's social licence to operate. Despite the economic opportunities offered to affected stakeholders, some can be sceptical or hostile to mining projects for various reasons, including proposed impacts to biodiversity and ecosystem services. Open and meaningful engagement, and, where feasible, acting upon stakeholder concerns, reduces the risk of stakeholder opposition.

3.4.3 Indigenous communities

Leading practice companies have developed ongoing relationships with traditional owners in the areas in which they operate. Indigenous people's deep understanding of the environment in which they live can add significant value to the operation's assessment and management of biodiversity values, including:

- the identification and documentation of biodiversity values of cultural, practical, medical and nutritional significance
- the identification of possible project alternatives in terms of biodiversity value
- biodiversity monitoring programs
- closure planning and management.

3.4.4 Stakeholders as land management partners

The development of strategic and technical relationships with national or international conservation NGOs, academic institutions and other stakeholders is now commonplace in the industry. Such relationships may be formal or informal and are often termed 'partnerships'. They enable the industry to better identify and work to address biodiversity issues of mutual interest and concern. By partnering with conservation NGOs, the industry can gain access to specialist skills, expertise and collaborative networks on biodiversity conservation issues. With the growing need for the industry to develop and implement land-based biodiversity offsets, the importance of long-term relationships with key stakeholders is also growing, as Australian-based and global NGOs position themselves to act on behalf of companies as biodiversity offset managers.

It is important that stakeholder engagement on biodiversity matters should not be delinked from other company stakeholder engagement.

Specific guidance on working with indigenous and other communities is in the *Community engagement and development* and *Working with Indigenous communities* leading practice handbooks in this series. In addition, ICMM (2006) includes a comprehensive section on stakeholder engagement.

Case study: Restoring biodiversity after closure

Mining companies can generate biodiversity values through their rehabilitation practices, as shown in this example from the Upper Hunter Valley in New South Wales from 2006 to 2011.

Anglo American's Dartbrook coalmine in the Upper Hunter region has been under care and maintenance since 2006, but biodiversity restoration works continue. In partnership with the Hunter Central Rivers Catchment Management Authority (now Local Land Services Hunter), Anglo American completed a five-year project to improve river bank stability and encourage biodiversity along 6.5 km of the Hunter River.

To improve river health, the project built and installed 20 logjams and two more complex log structures dubbed 'fish hotels', which create deep refuge pools to benefit native fish. Greater complexity of stream flow resulted, which in turn has created pool and riffle sequences not seen before the installation. An additional benefit of these structures has been improved bank stabilisation. This should benefit native fish species such as bass and discourage introduced fish species such as carp. Local fishermen have already reported an increase in the number of native fish in the river.

Another aspect of the project involved restoring the vegetation along all 6.5 km of riverbanks. After river red gums (*Eucalyptus camaldulensis*) were cleared for agriculture in historical times, the banks lost their stability and eroded into the river. River red gum seeds had been unable to germinate until Anglo American provided floodwaters to the area after heavy rains in 2007. Additional works included fencing to exclude stock from the riverbanks and installing troughs to provide cattle with off-stream watering points, as well as the removal of introduced species such as willows. Several thousand river red gum saplings grown from seeds collected onsite at Dartbrook were also planted. The seedlings add 8 ha of habitat to the remnant trees, making this one of the largest populations of this species in the Hunter Valley.

This restoration was not directly associated with rehabilitating the mine site but was undertaken as part of Anglo American's commitment to leading practice land management.



Preparing a 'fish hotel'.



Floodwater allows river red gum seeds to germinate.

4.0 ASSESSING BIODIVERSITY IMPACTS

Key messages

- Direct, indirect and cumulative impacts need to be assessed and quantified.
- Risks need to be assessed alongside impacts.
- Objectives should be set for biodiversity outcomes.

4.1 Direct, indirect and cumulative impacts

The ESIA process provides a structured and standardised approach to considering the environmental, economic and social aspects of options and alternatives when developing a mining project (ICMM 2006). Biodiversity impact assessment is the process of determining the types and significance of effects that the project will have, and can be divided into five general steps:

1. Definition of project alternatives
2. Impact identification
3. Impact characterisation
4. Mitigation strategies
5. Assessment of consequences and risk.

Considerable ESIA guidance and expertise exists both in Australia and overseas, which project managers can use to help design and implement effective ESIA processes with a strong biodiversity focus. Those resources include:

- the International Association for Impact Assessment website¹¹
- the ICMM's *Good practices for biodiversity inclusive impact assessment and management planning* (Hardner et al. 2015)
- Chapter 5 in *Good practice guidance for mining and biodiversity* (ICMM 2006).

Traditionally, impact assessment has focused on the *direct* physical impacts of the project on biodiversity values. However, regulators and stakeholders are now demanding a broader and more inclusive assessment based on three categories of impacts: *direct*, *indirect* and *cumulative*.¹²

¹¹ International Association for Impact Assessment, www.iaia.org.

¹² See Section 3.1.1 for definitions of the categories.

While there is a growing push to include cumulative impacts in biodiversity assessments, the information needed for such an analysis might not be easily available, owing to commercial sensitivities among companies operating in the same area. In such situations, Hardner et al. (2015) suggest the following strategy:

1. Negotiate the appropriate level of treatment of cumulative impacts with regulators, lenders and other key stakeholders.
2. Provide full transparency regarding the caveats and limits of the analysis being performed.

Where the impacts of a particular activity are uncertain (for example, because there is insufficient baseline data on the area's biodiversity values, or insufficient knowledge of the rehabilitation potential of particular ecosystems following mining), precautionary measures should be taken to avoid impacts (that is, employ the 'precautionary principle'¹³). Depending on the gravity of the potential environmental loss, this may involve delaying the project cycle until further research has been done. That might include strategic regional assessments, an analysis of cumulative impacts or the commissioning of additional baseline studies.

4.2 Risk assessment

It is not feasible to address every biodiversity issue that may occur at a project. A rigorous and transparent risk assessment is needed to limit the scope of impact and mitigation analysis to those potential impacts that are likely or certain to occur and that have significant consequences (beyond an appropriate threshold).

Risk is a function of the potential consequence and likelihood of an impact (Figure 4), and risk assessment is an accepted and sophisticated process in the Australian mining industry.

Figure 4: An indicative risk assessment matrix showing the risk ranking from the intersection of likelihood and consequence descriptors

Likelihood	CONSEQUENCE				
	Minor impact	Moderate impact	Serious impact	Extreme impact	Catastrophic impact
Almost certain: expected to occur in project plan	M	H	C	C	C
Likely: probably will occur in project plan	M	H	H	C	C
Possible: might occur in some circumstances	L	M	H	C	C
Unlikely: may occur at some time	L	L	M	H	C
Rare: will occur only in exceptional circumstances	L	L	M	H	H

Risk levels: L = low, M = moderate, H = high, C = critical.

Source: adapted from Hardner et al. (2015).

¹³ The precautionary principle states that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation (see EPBC Act).

In the context of impact assessment, it is helpful to think about three kinds of risk:

- *Intrinsic risk*: The risk to the viability of a biodiversity feature. The more vulnerable and irreplaceable the feature, the greater the consequence of a particular impact. Determining the true consequence of an impact on a biodiversity feature is arguably the most difficult aspect of biodiversity risk assessment.
- *Regulatory risk*: The risk of not complying with a regulatory or lender standard. Often, these standards are also framed around the vulnerability and irreplaceability of biodiversity features, and may prescribe the particular methodologies and thresholds to be used.
- *Reputational risk*: The risk of impacts that are unacceptable to important stakeholders.

These three types of risk may substantially overlap but are usually not identical. All three should be considered in a biodiversity risk assessment.

There is no universally accepted set of consequence descriptors available for use by the mining industry. Figure 4 shows one practical approach to risk ranking.

Companies undertaking impact assessments can draw from scientifically based and widely recognised assessments and methodologies, such as the IUCN Red List of Threatened Species¹⁴ and the 'critical habitat' definitions of IFC Performance Standard 6.¹⁵

Alternatively or additionally, companies can generate bespoke descriptors that use regulatory and lender standards, where available. They might include variables such as the magnitude of the loss, both spatial and temporal, the conservation status of the species and/or habitat and the significance of the species or habitat to local communities or other important stakeholders. Table 2 is an example of a theoretical set of consequence descriptors for intrinsic risk.

¹⁴ See IUCN (2001).

¹⁵ See IFC 2012b).

