Biodiversity Indicators for Monitoring Impacts and Conservation Actions

The Energy & Biodiversity Initiative

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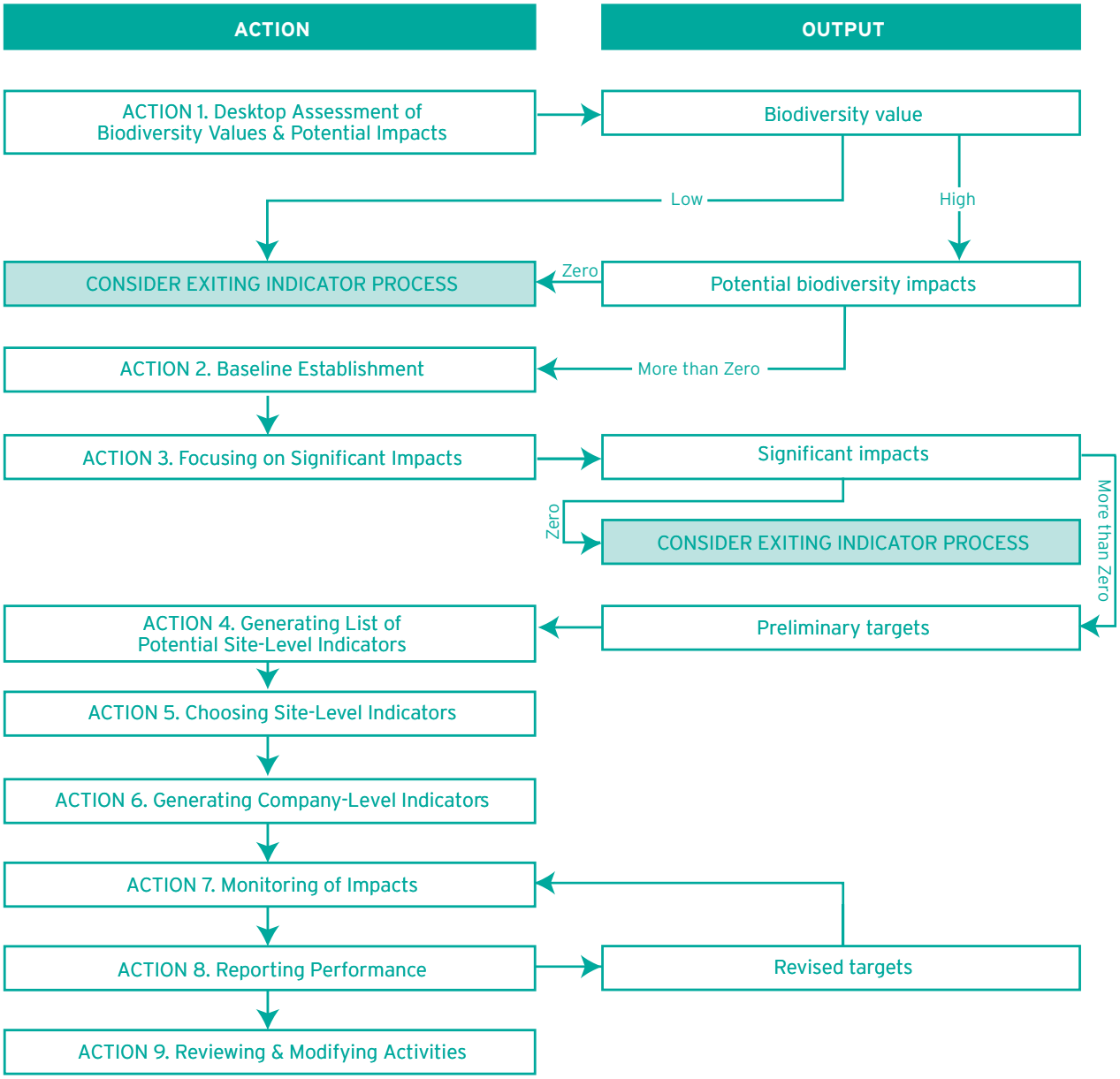
EXECUTIVE SUMMARY

Indicators are a way of presenting and managing complex information in a simple and clear manner. Using an approach based on risk assessment, this document outlines a methodology for developing site-level indicators to monitor significant positive and negative biodiversity impacts and company-level indicators to inform and report on the approach taken to biodiversity conservation at a strategic level. It is not the intention of this document to provide a prescriptive list of indicators to be used in every circumstance: the diverse nature of biodiversity and of oil and gas operations makes this an unrealistic expectation. Therefore, the emphasis

FIGURE 1. OVERVIEW OF METHODOLOGY FOR GENERATING INDICATORS



here is on the *method* of deriving indicators rather than the indicators themselves. Although based on a strong theoretical foundation, the methodology is centered on the practical needs of staff at oil and gas operations and corporate HSE professionals. Ideally, the methodology – summarized in Figure 1 below – should be used within a formal Environmental Management System (EMS), where much of the information required will already exist.

By monitoring impacts over time, the conservation outcomes that result from modifying or changing technology, adopting improved operational practices and integrating biodiversity issues into management strategy can be determined. A formalized system to measure and monitor the effects of an operation on biodiversity will allow a company – as well as regulators and civil society – to more easily understand, predict, minimize and prevent impacts; manage activities; and develop, monitor and refine management practices and eventually company policies. Establishing a system of indicators for reporting on impacts will also allow the company to provide assurance and transparency about its performance, especially if incorporated into the EMS. Although individual indicators will vary from project to project, "good" indicators follow the *SMART* philosophy (*specific*, *measurable*, *achievable*, *relevant* and *timely*). Biodiversity indicators must also be sufficiently sensitive to provide a warning of change before irreversible damage occurs – effectively they must serve to indicate where no significant change is occurring, and also where the threshold between insignificant and significant change lies.

Determining changes in natural systems can be a lengthy process, particularly if the relative importance of natural cycles and anthropogenic changes is to be properly understood. However, in many cases there may be an urgent requirement for an indicator, so that activities can be modified to immediately reduce significant impacts. In these cases, it may be appropriate to consider in the short term an indicator that does not directly measure change in a biological system but rather measures change in an activity that, if left unaltered, will lead to biodiversity impacts. Using a short-term, "indirect" indicator may enable activities to be quickly modified, while data are being acquired to develop the final long-term indicator based on the direct measurement of changes in the biological system. However, the less clear the link between the indicator and the impact, the greater the possibility of modification to activities not achieving the expected outcomes, and therefore indirect indicators must be used with caution and close monitoring.

1. BACKGROUND

Indicators are a way of presenting and managing complex information in a simple, clear, manner that can form the basis for future action and can be readily communicated to internal or external stakeholders as appropriate. Numerous indicators have been developed to monitor environmental and sustainable development issues. Fewer (but still numerous) indicator-suites are recommended specifically for measuring biodiversity (e.g. International Institute of Sustainable Development's *Compendium of Sustainable Development Indicator Initiatives* website at: www.iisd.org/measure/compindex.asp). Few have been developed specifically within the oil and gas sector. This document synthesizes many different methods, building on existing approaches to environmental management and protection in the oil and gas industry (such as ISO 14001 and OGP HSE-MS guidelines), and adapting and extending these to the specific theme of biodiversity measurement and conservation.