Table 2: Example definitions of intrinsic risk impact consequence based on regulatory and lender standards

CONSEQUENCE	DESCRIPTION
Minor	Incidental and localised impacts to natural habitat
Moderate	Small-scale conversion of natural habitat
Serious	Large-scale conversion of natural habitat or small-scale conversion of 'critical' habitat (e.g. known to be occupied by species with 'EN' conservation status)
Extreme	Large-scale loss of 'critical' habitat (e.g. known to be occupied by species with 'EN' conservation status)
Catastrophic	Large-scale loss of 'critical' habitat (e.g. known to be occupied by species with 'CR' conservation status)

The technical approach for assessing the consequences of impacts may range from qualitative expert opinion to analysis of quantitative data. The level of rigour should reflect the potential severity of the impact. There are many locations where information to support this assessment is lacking. For example, where little is known about a given biodiversity value, such as its distribution and vulnerability to cumulative effects, it is very difficult to determine the incremental effects of an individual project. In such cases, it is advisable to apply the precautionary principle to ensure that impacts are not underestimated simply because of lack of knowledge. Uncertainty should be documented, and the method and rationale used to develop a consequence rating should be explained in the ESIA.

4.3 Setting biodiversity objectives

As with land- and water-use objectives, biodiversity objectives should be developed in consultation with all stakeholders and linked to specific, measurable targets and standards. They should be part of the completion criteria developed for the mine closure plan. Leading practice requires that biodiversity objectives be driven in part by the physical and biological components within the landscape (recognising that mining may modify the physical components underpinning any rehabilitation). They should also be driven by the social and economic factors that are operating in the socioeconomic environment.

Further, there may be a need to divide the project area into distinct sub-areas, each with specific structural, physical, ecological and social parameters that must be considered in sustainable mine closure planning. Sub-areas may differ in their final land-use, water-use or biodiversity objectives and closure measures.

The biodiversity objectives depend on the identified biodiversity aspects and the requirements and opportunities to mitigate impacts. They can focus on a specific local issue, such as a plant or animal species, or they can be aimed more generally at the ecosystem level. In either case, the objectives should be realistic and achievable and be set in conjunction with the biodiversity values identified by the company and stakeholders. All participants should seek opportunities to reduce negative impacts and increase positive impacts on biodiversity.

Examples of goals and objectives include:

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

Actions to achieve the nominated objectives should be developed and then documented in the project's environmental management system. The mine should set specific, realistic targets that clearly describe what is to be achieved and by when, and that are linked into the overall rehabilitation and mine closure strategy. Each target should take into account the availability of resources, any technical limitations, the expertise of personnel and contractors, the views of landowners and the community, and long-term land management requirements.

5.0 MANAGING BIODIVERSITY ISSUES THROUGH THE MITIGATION HIERARCHY

Key messages

- The mitigation hierarchy is a key conceptual planning framework.
- Avoidance offers the best biodiversity outcomes and is often cost-efficient.
- Minimisation of impacts is also effective and efficient.
- Rehabilitation offers less certain outcomes and costs.

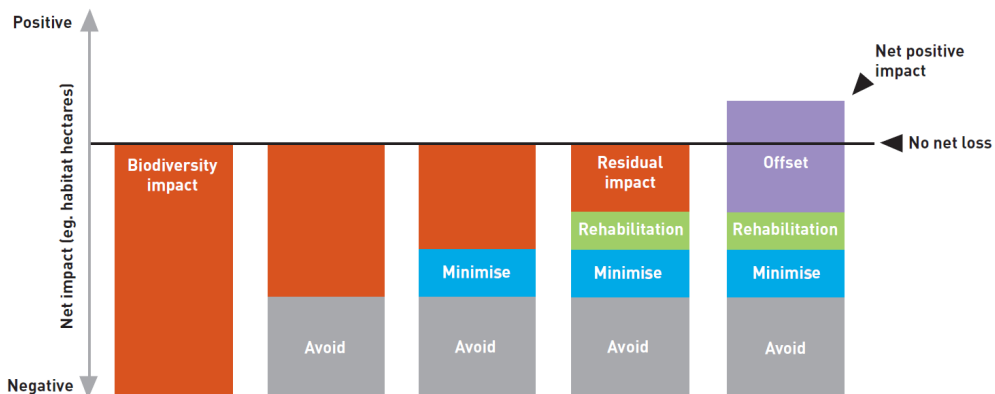
5.1 The mitigation hierarchy

The mitigation hierarchy can be used to help meet regulatory conditions, internal company standards and targets, such as no net loss or a net positive impact. It is a key conceptual framework for environmental impact assessment, in which it has been in widespread use for several decades. Most importantly, it is a planning tool to minimise offset costs, which are increasingly high.

The four components of the mitigation hierarchy—*avoid*, *minimise*, *rehabilitate* and *offset*—are sequential. However, the hierarchy is not a one-way linear process but usually involves iteration (the repeated application of its steps).

As a framework, the mitigation hierarchy is useful in many ways, including as a simple central planning reference and a platform for engaging stakeholders. Figure 5 shows schematically how the components of the hierarchy can be applied to reduce and compensate for impacts.

Figure 5: The mitigation hierarchy—avoidance, minimisation, rehabilitation and offsetting



The first two components, *avoid* and *minimise*, prevent impacts from happening. The second two, *rehabilitate* and *offset*, remedy impacts that have already happened. When preventive measures are feasible, they are usually preferable to remediative measures for ecological, social and financial reasons. Where performance standards set by legislation (for example, the EPBC Act), regulators or lenders (for example, the Equator Principles for financial institutions) require the remediation of impacts, they generally also require that avoidance and minimisation be undertaken first, so far as is feasible.

However, the costs and benefits involved at each stage need to be assessed. For example, avoidance by relocating infrastructure might often not be economically viable. Similarly, rehabilitation that restores important biodiversity values may be very slow or expensive, meaning that the emphasis for remediating remaining impacts is better placed on offsets.

As a general rule, however, there are fewer options and higher risks further along the mitigation hierarchy. When avoidance is feasible, it tends to have fixed, known costs and a higher probability of success than later components. Once the project's location and design are fixed, mitigation options diminish and there are fewer chances to correct mistakes, an increasing risk of time lag between loss and compensation, and decreasing trust among stakeholders in the likelihood of success.

While avoidance and minimisation can often be applied throughout the project cycle, they are most useful early on. Avoidance, in particular, should be considered at the earliest possible pre-planning stage, before decisions have been taken on infrastructure location and layout. Options for rehabilitation and offsets generally occur later and throughout operations.

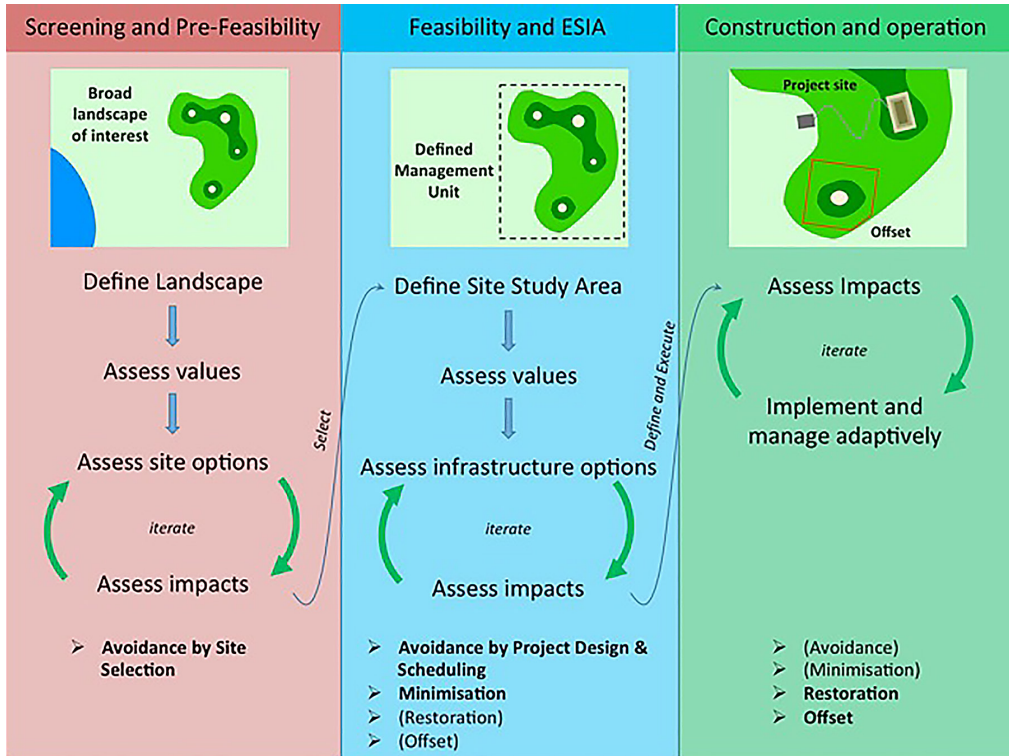
Figure 6 highlights the components of the mitigation hierarchy most likely to operate during each stage of the project life cycle. Common elements of work at each stage include defining study areas, assessing biodiversity values and impacts, and choosing and implementing mitigation options. Iterative decision-making is important throughout to assess and re-assess options and impacts and to improve the effectiveness of mitigation.