Indicators can measure many things, from pressures on biodiversity, to changes in the state of biodiversity, to how a company has responded to biodiversity issues. Indicators are used to check whether the trends or issues of concern are occurring: they should be objective-led, and the information they provide should indicate the success or failure of actions, and then actions changed accordingly. Thus key issues are in the choice of indicators and their subsequent use. Indicators are a fundamental input to management feedback loops that adapt behavior based on the results of monitoring and evaluation. Many assumptions have to be made about indicators, and decisions are made sometimes in the absence of complete information. Differing opinions of stakeholders regarding impact priorities, identifying which impacts are directly attributable to the company, and predicting what the change might be without the company's activities can present uncertainties in developing appropriate indicators. Consequently, the development, choice and use of indicators is an iterative and continual process – validation, review and revision are essential elements of fine-tuning the process, as is the case with an EMS.

A formalized system to measure and monitor the effects of an operation on biodiversity will allow a company to more easily understand, predict, minimize and prevent negative impacts; enhance positive impacts; manage activities; and develop, monitor and refine policies. Establishing a system of indicators for reporting on impacts will help the company communicate internally on biodiversity issues and provide greater assurance and transparency about its performance to external stakeholders. While indicators should focus on those factors that are having, or may have, the greatest impacts on biodiversity, companies may also wish to include more general indicators that address the wide range of issues, concerns and perceptions among stakeholders. Used correctly, biodiversity indicators can improve relationships with stakeholders by offering a common basis for measurement that can be collectively agreed and verified. Indicators and other tools that promote transparency can help oil and gas companies to win their societal license to operate, maintain access to new resources and business opportunities, and protect reputation related to performance, and government, community and NGO relations. Indicators should be developed not only for negative impacts, but also for positive outcomes, such as outreach programs, education, research and proactive conservation actions.

Although biodiversity indicators can play a key role in responding to concerns raised by the many stakeholders now scrutinizing the performance of the oil and gas industry (see Section 4.2), they must be business-relevant if they are to be widely used in the industry and not a public relations exercise. This means that they must be developed in response to a need, that a risk assessment approach should be central to their development, and that predicted significant impacts rather than potential impacts should be the focus of the process leading to their generation.

Using an approach based on risk assessment, this document outlines the development and use of indicators to monitor significant positive and negative biodiversity impacts and the biodiversity conservation actions of oil and gas companies at site and company levels. Although

based on a strong theoretical foundation, it is a practical approach, for "hands-on" use by staff at oil and gas operations.

Although this document is designed for use as a standalone document, other EBI products offer detailed guidance on key elements of the indicator development process.

See also **Integrating Biodiversity Conservation into Oil and Gas Development** (the EBI summary report and recommendations), **Integrating Biodiversity into Environmental Management Systems** and **Integrating Biodiversity into Environmental and Social Impact Assessment Processes**.

This document is set out in five sections:

1. Background.
2. Using this Document.
3. Understanding Indicators.
4. Developing Biodiversity Indicators.
5. Directory of Example Indicators.

To assist the reader, uncommon words and phrases are defined in the **EBI Glossary**. A wide range of additional and supporting information can be found in **Online Biodiversity Information Sources**.

2. USING THIS DOCUMENT

This document is primarily aimed at site managers, HSE professionals at both the company and site levels, and other relevant personnel involved in the monitoring and conservation of biodiversity throughout the lifecycle of upstream oil and gas operations (see Figure 2).

Other organizations interested in biodiversity issues in the oil and gas sector (e.g. conservation organizations) might also be potential end-users. Other staff and external stakeholders may find the document useful when considering biodiversity issues, as it will allow them to understand and follow the process of indicator development and contribute feedback that will help improve future versions of the method presented here.

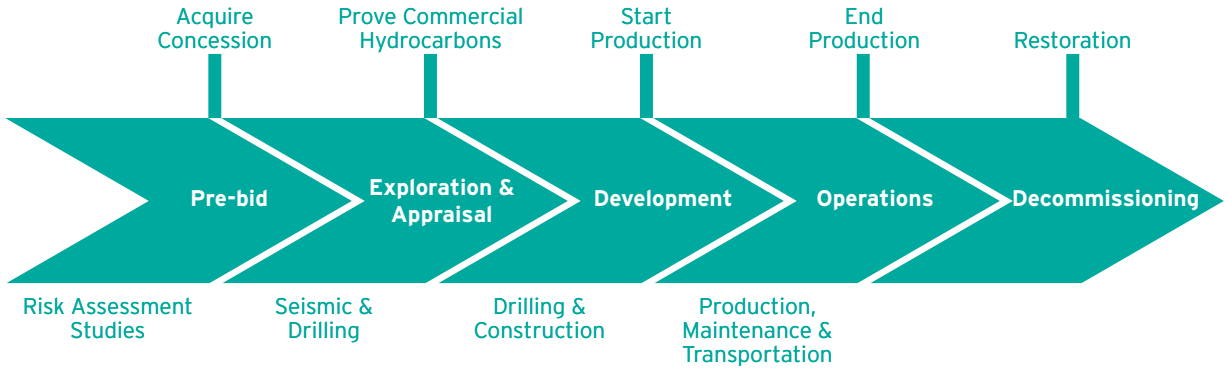
Ideally, this document should be used within a formal Environmental Management System (EMS) such as ISO 14001 or OGP's HSEMS guidelines, as much of the information and information required to produce indicators will exist already as a product of the EMS process.

See **Integrating Biodiversity into Environmental Management Systems**.

It is not the intention of this document to provide a prescriptive list of indicators to be used in every circumstance; the diverse nature of biodiversity and of oil and gas operations makes this an unrealistic expectation. The location-specific nature of many potential impacts on species, ecosystems or ecological processes means that a distinct system of indicators will need to be developed for each individual project – no single all-purpose indicator will meet all needs. Therefore, although a brief directory of example indicators is included (Section 5), the emphasis here is on the *method* of deriving indicators, rather than the indicators themselves. The objectives stating why indicators are needed and what they are required to measure, means that the indicators developed need to be specific to the situation. The use of "off-the-shelf" indicators without first taking the steps identified in this document may lead to important site-specific factors being ignored or misjudged, with subsequent unwanted impacts on biodiversity and corporate reputation.

Finally, the continued improvement of this document is dependent on the active participation of end-users and stakeholders. Therefore we welcome any

FIGURE 2. THE LIFECYCLE OF UPSTREAM OIL AND GAS OPERATIONS[1]



[1] At the pre-bid stage, a company may choose not to proceed with investment and exit the project lifecycle, because of biodiversity or other concerns. For technical, economic or other reasons, a company may not continue activity after completion of exploration and appraisal. In addition, at any point in the project lifecycle after the pre-bid stage, a company may choose (or be required by the host government) to "exit" a project by divesting and transferring its legal interest to another operator. This possibility may raise a number of issues about the continuity of biodiversity-related philosophy, commitment and practice from one company to another, potentially jeopardizing sustainable biodiversity conservation and a company's ability to maintain the reputational value of its activities related to biodiversity conservation (see *Integrating Biodiversity into Environmental and Social Impact Assessment Processes*, Section 3.11, and *Framework for Integrating Biodiversity into the Site Selection Process* for further discussion of this issue).

comments and suggestions relating to revisions and additions that will improve the usability, content and breadth and depth of application in the oil and gas sector. We are also actively seeking case studies examining the successful use of indicators in monitoring biodiversity impacts and conservation actions for inclusion in future updates.

PLEASE SEND COMMENTS, SUGGESTIONS AND QUESTIONS TO:

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3. UNDERSTANDING INDICATORS

3.1 INDICATOR TYPES

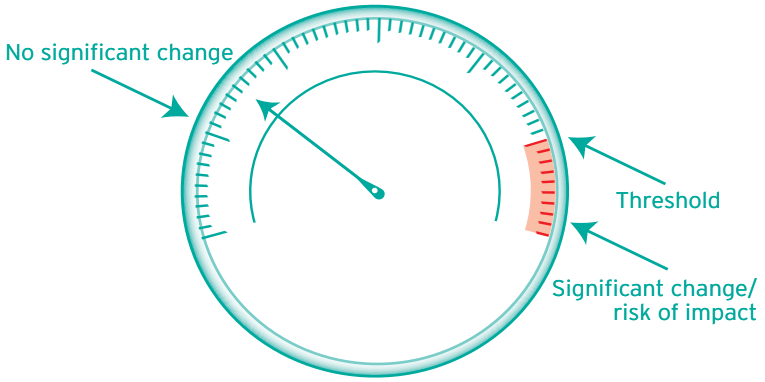
Outside of the biodiversity arena, many different types of indicators exist, including those that relate to financial, customer, efficiency, resource, input, emission/waste, risk and impact aspects of operations and business. Among these, indicators that relate to the measurement of emissions and wastes currently dominate ("output indicators"). The method described here for the development of indicators (Section 4) does not limit itself to output indicators, as there is rarely a link between the indicator and the impact. Instead, the process seeks to generate indicators that (a) relate to the actual or predicted significant impacts of operations, (b) measure progress towards a targeted goal ("outcome indicators") and (c) are useful in reporting site-level and company-level performance with respect to preventing impacts and promoting conservation ("input indicators").

Indicators must be able to show the effects of change (i.e. they must be dynamic). There must be clear, discernable, outcomes from the inputs made to the system. The ways in which changes are reported occurs in a tiered way, from the overall approach of a company, down to the actual monitoring at site-level of impacts and the outcomes of changes in activities. Based on the method described in Section 4, two indicator types are proposed: *site-level* and *company-level*. The relationship between these is examined in Section 4 (which includes worked examples). The company must decide, based on a risk assessment process, whether site-level, company-level, or both, types of indicator are relevant:

- *Company-level:* here, change relates to the way in which the company has considered the concept of biodiversity, and is seeking to reflect this in the way it operates. This would be reflected in the use of "corporate or management process" indicators, focusing on areas such as the scale and location of operations, policy information about approaches to managing biodiversity, case studies and information on compliance with those policies and processes (see Box 1 for further examples – the answers to some of the questions noted could be used as company-level indicators). These tell of the way in which a company is approaching the issues at a high level and the kinds of processes or mechanisms it is putting in place to achieve this cultural and operational change. Indicators here do not tell of direct biodiversity effects or outcomes.

- *Site-level:* the use of indicators here is based on direct questions of biodiversity importance for which there are expected outcomes. Typically, this may require the monitoring of two or more things: the factor/parameter that is causing the impact, and the chosen response to mitigate or prevent the impact. The need here is to recognize impacts on particular locations and their distinct biodiversity components (e.g. defined species or habitats). Measures of change may relate to biologically important issues, such as changes in survival or recruitment, expressed as an indicator in terms of changes in a population of a species for a given site or block. In this case, the indicator would be for population change within given thresholds, beyond which action might then be expected. For habitats, changes in quality or composition would be measured, with the indicator reported as loss or degradation when thresholds are exceeded.

FIGURE 3. THE SIGNIFICANCE OF A THRESHOLD TO BIODIVERSITY CONSERVATION AND MANAGEMENT



3.2 WHAT MAKES A GOOD INDICATOR?

Although individual indicators vary from project to project, "good" indicators follow the *SMART* philosophy (*specific*, *measurable*, *achievable*, *relevant* and *timely*). Biodiversity indicators must also be sufficiently sensitive to provide a warning of change before irreversible damage occurs – effectively they must serve to indicate where no significant change is occurring, and also where the threshold between insignificant and significant change lies (see Figure 3).

In addition, biodiversity indicators should also be:

- Simple and relate to something that people can understand and use.
- Able to address a need (e.g., be established through stakeholder dialogue or respond to a predicted significant impact).
- Sensitive to anthropogenic impacts – able to measure changes caused specifically by humans (i.e. able to differentiate between long-term background changes and those changes arising from the presence of oil and gas operations).
- Dynamic and responsive to ongoing changes.
- Able to address positive and negative changes.
- Spatially relevant across the required geographical level (i.e. local, regional, global).

BOX 1. BUSINESS IN THE ENVIRONMENT SURVEY FOR 2001: BIODIVERSITY

The Business in The Environment Survey of 2001 asked the questions about biodiversity noted below (presented here in summary form only). The idea of these questions was to help establish how far companies were progressing with their approach to biodiversity issues.

1. Measurement and reporting

Do you assess and monitor your impact on biodiversity? Answers based on percentage of operations, e.g. turnover and description of measure, period, indicator, performance and data if available.

2. Scope of information

Please indicate how much of your worldwide operations (e.g. percentage by turnover) is covered by the performance measure quoted above – percentages suggested.

3. Quality of information

Please indicate the quality of the information used to derive the performance measure above, e.g. from estimates to verified information.

4. Targets

Do you have a specific policy regarding your impact on biodiversity, e.g. from "no and not applicable" to what percentage of the operation it covers?

5. Performance improvement

Which phrase most closely describes your company' s performance on biodiversity?

- We cannot demonstrate any improvement in performance.
- We can provide evidence of an improvement in our performance on biodiversity:
  - Within the last year.
  - Within the last two years.
  - Over the last three to five years.

BOX 2. THE LIMITATIONS OF BIRDS AS BIODIVERSITY INDICATORS

BirdLife International has been researching and using birds as indicators of biodiversity for decades. Data from the work associated with birds from many organizations has been collated to give an understanding of threatened and endangered birds, endemic birds areas and Important Bird Areas. There are both positive and negative aspects of using birds as indicators species:

Appropriate Use Scenarios	Limited Use Scenarios
Birds are a good taxa for data collection: relatively easy data to collect, and people can be trained to spot presence and absence.	If only measuring birds, may not pick up changes that birds are not susceptible to (i.e., it is unwise to extrapolate from one situation to another).
Priorities have been established (Globally Threatened Birds, IBAs, IUCN red data list, etc.).	May encourage a managment focus on one or more bird species that does little or nothing to enhance overall biodiversity conservation.
Their behavior and interaction with the environment can be a good indicator of ecosystem health, i.e. they need plants, insects, nesting sites, water, etc.	May or may not be sensitive to a particular company activity.
Governments use them as indicators, e.g. UK use of skylark, presence and absence.	May provide misleading information, e.g. migratory species may be impacted by a wide range of detrimental environmental conditions, away from the site.
Good as a combined indicator with other aspects, e.g. plants.	The number of birds resting or wintering may not be a good indicator of impact.

- Valid and reliable using technically defensible measurement techniques.
- Cost-effective and involve the appropriate level of effort.
- Policy relevant (easy to interpret, showing trends over time against baseline or reference values).
- Able to address priorities and the issues of greatest importance.