Before ESIA, during screening and pre-feasibility/feasibility assessment, the mitigation hierarchy provides a framework to assess the magnitude of biodiversity risks.

Questions to ask include:

- Is there a risk of unacceptable or non-offsettable impacts?
- Are less-damaging alternatives available and feasible?
- What can realistically be achieved through rehabilitation?
- Could targets such as 'no net loss' be achieved in principle?

Figure 6: Applying the mitigation hierarchy at different stages of the project time line



Note: The selection of project sites through landscape-level screening occurs in the pre-feasibility phase. Once a site has been chosen, further avoidance and minimisation may be possible within the project site. During construction and operation, implementation requires adaptive management. Iterative processes (shown by the green arrows) are important throughout.

Source: adapted from CSBI (2015).

During ESIA, the mitigation hierarchy has a well-established role as the main organising framework for biodiversity, guiding planning and communication. Around halfway through the ESIA process, it can be used to check whether the impacts predicted to remain after avoidance and minimisation can potentially be remediated (with rehabilitation and offsets) to a sufficient extent. If addressing impacts through rehabilitation, offsets, or both is not feasible because of unacceptably high costs or risks, another iteration of avoidance and minimisation approaches is required.

After ESIA, during construction and operations, the mitigation hierarchy functions as an adaptive management framework and (where relevant) as a 'no net loss tool' in offset design.

Decision-making within the mitigation hierarchy is an iterative process that involves the following key steps:

1. Apply avoidance and minimisation to potential biodiversity impacts according to the significance of the biodiversity value affected, the level of risk and the cost-effectiveness of measures to avoid or minimise the risk.
2. Broadly define and scale the potential remaining impacts to be addressed by rehabilitation and, if necessary, offsetting.
3. Assess the feasibility of addressing this type and magnitude of impact through rehabilitation or offsets.
4. If risks, costs, or both are too high, return to avoidance and minimisation and repeat the evaluation process.
5. Throughout the process, communicate the options to planners, engineers and decision-makers.

5.2 Avoidance

Avoidance can be defined as ‘measures taken to anticipate and prevent adverse impacts on biodiversity before actions or decisions are taken that could lead to such impacts’.¹⁶ Typically, avoidance involves changes in early project planning to ‘design out’ impacts or risks.

Avoidance has many advantages in terms of effectiveness, certainty, immediacy and clarity of communication to stakeholders. Avoidance costs are usually ‘one-off’ and can be built into the project design. However, to be most effective avoidance requires early planning and action, at a stage when information about risks, alternatives and financial factors may be incomplete. For mining, in particular, some types of avoidance (such as relocating the project) may also simply not be feasible.

Companies use three broad approaches to avoidance—site selection, project design and scheduling—although many approaches include all of them.

5.2.1 Avoidance through site selection

Avoidance through site selection involves locating large-scale aspects of the mining project so as to avoid areas of high-biodiversity value. An example could be siting infrastructure away from threatened vegetation communities.

This type of avoidance may often not be feasible in the mining sector, in which pit locations are determined by resource bodies. However, project sites supporting highly localised or restricted-range endemic species or habitat (see case study) or very large project sites may decide to forgo some resource to avoid areas identified as most important for biodiversity. This may also be important to ensure that remnants of habitat and species remain to speed up rehabilitation.

¹⁶ See CSBI (2015).

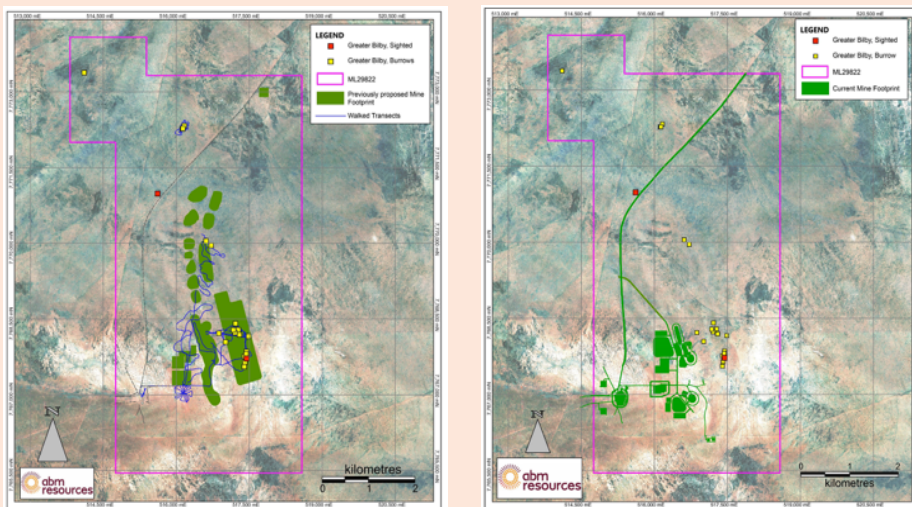
Case study: Avoidance of bilby habitat through site selection

Mining companies can reduce their impacts and risks to biodiversity and usually save money by designing avoidance actions, as shown in this example from 2013 at the Twin Bonanza gold deposit, Northern Territory.

When ABM Resources discovered populations of the greater bilby (*Macrotis lagotis*), a 'matter of national environmental significance', close to the Twin Bonanza gold deposit, they ran intensive on-ground surveys to map areas of bilby activity. ABM created a site-specific model of preferred bilby habitat based on geology, geomorphology and fire history. The model was based on mapped bilby burrows and activity and tested against newly discovered burrows.

ABM avoided impacts to the animal's habitat in several ways. Infrastructure such as waste rock dumps was repositioned away from preferred habitat. Infrastructure was also repositioned to create a more compact site layout and to reduce fragmentation of the habitat by roads and haul ways. The footprint was reduced by a further 36 ha by processing ore at a pre-existing processing plant 70 km away instead of constructing a new processing plant at the site. These avoidance actions reduced the direct footprint by 45%, from 260 ha to about 140 ha, and significantly reduced the project's capital costs.

This package of avoidance actions greatly reduced the project's impacts and risks to the bilby and contributed to its approval under the EPBC Act.

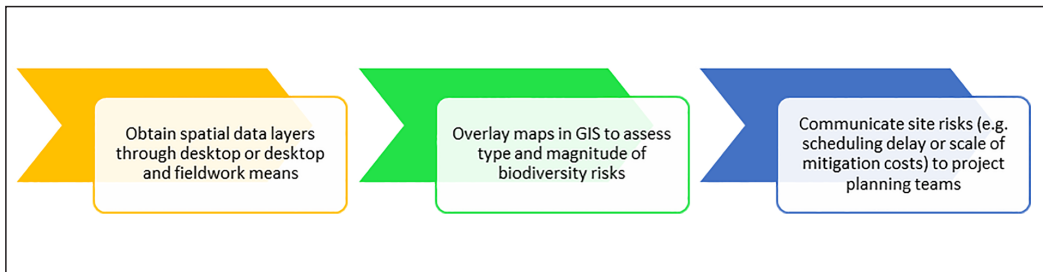


Left: Proposed pre-avoidance mine infrastructure; Right: agreed post-avoidance mine infrastructure.

Source: <http://www.ntepa.nt.gov.au/environmental-assessments/assessment/register/twin-bonanza-gold-mine>.

Avoidance through site selection requires biodiversity risk screening very early during planning (when entering a new geographical area, during exploration, or before choosing the sites for main and ancillary infrastructure), followed by an analysis of alternative project locations. Spatial biodiversity information is needed at the landscape level (that is, at a scale that shows potential project locations in their wider geographical context). Key steps are shown in Figure 7.

Figure 7: Key steps in avoidance through site selection



5.2.2 Avoidance through project design

Avoidance through project design involves selecting the type and placing of infrastructure and its mode of operation on or around the project site. Even where the main project location is fixed, it may be possible to route roads, transmission lines and pipelines and position ancillary infrastructure to avoid high-value biodiversity.

Careful fine-scale placement of infrastructure within a site and careful choice of construction and operational methods provide opportunities to avoid impacts, including potential 'downstream' effects outside the project site. Avoidance through project design can include:

- aligning new linear infrastructure along existing road, rail or transmission lines
- burying transmission lines or pipelines to avoid bird collisions and hampering animal movements
- conserving patches or corridors of valuable habitat as undisturbed set-asides
- locating linear infrastructure in already disturbed habitats to avoid direct damage
- micro-routing linear infrastructure around important habitat features, or running it through already degraded rather than pristine habitat
- minimising the size of camps and facilities and re-using facilities for later project phases
- minimising the width of access corridors during construction and operations
- modifying drainage systems (for example, routing sediment-laden stormwater run-off and other effluents away from high-biodiversity aquatic habitats)
- reducing the overall footprint by clustering project facilities
- relocating fixed infrastructure and facilities
- using aerial conveyor belts to move material
- using air coolers instead of water coolers to avoid thermal discharge to aquatic systems.