The absence of one or more of these preferred characteristics may lead to limitations in how the indicators can be developed and used. Some common limitations are shown in Box 2, using birds as an example. The key here is that, in deciding to use birds as an indicator, they help answer a direct question and are used appropriately, in the correct context.

3.3 ACQUIRING INFORMATION TO DEVELOP INDICATORS

It is important, where possible, to use existing research and monitoring studies as a precursor to the development of biodiversity indicators. This will both decrease the work and cost and increase the validity of the development process. It may also be that such studies can provide a detailed context for the project and its potential biodiversity impacts. A great deal of information is already routinely collected that can be used in the early stages of the indicator development process (as described in Section 4), for example:

- Data accumulated during Environmental and Social Impact Assessments (ESIAs).
- Data acquired to fulfill license requirements according to local or national laws and voluntary agreements.
- Information gathered during programs aligned with National Biodiversity Strategies and Action Plans (NBSAPs).

Further sources of information can be found in **Online Biodiversity Information Sources** and **Integrating Biodiversity into Environmental and Social Impact Assessment Processes**.

Indicators are dynamic tools – the reasons for generating and using them change with time, and it is not possible to prepare one unchanging set for the lifetime of a project. Instead, it may be necessary to update indicators periodically, just as an effective EMS must be continuously checked and revised. Used properly, indicators will allow project managers to increase the understanding of impacts as the project moves through its lifecycle. Therefore, the nature of data acquired and required, and the resulting indicators, will vary according to the lifecycle stage and the predicted significant impacts:

- During *pre-bid*, the data gathered will normally be based on existing information and surveys and will not require development of a new set of indicators. However, it might be necessary to consider the major factors and possible parameters that will affect change in the short, medium and long term.

See **Integrating Biodiversity into Environmental and Social Impact Assessment Processes**, Appendix 1.

- During *exploration and appraisal*, the need for a wider range of more detailed biodiversity information will require consideration of indicators for the possible impacts of exploration and beyond. Data may come from small-scale surveys, consultation with in-country conservation NGOs, careful extrapolation from desk studies or studies in areas that have similar physical and biological characteristics.

- During *development*, a suite of indicators will be developed where high biodiversity values have been identified in the ESIA process and detailed surveys. These assessments provide the baseline for future monitoring, evaluation and further research.

- During *operations*, additional biodiversity impacts not initially predicted may be identified, and mitigation and monitoring actions will need to be identified, including appropriate indicators. Indicators at this stage of the lifecycle will reflect the needs of compliance, site-specific issues, regional policy and company policy evaluation, and governmental reporting and assessment processes. The outcome of this monitoring will contribute to the refinement of processes and policy as necessary.

- During *decommissioning*, indicators will focus on ways to meet the final objectives of restoration and reclamation and, where appropriate, the longer-term aspects of aftercare.

4. DEVELOPING BIODIVERSITY INDICATORS

4.1 INTRODUCTION

The following sections set out a sequence of nine *actions* that lead to the development of site-level and company-level indicators relevant to both primary and secondary impacts. Figure 4 summarizes the sequence of actions, along with the *input(s)* necessary to carry out each action, and the *output(s)* resulting from that action. Some of these stages will occur concurrently, some consecutively but all are underpinned to some extent by stakeholder engagement. Within the context of this document, "impacts" is taken to include primary and secondary impacts unless otherwise noted.

For further information on the nature of primary and secondary impacts, see **Negative Secondary Impacts from Oil and Gas Development**.

The method described here is one that may at times require assistance from external experts in undertaking some of the steps (e.g. identifying and consulting with stakeholders, and specialist aspects of biodiversity such as species identification and numeration), particularly in those cases where capacity must be developed within the company.

Although the methodology does not specifically address whether an area is legally protected or a conservation priority area (i.e. such designations are not an individual input into the process of generating indicators), these aspects are captured as elements of the risk assessment that runs throughout the methodology (e.g. the risks of significant impacts may be higher in a legally protected area if that legal protection relates to a high degree of biodiversity sensitivity or the presence of unique habitats and species).

See **Framework for Integrating Biodiversity into the Site Selection Process** for further information on the relevance of legal protection and conservation priority areas for oil and gas operations.

A theoretical case study is used during the following sections, showing how the methodology builds from one Action to the next, finally delivering appropriate indicators. The context for the example is shown below. Throughout the methodology, unless otherwise noted, the term impact is taken to include both primary and secondary types. To assist readers in understanding the case study, it is also compiled in Appendix 1.

CASE STUDY - CONTEXT

Indigenous people living in a village five miles from an oil operation are concerned that a natural habitat supporting a range of endemic animal life central to their diet is being impacted by an adjacent oil project, to the extent that their access to food is diminishing. The company – which has not yet completed an ESIA – wishes to assess the nature and significance of the impacts and identify suitable indicators, if appropriate, to manage site operations to prevent any such impacts.

4.2 THE IMPORTANCE OF STAKEHOLDER ENGAGEMENT

There should be a robust process in discussing appropriate indicators with relevant stakeholders: conservation is neither the exclusive preserve of conservationists, nor of companies. The process should be built upon strong partnerships across a wide range of stakeholders if it is to have a sense of common ownership and be successful in the long-term. Those involved should include private companies (including oil and gas companies, and other relevant companies such as timber concessionaires), government (e.g. departments, agencies and local and regional authorities), the education and finance sectors and civil society (e.g. the voluntary and conservation NGO sector, other public bodies and individuals). Local, national or international conservation NGOs can serve as partners in bringing the various stakeholders together into a consultative process. Many have substantial experience working with other local stakeholders, such as communities, and have extensive knowledge of both biodiversity and the measures necessary to conserve it. They can therefore be

invaluable resources for companies wanting to determine the most effective measures for conservation.

Objectives and targets for conservation performance should reflect the needs for information as identified through internal and external discussions – identifying suitable stakeholders through stakeholder analysis (see Box 3) ensures that they are able to provide early input into developing the measurement objectives alongside the internal risk assessment process. Communication with stakeholders helps share uncertainties (e.g. resulting from the comparison of data collected using different methods) with the aim of gaining consensus on what the best approach might be and ensures that the indicators ultimately developed meet a biodiversity demand and satisfy conservation concerns. It is also important to communicate gaps and uncertainties as part of the engagement process, so that the indicators being proposed at a later stage are not misused or misinterpreted, or that unrealistic expectations are not raised. It is also important to recognize that there may not necessarily be a strong relationship between impacts and concerns raised through engagement (i.e. stakeholder perceptions of the risk or significance of certain impacts may not tally with the scenarios predicted using available data) and this must be considered in the indicator generation process (see Action 3). Engagement is not presented here as a separate Action, but rather as the foundation that underlies every stage of the indicator development process.

Further analysis of stakeholder engagement and its importance for biodiversity conservation can be found in **Integrating Biodiversity Conservation into Oil and Gas Development**, Box 11.

4.3 PRIMARY AND SECONDARY IMPACTS

Impacts to biodiversity can be broadly divided into two types: primary and secondary. In general, primary impacts are changes to biodiversity that result specifically from project activities. These impacts, which will be most familiar to project managers, are normally associated with the area relatively near to project activities. Primary impacts result from operational decisions and the activities of project personnel. They usually become apparent within the lifetime of a project, and often their effect is immediate. Secondary impacts, rather than resulting directly from project activities, are usually triggered by the operations and may result from government decisions and the actions and practices of nearby communities or immigrants, in response to the presence of the project. Secondary impacts may reach outside project or even concession boundaries and may endure beyond (and even begin before) a project's lifecycle. Consequently, the responsibility for predicting, preventing and mitigating secondary impacts may not be at all clear-cut.

To place primary and secondary impacts in context, an example of primary and secondary impacts might be the clearing of dense-canopy forest to build project infrastructure that results in immediate deforestation and loss of habitat (the primary biodiversity impact). Longer-term soil erosion then impacts water quality and contributes to pressure on a rare fish species many miles downstream (the secondary impact). The deterioration in water quality resulting from the soil erosion may be a significant pressure, but the species may only be threatened as a result of cumulative pressures (e.g. discharge of untreated sewage from human settlements, agri-chemicals from farmland runoff, etc.). Therefore, in absolute terms, it may not be possible for a company to identify where its responsibilities begin and end – many other activities may also have cumulative (and unseen) impacts on biodiversity at a local and regional scale (e.g. agriculture, infrastructural development, urban development, logging and mining). Thus, while pursuing the measurement of impacts and performance are central to their biodiversity conservation efforts, oil and gas companies must also be aware of wider ranging issues.

The nature of primary and secondary impacts and management responses to them are examined in **Negative Secondary Impacts from Oil and Gas Development** and **Good Practice in the Prevention and Mitigation of Primary and Secondary Biodiversity Impacts**.

4.4 METHODOLOGY FOR DEVELOPING INDICATORS

ACTION 1. Desktop Assessment of Biodiversity Values and Potential Biodiversity Impacts

This is the starting point for the process of indicator development. It begins with an assessment of biodiversity value of the site and associated area. This establishes in general terms the nature of any biodiversity values that may be present and potentially impacted. Stakeholder analysis and subsequent

BOX 3. STAKEHOLDER NEEDS ANALYSIS – A CONCISE SUMMARY

Information is needed by all involved in understanding the impacts of the workings and potential workings of the energy sector – from governments through to energy companies and civil society. Each of these groups addresses its need for data from a different perspective and asks a range of different, but complementary, questions. The needs of the different groups can be summarized as follows:

Government needs information to:

- Evaluate the effectiveness of its biodiversity policies and legislation, and to frame new policies.
- Assess the workings of spatial planning and sectoral policies at national, regional and local levels, and to develop policy.
- Provide information to report on its national and international obligations under laws, conventions and treaties.
- Assess level of compliance with legal requirements.
- Work in partnership with industry and civil society.

Industry needs information to:

- Minimize its overall biodiversity impacts and to mitigate any possible effects on biodiversity.
- Recognize areas of biodiversity importance and potential regulatory conflict.
- Understand its potential environmental and reputational risks when considering potential areas for exploration and extraction.
- Understand the scale of, and potential for, biodiversity impacts – both primary and secondary – at each stage of the project lifecycle.
- Be appropriate for use at the individual site level, but also suitable when aggregated to assess overall company performance.
- Understand potential impacts on key biodiversity components and to identify appropriate biodiversity indicators for different stages in the project lifecycle.
- Help provide information for its own delivery and assessment systems, and to provide the basis for continual improvement.
- Report to regulatory authorities on operational performance and to its stakeholders.
- Refine operational procedures as part of its external reporting roles and requirements.
- Help assess its role in contributing to the drivers affecting longer-term biodiversity change.
- Work in partnership with government and civil society.

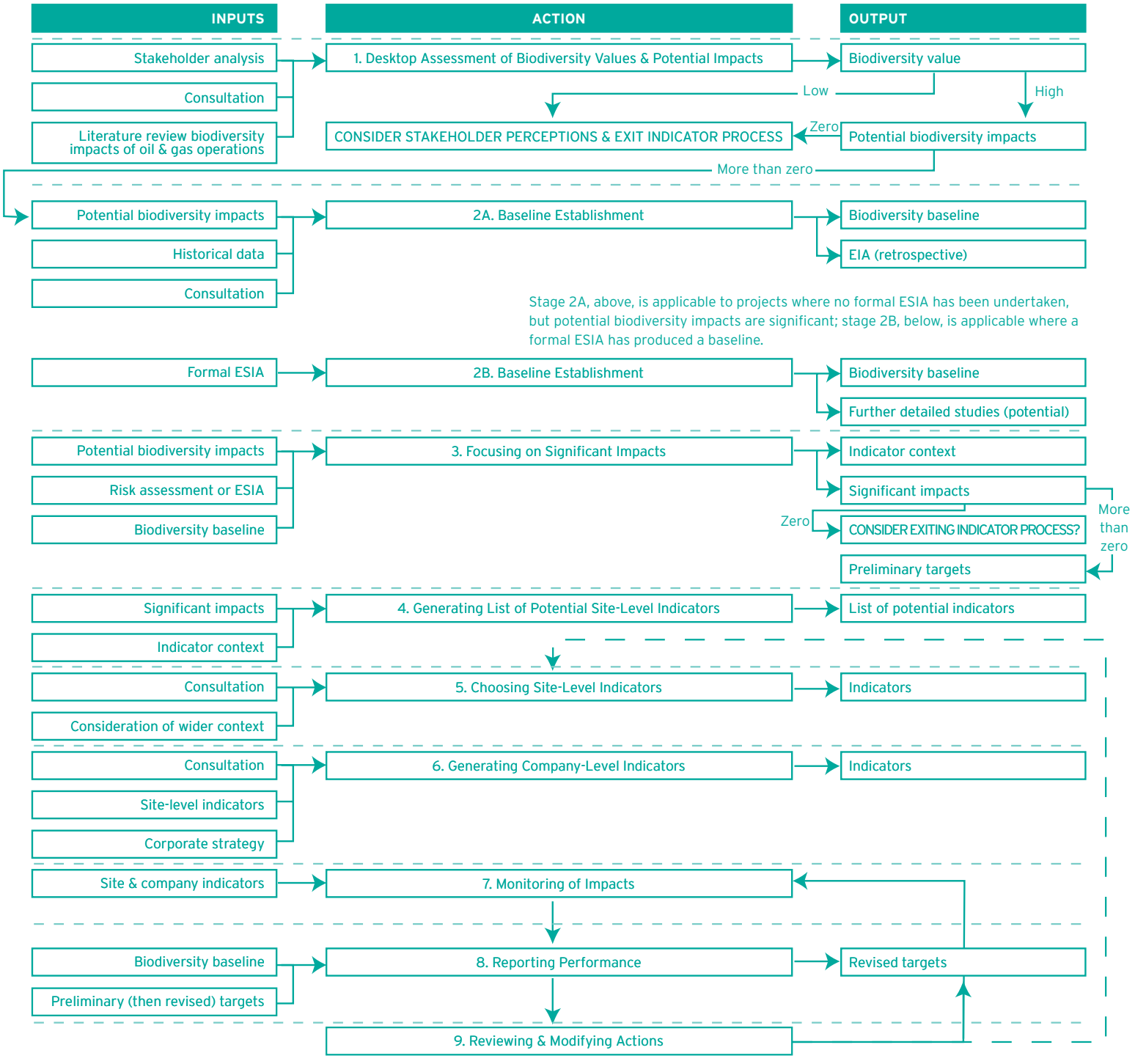
Civil society needs infomation to:

- Assess the impacts of policy and sectoral projects on biodiversity.
- Understand spatial and temporal change in biodiversity, and the impacts made by different industrial sectors.
- Help provide the basis for informed dialogue on biodiversity issues and options for the future.
- Work in partnership with industry and government.

engagement (e.g. with local communities, regional/national government departments and local/national conservation NGOs) should be used to assist in understanding the context within which potential impacts may occur. This also helps to develop the reasoning behind why indicators should be developed and used.