Avoidance through project design is most effectively applied once a project site has been selected, but before major design decisions have been made. It should be considered during conceptual design, feasibility study and front-end engineering design. The project environmental team thus needs to communicate early with project planners, engineers and construction teams (including external contractors).

This form of avoidance is usually a major component of an environmental impact assessment. The pre-assessment risk screening results can inform field data collection and stakeholder engagement. Spatial data in a GIS application is very helpful in assessing potential impacts and options.

Avoidance through project design is standard practice in Australia, but it usually occurs before publicly available project documents are written. For example, the Queensland Coordinator-General's approval of the Adani Carmichael mine included changing an open-cut pit to an underground mine to avoid 1,500 ha of clearance and relocating topsoil storage locations to avoid 400 ha of high-value habitat for the black-throated finch.

5.2.3 Avoidance through scheduling

By understanding and taking into account seasonal and diurnal patterns of species behaviour (such as breeding, migration, roosting) and ecosystem functioning (for example, river flow, tree fruiting patterns, vegetation growth cycle/pattern), it may be possible to alter the timing of construction and operational activities to avoid impacts.

Avoidance through scheduling is usually concurrent with avoidance through project design and continues into the operational life of the project. Good ecological information on diurnal and seasonal patterns of behaviour and ecosystem function in the project landscape should feed into close collaboration between project planners, engineers and ecologists.

Examples of avoidance through scheduling include:

- confining construction activities to outside animal breeding or migration seasons
- scheduling daily or nightly no-traffic 'windows' on road or rail transport to allow wildlife to cross
- sequencing project construction or resource extraction across a landscape so as to ensure connectivity between habitat patches at all times.

5.2.4 Key considerations in avoidance

Baseline studies, planning at the landscape scale and early stakeholder engagement are important considerations for avoidance. They are covered in Section 3 of this handbook.

5.2.5 Cost-benefit analysis

The cost of potential avoidance actions can sometimes be large after forgone opportunities, additional infrastructure requirements or delays through timetable changes are added up. However, the risks and costs of not avoiding biodiversity impacts could be even greater, especially for species and vegetation communities for which offsets are very expensive. This may need to be assessed through a rigorous cost-effectiveness analysis (Cellini & Kee 2010) or cost-benefit analysis.

5.3 Minimisation

Minimisation involves ‘measures taken to reduce the duration, intensity, significance and/or extent of impacts (including direct, indirect and cumulative impacts, as appropriate) that cannot be completely avoided, as far as is practically feasible’ (CSBI 2015).

Minimisation is a core part of environmental impact management. It is usually most effective if incorporated from the earliest stages of project design. The construction phase tends to be the key one for minimisation, but the planning and implementation of minimisation measures can occur adaptively throughout the project life cycle in response to performance monitoring.

To implement minimisation:

1. *Predict impacts remaining after avoidance.* Which impacts could significantly affect priority biodiversity features but are not technically possible or cost-effective to avoid?
2. *Design minimisation measures to reduce impacts.* Engage appropriate specialists to work closely with engineers, planners and finance and permitting managers.
3. *Explore additional minimisation opportunities throughout the project life cycle, including opportunities for innovation.* Adaptive management can be used to monitor impacts and assess opportunities for further minimisation measures during construction and throughout operations. Minimisation lends itself to innovative approaches, but it is best to monitor the measures closely to check whether they are effective and not too costly.

There are three broad (and sometimes overlapping) approaches to minimisation:

- *physical controls:* adapting the physical design of project infrastructure
- *operational controls:* managing and regulating project activities
- *abatement controls:* reducing levels of pollutants.

Examples of measures in each category are given below, but the list is not intended to be comprehensive. Many potential minimisation measures are already well established and familiar as good environmental practice, such as controls to reduce noise, dust and erosion, but additional measures may be needed to reduce risks for specific sensitive biodiversity features.

Physical controls include:

- designing exploration activities to minimise vegetation clearance and fragmentation of habitat and to maximise the potential for regrowth
- designing infrastructure to minimise habitat fragmentation and loss of connectivity, such as by maintaining corridors of natural vegetation (for example, along drainage lines) and constructing safe crossing places for animals along transport lines
- designing operations or facilities to reduce the number of access points or opportunities for off-road tracking
- fencing areas to limit incidental damage to existing biodiversity (but taking care not to introduce new impacts by restricting animal movements)
- protecting watercourses from sources of contamination and siltation
- shading and/or carefully directing light sources to reduce behavioural disruption or mortality among nocturnal animals.

Operational controls include:

- managing access to project sites and environmentally sensitive areas
- implementing hygiene and biosecurity measures to prevent the introduction of non-native or invasive species
- managing the pattern and timing of vegetation clearance (for example, to reduce fragmentation and promote regeneration)
- implementing procedures during vegetation clearance to safeguard or retain plant species and materials used by local communities (seeds, rootstock, medicines)
- keeping traffic to the minimum necessary for operations and imposing and enforcing speed limits
- restricting disturbance at rehabilitation sites to avoid disrupting natural revegetation and colonisation
- sensitising the workforce to environmental performance expectations and requirements, including those related to biodiversity
- after careful risk assessment, relocating individual animals and plants representing particularly sensitive biodiversity values.

Abatement controls include:

- implementing drainage and water treatment systems that control pollutant discharge (for example, constructing wetlands, which may also contribute positively to biodiversity)
- managing solid waste to avoid attracting feral scavengers, such as foxes and cats
- eradicating or controlling weeds at disturbed project sites
- using designs or technologies that reduce or limit pollution, such as low-intensity lighting, noise silencers and dust-control devices.

Case study: Minimising impacts and risks of phytophthora dieback

Mining companies can often use cost-effective minimisation actions to mitigate risks to biodiversity, as shown in this example in Western Australia.

Dieback, caused by the fungal pathogen *Phytophthora cinnamomi*, has been present in the jarrah forest around Alcoa's Western Australian bauxite mines for more than 80 years and is thought to affect over 2,000 native plant species in that state.

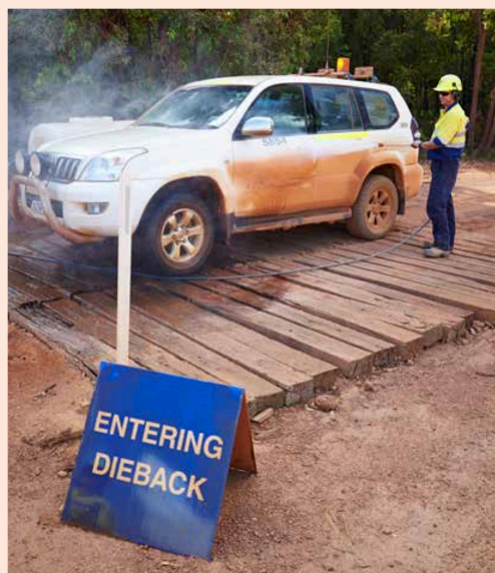
Dieback is spread via soil and water movement. Natural spread is about 1 metre per year upslope but significantly more downslope due to surface and groundwater movement. Dieback can also be spread by moving infected soil and plant material.

Alcoa's 2014–2016 Environmental Improvement Plan includes the objective 'Minimise spread of phytophthora dieback attributable to mining operations'. The two key actions to support this objective are to:

- develop eradication procedures for dieback found in haul roads and stockpiles
- investigate options to improve dieback hygiene procedures and implement them where practical.

Alcoa's dieback management procedures to minimise dieback spread include:

- mapping the presence of dieback throughout the mining envelope
- minimising the movement of dieback soils
- keeping dieback-infested and dieback-free soils separate during all stages of mining and rehabilitation
- designing mine pits and haul roads to prevent water flowing into dieback-free forest
- restricting vehicle movements between infested and uninfested areas
- cleaning vehicles and machinery before movement from a dieback area into a dieback-free area
- scheduling high-risk operations during low-risk periods of the year
- training all field staff and planners in these measures
- monitoring and auditing the spread of dieback from the mining areas to ensure that procedures are effective
- investing in research to understand dieback better and to identify practical management measures (for example, by supporting the Centre for Phytophthora Science and Management).



Monitoring has shown that the level of spread is very low—about 6 m² of spread for every 10,000 m² mined. Monitoring also helps to identify the causes of spread, which are then addressed to reduce the risk of it happening again.

Alcoa's commitment to its Environmental Improvement Plan is voluntary: it both complements and exceeds the requirements of the company's environmental regulation obligations.

Source: Alcoa, *Environmental Improvement Plan 2014-2016*, https://www.alcoa.com/australia/en/pdf/Dieback_Management_Fact_Sheet.pdf.

5.4 Rehabilitation

In the context of the mitigation hierarchy, rehabilitation (often called 'restoration') can be defined as 'measures taken to assist the recovery of specific functions or biodiversity features in degraded or damaged ecosystems following project impacts'. This does not imply that the goal is to return the site to exactly its pre-project state before damage occurred, which in many cases would not be feasible or cost-effective. However, rehabilitation may aim for the long-term re-establishment of priority aspects of ecosystem structure, function or species composition.

The *Mine rehabilitation* leading practice handbook (DIIS 2016) describes in detail material handling procedures, earthworks, topsoil management, vegetation and fauna establishment techniques, and post-establishment maintenance. It should be consulted for practical details of leading practice rehabilitation, including for biodiversity. To avoid duplication, this section does not cover those details.

As a general rule, rehabilitation is more challenging and uncertain, and likely to be more expensive, than avoiding and minimising particular impacts (where that is feasible). Therefore, rehabilitation should be planned to remediate only the impacts remaining after avoidance and minimisation measures have been iteratively applied.

How far rehabilitation can contribute to addressing residual project impacts varies greatly from case to case, depending on ecological and technical feasibility, cost, stakeholder concerns and timescales. Because rehabilitation is typically slow, there can be long time lags between impacts taking place and ecological outcomes accumulating. This can cause a temporal loss, in which a species or habitat becomes locally extinct before suitable habitat is rehabilitated; in such cases, rehabilitation should not be relied upon too heavily.

5.4.1 Key considerations in rehabilitation

Rehabilitation is most likely to be successful if it is planned and trialled early in the project cycle, is implemented as early as possible after impacts, and uses well-established techniques. Careful monitoring can help to optimise its effectiveness during implementation.

5.4.2 Developing a good baseline

As for other components of the mitigation hierarchy, a good biodiversity baseline (Section 3.1) is important for rehabilitation, providing the reference against which a rehabilitation plan can be developed. The project's baseline biodiversity study should include information on species composition, population densities, vegetation structure and ecological functions for the project site and disturbed and undisturbed reference sites, particularly if disturbed reference sites illustrate different stages of recovery from impacts.

5.4.3 Planning early

The mitigation hierarchy is applied iteratively. Thus, understanding how far rehabilitation can realistically address remaining impacts is important at the start of the planning process. Rehabilitation should not be an afterthought once project construction has begun.

It is good practice to begin rehabilitation trials as soon as possible. If rehabilitation is being heavily counted on to address impacts, there should be high certainty of success—either from similar rehabilitation exercises carried out elsewhere or from trials carried out as part of the project. The EPBC Act offset guidance requires project proponents to estimate the confidence of success for rehabilitation, and requires that estimate to be justified by the results of onsite trials and offsite actions in similar abiotic environments and habitats, using similar rehabilitation techniques.

Early planning is also important to ensure that appropriate measures are taken during construction to enable rehabilitation later. This might include topographic and hydrological surveys of the site; documentation of associated vegetation; the collection and storage of topsoil; and the collection of germplasm (seeds, cuttings, seedlings) if another local source is unavailable.¹⁷

5.4.4 Setting realistic goals

Rehabilitation plans need to consider, and if necessary find a compromise among, what is ecologically possible at the site, what stakeholders and regulators expect, and what is viable in terms of costs and timescale. An assessment of the site's rehabilitation potential is needed. This may be severely limited where major impacts have occurred (for example, at an open-pit mine).

Where rehabilitation is an option, the costs and benefits should be compared with the potential for addressing remaining impacts on biodiversity through offsetting. In some cases, for some or all biodiversity features, site rehabilitation might not be good value for the biodiversity outcomes likely to be achieved. In such cases, rehabilitation might have different objectives, such as the creation of grazing land or public amenity land.

5.4.5 Building on experience

Rehabilitation is much more straightforward in some habitats than in others. For a number of habitats, there is now considerable expertise in rehabilitation techniques, from saving and storing topsoil and seedbanks during construction to collecting and germinating wild seed (DIIS 2016). Techniques that work well in one place will not necessarily do so elsewhere, but should be a starting point for practical implementation and, if necessary, experimentation.

In some environments, passive rehabilitation (allowing natural regeneration to take place) may achieve the desired outcome in an acceptable timeframe. More commonly, active intervention will be needed, at least initially, to set the site on a trajectory towards natural regeneration. This could involve the physical or chemical modification of substrates, hydrological engineering or biological management via enrichment planting, reseedling, reintroduction of species or the control of predators or invasive species.

¹⁷ It might also require a phenological study to ensure that seed can be collected at the appropriate time.

5.4.6 Monitoring, research and adaptive management

A good ecological understanding of how the ecosystem functions and responds to environmental conditions and chance is very useful in managing rehabilitation. It may be possible to build a conceptual model for this by building on baseline information with ongoing targeted research and monitoring. Interim targets should be set for monitoring, along with performance thresholds that trigger adaptive management decisions. Control information from a reference site (in addition to the before and after impact baselines) is important for interpreting the success of interventions.

If possible, rehabilitation should be implemented progressively as impacts occur. As well as reducing time lags between impact and remediation, this allows for research and learning so that methods can be refined and improved for later application.

5.5 Biodiversity offsets

Ideally, applying comprehensive and well-targeted avoidance, minimisation and rehabilitation measures would completely address a project's risks and impacts related to biodiversity. However, significant residual adverse impacts often remain. They can potentially be addressed through biodiversity offsets.

Offsets are 'measurable conservation outcomes, resulting from actions applied to areas not impacted by the project, that compensate for significant, adverse impacts of a project that cannot be avoided, minimised and/or rehabilitated'.¹⁸ Offsets frequently aim to achieve overall maintenance or enhancement of a biodiversity value's viability (the EPBC Act target), 'no net loss' or 'net gain'—in other words, complete compensation for significant residual impacts of the project—but other aims are possible. Actions likely to result in a significant net loss are better termed 'compensation' actions, rather than offsets.

Offsets typically involve changes to land or water management in an area holding the biodiversity features of concern that are affected by the project.

The EPBC Act and state and territory laws (in all jurisdictions except the Northern Territory) require the implementation of offsets where significant residual project impacts on environmental features of concern are expected. The EPBC Act environmental offsets policy and offsets assessment guide explain how to identify suitable offsets for matters protected under national environment law.¹⁹

¹⁸ From CSBI (2015). There are numerous similar definitions.

¹⁹ Protected matters under the EPBC Act are World Heritage properties; national heritage places; wetlands of international importance (listed under the Ramsar Convention); listed threatened species and ecological communities; migratory species protected under international agreements; Commonwealth marine areas; the Great Barrier Reef Marine Park; a water resource, in relation to coal seam gas development and large coalmining development; the environment, where nuclear actions are involved; the environment, where actions proposed are on or will affect Commonwealth land and the environment; the environment, where Australian Government agencies are proposing to take an action.

Many lenders also require offsets in such circumstances. For example, the financial institutions that have signed the Equator Principles, which include major Australian banks, have adopted the International Finance Corporation's Performance Standard 6 (IFC 2012a). PS6 requires 'no net loss' for impacts to natural habitat and 'net gain' for impacts to critical habitat (identified on the basis of highly threatened and/or irreplaceable species and habitats).²⁰

An increasing number of businesses have also committed to voluntary 'no net loss' or 'net positive impact' goals for biodiversity.

To be effective and acceptable to stakeholders and regulators, offset design should follow a set of basic principles:

1. *Apply the mitigation hierarchy.* Offsets should compensate only for impacts that cannot feasibly be prevented or remedied through avoidance, minimisation or rehabilitation. Systematic and, where appropriate, iterative application of the mitigation hierarchy is required.
2. *Recognise limits.* Not all impacts can be offset, and some impacts may be unacceptable to regulators or stakeholders.
3. *Ensure equivalence.* Biodiversity gains from an offset should offer a fair exchange for what is lost. Usually, a direct and clear correspondence between biodiversity features is expected. An exception is 'trading up', in which (with regulator and stakeholder agreement) the offset focuses on biodiversity features considered to be higher priorities than those being offset.
4. *Ensure clear and additional outcomes.* An offset should deliver specified and (where possible) quantitatively assessed outcomes for biodiversity, additional to those that would have resulted anyway.
5. *Engage stakeholders.* Experience shows the importance of engaging appropriate stakeholders from an early stage and involving them in the planning, design and implementation of the offset. This is especially important in environments where there is a risk of community and political opposition to proposed offsets.
6. *Ensure permanence.* Financial and governance measures that will ensure that the offset lasts at least as long as the project's impacts are needed.