This is followed by a desktop risk assessment of biodiversity impacts based on (i) a preliminary understanding of the site/operation in question, (ii) the environment in which it is, or will be, operating, and (iii) the stakeholders that have some valid interest in the operation or area. The purpose of Action 1 is to identify as many relevant potential negative site-level impacts as possible in the context of the biodiversity values initially determined – this is a preparatory stage

FIGURE 4. SUMMARY OF THE INDICATOR DEVELOPMENT PROCESS



for the subsequent identification of a smaller subset of significant issues for which biodiversity indicators will be generated via a risk assessment process (see Figure 5). Where an ESIA has been undertaken, this Action is equivalent to the *screening* and *scoping* stages.

Further information relating to stages in the ESIA process is presented in **Integrating Biodiversity into Environmental and Social Impact Assessment Processes**.

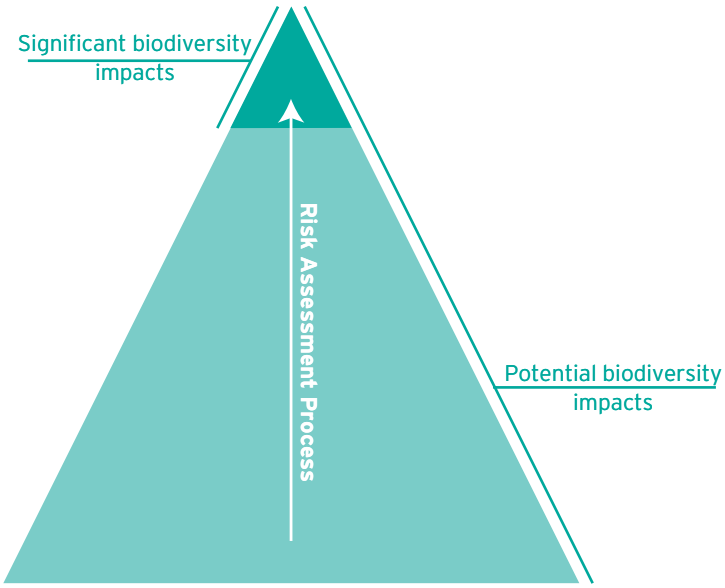
Specific *inputs* to Action 1 include a review of published and "grey" literature detailing the potential biodiversity impacts of oil and gas operations in the specific context of the operation, the relevant lifecycle stage and the environment under consideration.

The desktop review should also consider **Good Practice in the Prevention and Mitigation of Primary and Secondary Biodiversity Impacts**. Further extensive information is also referenced in **Online Biodiversity Information Sources.**

The *output* from Action 1 is a comprehensive assessment and list of relevant potential impacts on biodiversity. If this list contains no potential impacts, the company may choose to exit the biodiversity indicator generation process. Where there are potential impacts, the company should proceed to Action 2A (in cases where no ESIA has been undertaken) or 2B (in cases where a formal ESIA has been completed) in order to establish the biodiversity baseline. It is important to note that even if there are potential impacts highlighted during Action 1, there may still be no significant impacts (i.e. a potential impact may not translate to a significant impact). A word of caution is, however, necessary here. In some cases, the lack of impacts found in Action 1 does not mean that there is no need for a baseline – it may instead indicate that there is a deficiency in the information that should be addressed by undertaking Action 2A or 2B. Therefore, the company should consider carefully the implications of premature termination of the indicator process, although in practical terms it is likely that large-scale information deficiencies would be highlighted during the ESIA process, resulting in the restarting of the indicator methodology as appropriate.

An additional output at this stage needs to be establishment of the reasons for developing indicators;

FIGURE 5.
RELATIONSHIP BETWEEN POTENTIAL IMPACTS AND SIGNIFICANT IMPACTS



otherwise progressing through this process may not achieve the desired result. Objectives for performance measurement should reflect the needs for information as identified through internal and external discussions.

See also **Framework for Integrating Biodiversity into the Site Selection Process** and **Integrating Biodiversity into Environmental and Social Impact Assessment Processes**.

CASE STUDY – ACTION 1

Building on the case study introduction in Section 4.1, the principal stakeholders in this case have been clearly identified, and the engagement focus will remain with them throughout the process. Other stakeholders have also been consulted, including local and national government departments with responsibilities for indigenous peoples and national conservation NGOs. Biodiversity values have been established through discussions with the local indigenous people, a review of published literature relating to the area and discussions with local and regional academic institutions. The historic presence of the endemic animal species within the specified habitat has been confirmed from these exercises. The company has completed a desktop risk assessment and

drawn up a list of potential impacts based on available literature. Major pathways linking the operation to the habitat area have been identified as air, surface water, noise and vibration, and possible disposal and subsequent dispersal of solid wastes. Other potential pathways such as groundwater have been discounted on the basis of existing geological and hydrogeological data.

ACTION 2. Baseline Establishment

Baselines are useful snapshots in time against which change in status can be compared. There are many approaches to establishing a baseline – bearing in mind that the area may have already been impacted by human activity and that biodiversity varies through time. Equally, a particular survey period may or may not be representative. In general, the more information established and the longer the survey period, the better, but this is not always possible in the timescale of company activities, so assumptions have to be made. It is important when setting up a baseline that the limitations and assumptions are understood and communicated to stakeholders. Two types of baseline are considered below, those without a formal ESIA, and those with.

ACTION 2A. Baseline Establishment – in the absence of a formal ESIA

Where an ESIA has not been completed or is not planned, and Action 1 indicates potential impacts, the baseline should be established as part of the process of indicator development (in these cases it is also likely that an ESIA would need to be planned retrospectively if the operation is to meet "best practice" criteria, which would sensibly include an ESIA for all new projects or major modifications). The output from Action 1 will help focus the process of establishing the biodiversity baseline, which will contain information on potential water, land and air impacts, activities likely to cause physical disruption and degradation, chemical pollutants that may be released and so on. The baseline should allow identification of significant changes, should they occur. There are different ways of surveying the status of ecological resources, such as the Rapid Assessment Program created by Conservation International and the Rapid Ecological Assessment program created by The Nature Conservancy. The involvement of experts to identify the ecology of the area via on-the-ground surveys can be a key means of establishing the baseline state of the ecosystem. In other areas, where the risk to biodiversity is low, there may be little or no need to collect baseline information or develop indicators. Therefore, Action 2A is only necessary where the output from Action 1B indicates there are potential biodiversity impacts or where impacts were not fully assessed due to deficiencies in information.

The use of existing literature (such as IUCN lists, National/Local Action Plans, Hotspots, WWF Ecoregions, Endemic Bird Areas, Important Bird Areas, Centres of Plant Diversity and nationally designated protected areas) can assist in identifying key habitats/species that may be at risk and their current condition. These should be considered as context for the more detailed localized risk assessment undertaken in Action 3.

The principal output from Action 2A is the biodiversity baseline. A retrospective ESIA may also be recommended based on the results of establishing the baseline, particularly where a lack of information was identified.

Further information on identifying key habitats and species can be found in **International Conventions** and **Online Biodiversity Information Sources**.

ACTION 2B. Baseline Establishment – with a formal ESIA

The ESIA process is used to predict, analyze, understand, prevent, minimize and mitigate the environmental consequences of current or proposed activities. ESIA is now widely accepted throughout the oil and gas industry – and other sectors – as a valid and important tool, and in many countries it is required by law before project activity begins. However, few standard forms of impact assessment include the full range of biodiversity impacts that can result from development. Furthermore, the traditional ESIA process generally focuses on primary, immediate impacts, although many of the most intense and pervasive types of impacts on biodiversity will be secondary and cover a wider scope, both in terms of time and geographic area.

See also **Integrating Biodiversity into Environmental and Social Impact Assessment Processes**.

The *output* from Action 2B is the baseline with which impacts are compared and becomes an *input* to Action 3. Those elements for which some baseline measurement

exists are the ideal candidates for preliminary indicators, as the effect of actions based on the indicator in preventing or minimizing impacts is more readily measured. The output from Action 2B is also an input to Action 8 (Reporting Performance). Further detailed studies may also be required if the initial survey does not define the baseline in sufficient detail.

CASE STUDY – ACTION 2

The company has brought in external experts in order to compare habitat quality and identify and numerate relevant species in two areas. The first area is that considered by the local indigenous people to be affected by the oil operation, and the second is a similar area remote from the operation and other human influence. The latter is used as a control to determine the baseline. The company has also sought information from the local people regarding change in hunting patterns and intensity and has determined that no significant local human population increase or increased hunting activity have taken place during the period of apparent decline of food resources. The external experts' studies have shown that there is no significant difference with respect to habitat quality in the two areas, but there is a significant depression in animal numbers in the area adjacent to the oil operation relative to the control, and that some other mammalian species are present in lower numbers than noted in the control.

ACTION 3. Focusing on Significant Impacts

Up to this point, the methodology has only considered potential impacts. As a precursor to developing indicators, it is essential to narrow the focus from these potential impacts to those impacts that are significant in the context of the operation and the surrounding environment (see Figure 5). The inputs to Action 3 are therefore the preliminary analysis of biodiversity values and the full list of potential impacts derived in Action 1, the biodiversity baseline (if undertaken) that establishes the context for understanding which of the potential impacts are significant and an appropriate site-level risk assessment process as a means of defining the significant impacts. Where an ESIA has been undertaken, Action 3 is equivalent to the *evaluation* stage.

The nature of significance in the context of biodiversity impacts is explored in more detail in **Integrating Biodiversity into Environmental and Social Impact Assessment Processes**.

The *outputs* from Action 3 are a quantitative or qualitative description of what the indicators will relate to (e.g. the indicator context in terms of area or region, or corporate unit) and a smaller group of significant impacts derived from the longer list of potential impacts. Failure to correctly and clearly describe the boundaries can result in the misapplication of the indicators outside those boundaries or false expectations for their use on the part of end-users and other relevant stakeholders.

If the risk assessment process indicates that there are no significant impacts, then the company may choose to exit the indicator generation process. Once again, a note of caution is required: although the scientific process may indicate an absence of significant impacts, stakeholders may not concur for a number of reasons, and there may still be the need to address *perceived* impacts through the generation of indicators. Each company must judge the risk of failing to account for different stakeholder perceptions and consider whether additional impacts should be included in the indicator generation process that would otherwise not be considered significant.

If there are significant impacts, then indicators will be required to ensure these impacts are managed effectively. For each significant impact, a preliminary target could be set – this will then form the baseline for initially reporting performance (Action 8). Subsequently, targets can be revised as the process cycles through review, monitoring and reporting performance.

CASE STUDY – ACTION 3

The company has determined from the baseline studies that only land-based animals appear to be affected, and that it is therefore unlikely that a water-based pathway is involved in any potential impact. Therefore, it has focused on the other principal pathways (air, noise and vibration, and dispersion of wastes). Air quality monitoring data indicate that there are no significant discharges of either gases or particulates and sampling and analysis shows there are no discernable contaminants in the soil or flora in the area where species numbers are depressed. Noise and vibration monitoring at the local community's village five miles from the oil operation indicates that the levels are well within acceptable limits and have not been considered an issue by the village's occupants. However, further monitoring in the intermediate area between the village and the operation shows that there is significant noise and vibration within one mile of the operation's boundary, although this drops rapidly with increasing distance beyond this point. Noise levels and vibration frequencies are accurately

determined, and the data assessed by relevant experts, who conclude from existing scientific studies that the noise is unlikely to have a physiological or other impact on the affected animals, but certain of the vibration frequencies present are likely to deter the presence the species for which a decline in numbers has been noted. The wider implications of deterrence include reduced mating and offspring. Based on this information, the company sets a preliminary target of returning populations of affected species to 90 percent of the baseline noted in the control area within six months.

ACTION 4. Generating List of Potential Site-Level Indicators

Having completed the risk assessment (Action 3) and defined a list of significant impacts (and the context in which those impacts will occur), the generation of indicators can be undertaken. This may begin with site-level indicators, as these may be precursors to some of the company-level indicators (see Section 3.1 – Indicator Types). Each significant impact on biodiversity identified in Action 3 can generate one or more potential indicators. For example, one impact may be reduction of the number of trees of vulnerable species "X" on site due to historical clearance for site infrastructure. Appropriate targets would be established through stakeholder engagement and scientific assessment, and then potential indicators to monitor changes developed, for example:

- Change in percentage of land used for infrastructure by company.
- Numbers of trees replanted on site from managed tree nursery.

Determining changes in natural systems can be a lengthy process, particularly if the relative importance of natural cycles and anthropogenic changes is to be properly understood. However, in many cases there may be an urgent requirement for an indicator so that activities can be modified to immediately reduce significant impacts. In these cases, it may be appropriate to consider in the short term an indicator that does not directly measure change in a biological system but rather measures change in an activity that, if left unaltered, will lead to biodiversity impacts.

The first task in generating indicators is to produce for each significant impact a comprehensive list of potentially appropriate indicators. A good starting point is a consideration of the wider context; an appreciation of the priorities and the measures being used by wider processes and plans is useful in establishing what may work at site-level. For example, using biodiversity indicators in common with government or local plans may benefit the company (and the government) in terms of sharing information and aligning indicators with these wider processes (e.g. National Action Plans and local Biodiversity Action Plans encouraged by the Convention on Biological Diversity – see www.biodiv.org/world/reports.asp?t=all). Indicators used to monitor sustainable development at local, regional and national levels may also have parallels with biodiversity issues and conservation needs, and these should also be considered in the increasing number of countries that are developing sustainability indicators.

At this stage, only a limited degree of screening to remove inappropriate indicators should be undertaken and it is better to list too many than too few. Any screening that is undertaken should be done according to the criteria discussed in Section 3.2. The *output* from Action 4 is a list of potential indicators for each significant impact on biodiversity.