²⁰ IFC (2012a) defines 'critical habitats' as areas with high biodiversity value, including habitat of significant importance to critically endangered and/or endangered species; habitat of significant importance to endemic and/or restricted-range species; habitat supporting globally significant concentrations of migratory species and/or congregatory species; highly threatened and/or unique ecosystems; and/or areas associated with key evolutionary processes. 'Natural habitats' are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition. The World Bank's draft Environmental and Social Safeguard 6 and equivalent standards of other multilateral finance institutions adopt similar definitions.

5.5.1 Types of biodiversity offsets

Offsets take two basic forms:

- *Restoration offsets* are designed to remediate *past damage* to biodiversity (not damage caused by the project). This could involve the rehabilitation or enhancement of biodiversity features, or even the recreation of ecosystems and their associated biodiversity values, at suitable offset sites. Note that rehabilitation within an offset should be distinguished from the rehabilitation step of the mitigation hierarchy, which is aimed at direct or indirect project impacts (covered in Section 5.4).
- *Protection or averted loss offsets* are designed to prevent *future damage* to biodiversity in an area that is under threat of imminent or projected loss because of factors unrelated to the project.

The two kinds of offsets can be combined. For example, an offset could aim to remove invasive mammals (*restoration*) while also protecting a site against predicted future habitat degradation (*averted loss*).

In either case, offsets must demonstrate additional gains through the intervention, over and above what would have resulted otherwise. Thus, simply purchasing an area of land is in itself not adequate to count as an offset: there is a need to show how improved management is creating benefits for conservation (and specifically for the biodiversity features of concern) that otherwise would not have resulted. Moreover, 'protection' or 'averted loss' offsets are valid only if there is an agreed and quantified future threat to biodiversity, whereas much Australian biodiversity is protected against any such threat.

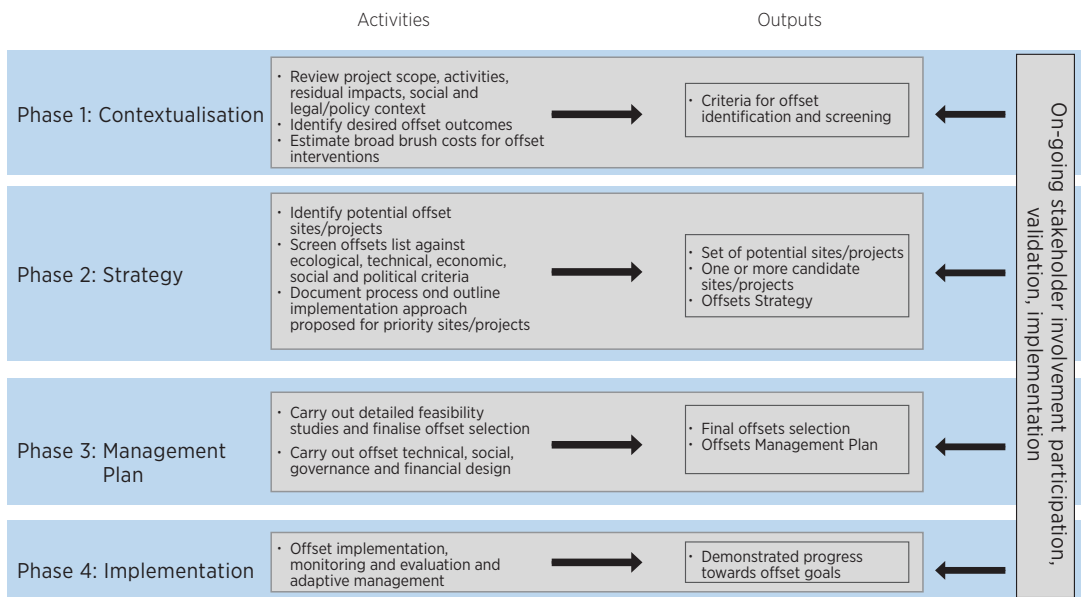
5.5.2 Implementing offsets

The implementation of offsets requires the following steps:

1. Identify the biodiversity features of concern, apply the mitigation hierarchy and assess residual impacts.
2. Identify candidate offset sites and scope them for feasibility, considering aspects of theoretical feasibility (is there sufficient area and is there potential for gains?), technical feasibility (are appropriate and reliable conservation interventions available?) and sociopolitical feasibility (Can stakeholders' expectations be met? Is the offset affordable? Are appropriate tenure and governance arrangements possible?).
3. Select preferred offset sites, implement conservation interventions, monitor and manage adaptively.

The engagement and involvement of relevant stakeholders are important throughout. Key steps and outputs constituting leading practice are summarised in Figure 8.

Figure 8: Key steps and outputs in offsets implementation



Source: adapted from CSBI (2015).

5.5.3 Loss/gain accounting

Setting targets for ‘maintained/enhanced viability’, ‘no net loss’ or ‘net gain’, monitoring progress towards the targets and demonstrating that they have been achieved cannot be done without quantification, usually using loss/gain accounting. Loss/gain estimates are also important when investigating the theoretical and technical feasibility of offsets.

Biodiversity is complex and intrinsically challenging to measure, so it is helpful to focus on the selected features of concern (rather than trying to measure everything) and to use standard, simplifying metrics.²¹ Some state offset frameworks have developed standard metrics that can be applied, while a comprehensive offsets assessment guide²² acts as a balance-sheet calculator for the EPBC Act environmental offsets policy. Good baseline information is needed both for planning and for demonstrating long-term gains (Section 3.1). Note that impacts should be considered at the landscape scale and include both direct and indirect effects.

For ‘averted loss’ offsets, loss/gain calculations rely heavily on estimates of the counterfactual situation; that is, the situation without the offset intervention (for example, predicted ongoing loss of a specific habitat type in the region). The results can depend heavily on what the assumptions have been. Counterfactual estimates should therefore be cautious and based on a clear rationale that is convincing to regulators and other stakeholders.

Predictions for offset gains have some degree (sometimes a substantial degree) of intrinsic uncertainty. There may also be time lags between impacts taking place and offsets producing compensatory gains. In loss/gain calculations, these elements are usually dealt with by applying a discount to gains—meaning, for example, that a larger offset might be needed to ensure ‘no net loss’.

Companies should seek expert advice when making loss/gain calculations for offsetting.

5.5.4 ‘Off-the-shelf’ versus ‘do-it-yourself’ offsets

New South Wales and Victoria offer biodiversity banking mechanisms, allowing project proponents to purchase ready-made and certified offset credits to compensate for the project’s residual impacts. There are a number of advantages to that approach, including simplified governance arrangements and accountability (for the proponents) and reduced (or no) time lags between impacts and offset delivery.

Especially for large projects, however, there may be problems with the availability, geographical location and expense of ready-made offset credits. At times, it may be preferable for a proponent to develop their own ‘do-it-yourself’ offsets rather than use the offsets market. This may make it easier to consolidate an offset into a single land management unit, to target interventions and to communicate the offset and its positive achievements to stakeholders. Where a proponent develops their own offsets, it is often less risky and more cost-effective to contract the ongoing management of the offset to a specialised third party, such as an NGO.

²¹ Examples are ‘quality hectares’ for habitats (a measure of area, weighted by an assessment of quality based on specific ecological features) and numbers of individuals for species.

²² See DoE (n.d. b).

5.5.5 Monitoring

Monitoring an offset's performance is important for managing the schedule and budget for interventions, to evaluate progress towards targets and to adapt approaches that are not producing results. It can also help guard against scope-shift, which is a hazard for offsets because of their long-term aims and often diverse stakeholders. Monitoring can be costly and is best targeted carefully at the key aspects that require tracking. The detailed offsets management plan (see Figure 8) should include a plan for monitoring. Often, monitoring can be a good practical route for engaging stakeholders and building partnerships with researchers and conservation NGOs.

5.6 Additional conservation actions

An optional final step in the mitigation hierarchy is *additional conservation actions*. Such actions are sometimes considered to be 'indirect offsets', as they contribute to conserving the affected biodiversity values but do not have quantifiable direct benefits. Some regulators allow indirect actions to count towards offset requirements, but the EPBC Act explicitly excludes indirect offsets unless direct benefits can be quantified. The most common additional conservation actions are education and research. Education-based actions are perhaps better considered under the topics of stakeholder engagement and social licence to operate.

Research helps companies to better understand their management actions. This improves the efficiency and certainty of delivering biodiversity outcomes, which reduces risks and costs, as well as providing a better platform for developing and negotiating future mitigation programs.

Well-designed research projects are an integral component of all leading practice biodiversity management programs because each mine and the environment in which it operates is unique. Procedures used to minimise, rehabilitate and offset impacts on biodiversity often need some finetuning for each site to maximise their effectiveness. For more experimental or novel techniques (for example, reinstating a native vegetation type where that has never been attempted before, or implementing an offset for a particular threatened species for which the most effective management methods are not known), significant research may be needed to develop appropriate and effective management actions, informed by the results of ongoing monitoring and adaptive management.

The company should seek opportunities to integrate its research programs with those of government, academic research institutions and specialist scientists. For example, research into biodiversity management usually requires the involvement of technical experts from research institutions (such as universities, botanic gardens, museums or zoos), specialist consultancies and government agencies such as CSIRO and state research departments. In some cases, opportunities exist for the integration of mining industry research with research by other sectors that need to manage their biodiversity impacts, such as the forestry, agriculture and water sectors.

6.0 MONITORING AND REPORTING PERFORMANCE

Key messages

- Monitoring can be designed to achieve multiple purposes.
- Developing robust metrics of biodiversity is challenging but feasible.

Biodiversity monitoring is an essential component of leading practice biodiversity management for any mining operation. The methodologies and procedures for biodiversity monitoring differ considerably depending upon the reason for the monitoring and the management objectives that the monitoring is assessing, so a detailed discussion of monitoring methodologies is beyond the scope of this handbook. The Australian Government and most state governments have written guidance on survey monitoring methodologies for some terrestrial and aquatic vegetation and fauna, and further guidance is available in the scientific literature

When designing and implementing cost-effective biodiversity monitoring programs, a number of key drivers and factors should be kept in mind. Specifically, biodiversity monitoring programs should:

- meet all regulatory requirements and other commitments developed during the environmental impact assessment
- act as a quality-control checklist to confirm that environmental management actions are carried out according to agreed procedures
- provide the temporal and successional data needed to assess and manage impacts on biodiversity, and thereby achieve continuous improvement; this will include both monitoring data on environmental performance (how is it going?) and related research data comparing methods of biodiversity management (how can we improve it?)
- assess the effectiveness of mitigation actions on the affected biodiversity values and maximise the re-establishment of biodiversity values after mine closure and the rehabilitation or recovery of degraded areas
- identify the need for research into specific problems and provide relevant data
- facilitate transparency and a cooperative approach to biodiversity management by providing information to stakeholders and the public
- reveal to the company and key stakeholders whether biodiversity objectives and completion criteria and standards are being, or will be, met within an acceptable time frame as part of the mine closure
- jointly with key research projects, enable the company and stakeholders to assess the long-term sustainability of rehabilitated areas under the proposed post-mining management regime.

Monitoring programs to assess both impacts on biodiversity and the subsequent recovery of biodiversity values should be designed so that they will achieve these aims while taking into account the practicalities of monitoring, costs and safety.

6.1 Measuring biodiversity

Measuring losses and gains in biodiversity is not a straightforward task. Biodiversity can be measured at a number of different scales, from genes to ecosystems. Measurement is further complicated by the fact that different people place different values on biodiversity: some focus on existence values (for example, the inherent value of a rare habitat or threatened species), whereas others focus on service values (for example, a certain species of cultural importance). All stakeholder values merit consideration by a mining company engaged with various human groups from global to local scales. Differences in the nature and spatial scale of biodiversity and the values that humans place on it all contribute to the wide range of biodiversity metrics so far developed.

In contrast with the area of climate change, where tonnes of CO₂-equivalent is a common currency or metric for measuring greenhouse gas emissions in any part of the world, there is no single widely accepted metric for biodiversity (Salzman & Ruhl 2000).

6.2 Biodiversity metrics

Given the philosophical, technical and financial constraints in measuring all aspects of biodiversity, the mining operation should aim to measure losses and gains in a pragmatically selected subset of biodiversity features. Generally, measurements of biodiversity values involve habitat (vegetation community) measures, species measures, or both.

For habitat, area multiplied by condition (area x condition) metrics are commonly used and well accepted in Australia and internationally. Many biodiversity offsetting systems worldwide use a similar area x condition metric first developed in Victoria and now highly developed in New South Wales and Queensland. A wide range of biodiversity values, including threatened species, rare habitats and non-timber forest products, can be expressed in terms of their area and quality (against a 'pristine' benchmark condition).

Quality or condition can be measured in a variety of different ways, depending on the habitat in question. There is no accepted 'one size fits all' method for measuring habitat quality because it is so context dependent. Where available, established and accepted methods in federal or state guidance should be used. In practice, proponents often need to work collaboratively with regulators, experienced consultants and other stakeholders to derive a context-specific method.

Species measures are even more variable. Measures of absolute abundance and indices of abundance can be effective in the right circumstances (Gullison et al. 2015). Those two approaches use either direct or indirect measures of the species to infer abundance, which can then be compared to benchmark data and tracked over time to determine trends in abundance. Habitat area x species-specific quality might be a better proxy for numbers of low-density or cryptic species.

Direct measures of biodiversity values such as absolute abundance are referred to as 'outcome' measures or 'state' measures. Such indicators may be considered as 'lagging' because it may take considerable time for the negative or positive effects of a project to be detected in the status of the biodiversity value. These direct measures are best monitored alongside measures of the project's impact and measures of the project's mitigation actions. These three components, also referred to as a 'state-pressure-response' model, offer the best framework for monitoring outcomes and adaptively managing inputs.

CONCLUSION

In the past decade, the Australian mining industry has made significant improvements to its management of biodiversity. Society increasingly expects the industry, which is perceived to be profitable but dirty, to continue this improvement towards its objective of environmental sustainability. Many governments and companies have committed to the objective of no net loss (also phrased as net gain, net positive impact, or improve or maintain). This objective is commendably clear and aspirational, but government and industry have to accept the technical challenges and financial costs and deliver convincingly or risk losing public support.

Tightening societal expectations are being followed by increasingly stringent legal compliance requirements, including baseline studies, impact assessments and mitigation and offset measures. The IFC's Performance Standard 6 has set a biodiversity standard for a large number of global financial institutions and is largely consistent with Australian aspirations, but ahead of current government requirements.

These legal and financial drivers are complemented by the need to manage reputational, competition and market risks, which can be encapsulated as the risk to the company's social licence to operate. Such 'non-technical' risks account for a significant proportion of delays to extractive industry projects, and social conflict over environmental resources is a major factor. They also indicate the direction of future regulatory requirements.

The industry has responded to these challenges by developing tools and guidance that are winning wide stakeholder acceptance. The mitigation hierarchy is a relatively new framework that offers a clear planning process to minimise residual impacts and offset costs, which are increasingly high. The effective use of the mitigation hierarchy requires early engagement, often at the pre-feasibility stage, when biodiversity assets and risks have not yet been reliably assessed. Avoidance of impacts offers the best outcome for biodiversity and is often the most cost-effective form of mitigation.

Government has responded to these challenges by tightening regulatory requirements, in particular by setting objective 'no net loss' objectives and requiring the use of offsets. Offsets are 'measurable conservation outcomes, resulting from actions applied to areas not impacted by the project, that compensate for significant, adverse impacts of a project that cannot be avoided, minimised and/or rehabilitated'. Offsets can be a win-win for industry and the environment, but most stakeholders underestimate the challenges in designing robust offsets. In practice, quantifying biodiversity, including projected trends in various project and offset scenarios, is a developing science that has yet to offer standard methods. Government, industry and academia need to develop better tools, to share examples and learnings, and to build society's trust and acceptance of offsets.

This handbook illustrates many examples of leading practice and new practice. Industry and government have made much technical progress but need to follow through and demonstrate real achievements on the ground to maintain the mining industry's social licence to operate.

REFERENCES

- CBD (Secretariat of the Convention on Biological Diversity) (2006). *Biodiversity in impact assessment*, background document to CBD Decision VIII/28: Voluntary guidelines on biodiversity-inclusive impact assessment, CBD, Netherlands Commission for Environmental Assessment, Montreal, Canada.
- Cellini, SR, Kee, JE (2010). 'Cost-effectiveness and cost-benefit analysis', in Wholey, JS, Hatry, HP, Newcomer, KE (eds), *Handbook of practical program evaluation* (Chapter 21, 493–531), Jossey-Bass (John Wiley & Sons).
- CSBI (Cross-Sector Biodiversity Initiative) (2015). *A cross-sector guide for implementing the mitigation hierarchy*, <http://www.csbi.org.uk/wp-content/uploads/2015/09/CSBI-Mitigation-Hierarchy-Guide-Sept-2015-1.pdf>.
- DEST (Department of the Environment, Sport and Territories) Biodiversity Unit (1993), *Biodiversity and its value*, Biodiversity series, paper no. 1, Biodiversity Unit, DEST.
- DIIS (Department of Industry, Innovation and Science) (2016). *Mine rehabilitation*, Leading Practice Sustainable Development Program for the Mining Industry, DIIS, Canberra.
- DoE (Department of the Environment) (2011). *State of the Environment 2011* (SoE 2011), DoE, Canberra, <http://www.environment.gov.au/science/soe/2011>.
- DoE (Department of the Environment) (no date a). *Strategic assessments*, DoE, Canberra, <http://www.environment.gov.au/protection/assessments/strategic>.
- DoE (Department of the Environment) (no date b). *How to use the offsets assessment guide*, DoE, Canberra, <http://www.environment.gov.au/system/files/resources/12630bb4-2c10-4c8e-815f-2d7862bf87e7/files/offsets-how-use.pdf>.
- Franks, DM, Davis, R, Bebbington, AJ, Ali, H, Kemp, D, Scurrah, M (2014). 'Conflict translates environmental and social risk into business costs', *Proceedings of the National Academy of Sciences of the United States of America*, 111(21):7,576–7,581.
- Gullison, RE, Hardner, J, Anstee, S, Meyer, M (2015). *Good practices for the collection of biodiversity baseline data*, prepared for the Multilateral Financing Institutions Biodiversity Working Group and Cross-Sector Biodiversity Initiative, ICMM, London, <https://www.icmm.com/document/9454>.
- Hardner, J, Gullison, RE, Anstee, S, Meyer, M (2015). *Good practices for biodiversity inclusive impact assessment and management planning*, prepared for the Multilateral Financing Institutions Biodiversity Working Group, <http://publications.iadb.org/handle/11319/7094>.
- ICMM (International Council on Mining and Metals) (2006). *Good practice guidance for mining and biodiversity*, ICMM, London, <http://www.icmm.com/page/1182/good-practice-guidance-for-mining-and-biodiversity>.
- IFC (International Finance Corporation) (2012a). *Performance standard 6: Biodiversity conservation and sustainable management of living natural resources*, IFC, Washington DC, http://www.ifc.org/wps/wcm/connect/bff0a28049a790d6b835faa8c6a8312a/PS6_English_2012.pdf?MOD=AJPERES.

IFC (International Finance Corporation) (2012b). *Performance standards on environmental and social sustainability*, IFC, Washington DC, http://www.ifc.org/wps/wcm/connect/115482804a0255db96fbffd1a5d13d27/PS_English_2012_Full-Document.pdf?MOD=AJPERES.

IUCN (2001). *IUCN Red List categories and criteria*, version 3.1, IUCN Red List, http://jr.iucnredlist.org/documents/redlist_cats_crit_en.pdf.

Mace, GM, Norris, K, Fitter, AH (2012). 'Biodiversity and ecosystem services: a multilayered relationship', *Trends in Ecology and Evolution*, 27:19–26.

MCA (Minerals Council of Australia) (2015), *Enduring value: the Australian minerals industry framework for development*, MCA, Canberra, http://www.minerals.org.au/leading_practice/enduring_value.

Salzman, J, Ruhl, JB (2000). 'Currencies and the commodification of environmental law', *Stanford Law Review*, 53:607–694.

FURTHER READING

Australian Government (2012). EPBC Act environmental offsets policy documents, <http://www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy>.

Business and Biodiversity Offsets Program (BBOP) (2012). *Standard on biodiversity offsets*, BBOP, Washington DC, http://www.forest-trends.org/documents/files/doc_3078.pdf.

— (2012). *Offset design handbook and appendices*, BBOP, Washington DC, http://www.forest-trends.org/documents/files/doc_3101.pdf and http://www.forest-trends.org/documents/files/doc_3127.pdf.

— (2009). *Biodiversity offset cost-benefit handbook*, BBOP, Washington DC, http://www.forest-trends.org/documents/files/doc_3094.pdf.

— (2009). *Biodiversity offset implementation handbook*, BBOP, Washington DC, <http://www.forest-trends.org/biodiversityoffsetprogram/guidelines/oih.pdf>.

Cross-Sector Biodiversity Initiative (CSBI) (2013). *Timeline tool: a tool for aligning timelines for project execution, biodiversity management and financing*, CSBI, http://csbi.ipecca.org/Uploads/CSBI_timeline_tool.pdf.

— (2013). Framework for guidance on operationalizing the biodiversity mitigation hierarchy, <http://www.csbi.org.uk/workstreams/mitigation-hierarchy/>.

— (2015). *The practice of the mitigation hierarchy: guidance from the Cross-Sector Biodiversity Initiative*, prepared by the Biodiversity Consultancy on behalf of IPECA, ICMM and the Equator Principles Association, Cambridge, UK, <http://csbi.org.uk>.

Equator Principles (2014). *Guidance for EPFIS on incorporating environmental and social considerations into loan documentation*, http://www.equator-principles.com/resources/ep_guidance_for_epfis_on_loan_documentation_march_2014.pdf.

European Commission (2015). *Europe Aid Cooperation Office cost-effectiveness analysis*, European Commission, http://ec.europa.eu/europeaid/evaluation/methodology/tools/too_cef_en.htm.

Gullison, RE, Hardner, J, Anstee, S, Meyer, M (2015). *Good practices for the collection of biodiversity baseline data*, prepared for the Multilateral Financing Institutions Biodiversity Working Group and Cross-Sector Biodiversity Initiative, ICMM, London, <https://www.icmm.com/document/9454>.

International Council on Mining and Metals (ICMM) (2006). *Good practice guidance for mining and biodiversity*, ICMM, London, <http://www.icmm.com/page/1182/good-practice-guidance-for-mining-and-biodiversity>.

— (2010). *Mining and biodiversity: a collection of case studies*, ICMM, London, <http://www.icmm.com/document/1246>.

International Finance Corporation (IFC) (2012). *Good practice handbook: cumulative impact assessment and management guidance for the private sector in emerging markets*, IFC, Washington DC, http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/learning+and+adapting/knowledge+products/publications/publications_handbook_cumulativeimpactassessment.

— (2012). *Performance Standard 6: Biodiversity conservation and sustainable management of living natural resources*, IFC, Washington DC, http://www.ifc.org/wps/wcm/connect/bff0a28049a790d6b835faa8c6a8312a/PS6_English_2012.pdf?MOD=AJPERES.

— (2012). *Guidance Note 6: Biodiversity conservation and sustainable management of living natural resources*, IFC, Washington DC, http://www.ifc.org/wps/wcm/connect/a359a380498007e9a1b7f3336b93d75f/Updated_GN6-2012.pdf?MOD=AJPERES.

International Council on Mining and Metals (ICMM) and International Union for Conservation of Nature (2012). *Independent report on biodiversity offsets*, ICMM, London, <http://www.icmm.com/document/4934>.

IPIECA and OGP (2011). *Ecosystem services guidance: biodiversity and ecosystem services guide*, OGP report no. 461, IPIECA and OGP, London, http://www.ipieca.org/sites/default/files/publications/ecosystem_services_guidance_8.pdf.

IUCN (International Union for Conservation of Nature) (2014). *Technical conditions for positive outcomes from biodiversity offsets*, IUCN, Gland, Switzerland, <https://portals.iucn.org/library/sites/library/files/documents/2014-027.pdf>.

Minerals Council of Australia (MCA) (2015), *Enduring value: the Australian minerals industry framework for development*, MCA, Canberra, http://www.minerals.org.au/leading_practice/enduring_value.

Organisation for Economic Co-operation and Development (OECD) (2003). *Using the pressure-state-response model to develop indicators of sustainability*, OECD, Paris, <https://www.ibama.gov.br/category/59?download=2919>.

Pilgrim, J, Ekstrom, J (2014). *Technical conditions for positive outcomes from biodiversity offsets: an input paper for the IUCN Technical Study Group on Biodiversity Offsets*, IUCN, Gland, Switzerland, <https://portals.iucn.org/library/sites/library/files/documents/2014-027.pdf>.

GLOSSARY

Technical terms and abbreviations are defined in the text. Alternative definitions and additional terms are defined in the following references:

- United Nations Environment Programme and World Conservation Monitoring Centre, *Biodiversity A-Z*, <http://www.biodiversitya-z.org/>
- Business and Biodiversity Offsets Program, I, http://www.forest-trends.org/documents/files/doc_3100.pdf
- Cross-Sector Biodiversity Initiative, *Good practices for the collection of biodiversity baseline data*, 2015, http://www.csbi.org.uk/wp-content/uploads/2015/07/Biodiversity_Baseline_JULY_4a-2.pdf.



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