CASE STUDY – ACTION 4

The company determines that potential biodiversity indicators include:

- Ratio of species numbers per hectare in affected area and baseline area for each impacted species (a ratio of 1 indicating that there is no difference between the two areas).
- Ratio of mating pairs in affected area and baseline area for each impacted species.

However, the company also recognizes that it might take longer than its target period of six months to acquire data relevant to these indicators and therefore also chooses an additional indirect indicator to use in the short-term:

- Percentage decline in vibration magnitude at problem frequencies at the site boundary and one mile into the affected area (the target set for this is 70 percent at three months, rising to 85 percent at six months, based on advice from animal experts regarding the changes likely to reduce deterrence)

ACTION 5. Choosing Site-Level Indicators

The list of potential indicators generated in Action 4 must now be reduced to a smaller number of the most appropriate indicators. There is no definitive number that is required – in some cases it may be possible to identify one or more potentially appropriate indicators for each significant impact. In other cases, it might only be possible to identify a single indicator that reflects a group of associated impacts, rather than each individual significant impact. In all cases, the key to the choice of indicators is that they are *SMART*, based on suitability to address the measurement objectives and ability to monitor the results of modifying activities. In cases where the context changes (e.g. operational activities undergo major modifications) it may also be necessary to consider changing the indicator. It is at this stage that engagement with stakeholders having a significant interest in the operation is particularly crucial.

There are a number of ways to carry out the process, depending on the nature and number of stakeholders and their interest in the development of indicators. It is important to remember that different stakeholders may have varying degrees of technical and scientific knowledge and this may heavily influence their willingness or interest in being involved in the process and bias toward certain types of indicators:

- Consult with a representative group of stakeholders regarding the choice of indicator for each significant impact.

- Use questionnaires, meetings with groups and individuals, structured interviews with stakeholder representatives or other methods as appropriate to the situation.

Despite the involvement of stakeholders to inform the process, the company should retain the power to amend the choices of external stakeholders if it can make a robust and transparent case for doing so (with the exception of indicators that are derived from regulatory requirements). Although ultimately it is the responsibility of the company to ensure that the indicator is the most appropriate, any rejection should relate to the failure of the indicator to meet the criteria noted in Section 3.2.

There is, however, little value in implementing an indicator that does not have at least a degree of support among stakeholders. The company should revert to the stakeholders previously consulted to explain the proposed indicators and discuss the rationale for each of them. In many cases the reasons for measuring particular indicators and their limitations are not communicated, leading to confusion and misuse of the resulting information. Ultimately, the rationale for deciding on particular indicators should always be documented to facilitate future review.

The *output* from this Action is a suite of indicators that adequately address the significant impacts identified in Action 3. These become the *inputs* to the monitoring stage (Action 7).

CASE STUDY - ACTION 5

Following consultations with the local indigenous community, the company determines that the most appropriate biodiversity indicator is the ratio of species numbers per hectare in affected area and baseline area for each impacted species (a ratio of 1 indicating that there is no difference between the two areas). The second candidate indicator is rejected on the basis of the delay in acquiring data beyond direct enumeration of species numbers and also concerns regarding the non-linear relationship between mating pairs and total population.

Recognizing that it will take some time to acquire suitable data to use these indicators, the company agrees with the local community to use the indirect indicator (noted in the previous Case Study box) in the short-term to allow it to immediately begin to modify its activities to reduce impacts on the affected species. The company agrees with local people that this indicator should not be used for more than 12 months without additional consultation.

ACTION 6. Generating Company-Level Indicators

As noted in Section 3.1, company-level indicators are more likely to be about process than impact. Depending on their aspirations, companies may choose to align their company-level indicators with the Sustainability Reporting Guidelines published by the Global Reporting Initiative (GRI), a voluntary initiative promoting globally applicable sustainability reporting guidelines (see www.globalreporting.org for further details).

Company-level indicators can be derived by the aggregation of site-level indicators where this is possible. If site-level indicators are to be aggregated, then they *must* have the same unit of measurement, relate to the

same biodiversity impact *and* add value at the company level. Just as in the collection of any health, safety and environment information, there should be a common protocol for use by all of the company's reporting sites.

Not all company-level indicators are created by consideration of site-level indicators; they can also be generated to measure some of the responses that a company has taken. Although this may or may not directly change the status of biodiversity, the assumption is that these types of measures give an indication of the responsibility of the company and the types of actions taken. This is the approach that several organizations have been promoting, for example Earthwatch and the *Business in the Environment Index*. The questions asked for the 2001 Business in the Environment survey of companies are listed in Box 1. Company-level indicators may also include capacity-building indicators, to encourage shared knowledge/resources, extent of education and research programs, and case studies of outreach programs, to give an idea of the wider positive impact in the community the company may be having. See Section 5 for additional indicator examples that could be considered for development.

The *output* from this Action (company level indicators, and setting of appropriate targets) becomes an *input* to the monitoring stage (Action 7).

CASE STUDY - ACTION 6

The company integrates the outcome of the process of indicator generation and activity modification into an overall assessment of the performance of this specific site. This overall assessment may include measures such as percentage of significant issues addressed within six or 12 months of identification

ACTION 7. Monitoring of Impacts and Conservation Actions

Once the site-level and company-level indicators have been chosen, it is then necessary to put them into operation. Initially, the preliminary targets developed in Action 3 should be adopted, but as time progresses more refined and appropriate targets can be implemented. It may take an extended period using the indicators for monitoring before new targets can be set. The preliminary targets should be challenging but also realistic, and should be clearly documented in the reporting process (Action 8). The foundation for subsequent monitoring is the baseline survey (see Action 2). In general terms, monitoring is used to check that objectives and targets have been achieved, to identify new issues and potential impacts and as a feedback mechanism to modify and improve practices (e.g. through changes in operational activities). Monitoring can be used to ensure quality assurance throughout the indicator development and implementation process and verify that the correct indicators have been chosen to measure actions and assess objectives, right through to whether that measurement is being carried out in an accurate and representative fashion

An effective way to manage progress is by incorporating impact measurement into the standard EMS process of planning, checking and corrective action (see Figure 6). The objective of addressing the impacts identified through risk assessment should already have been incorporated into the EMS, thus including the measurement of performance indicators against those objectives should also be a natural fit. It is at this point where training of staff in the use of indicators can also be introduced as a part of the EMS process. Incorporating biodiversity impact and action measurement into the EMS also ensures that those responsible for the measurement are identified and made accountable. Their role as it relates to the use of indicators should be clearly described to ensure their responsibility is understood.

Assurance should be performed by personnel/ organizations who can offer an unbiased opinion; they can be personnel from a separate part of the organization or from an external audit organization. Whichever is chosen, assurance is an important step in maintaining reputation and improving internal processes.

FIGURE 6. THE EMS PROCESS

CASE STUDY – ACTION 7

The company monitors vibration frequency and magnitude at the site boundary and one mile into the affected area and compares data with the targets established under Action 4 for the first eight months, after which it has acquired sufficient monitoring capacity and data to switch to the direct indicator.

ACTION 8. Reporting Performance

Communicating and reporting performance, as an internal process, as a legal requirement or voluntarily to external stakeholders is an integral part of measuring both impacts and the actions taken to address those impacts. This is possible at various spatial levels: locally, nationally, regionally or globally, depending on the requirements identified. Types of information and methods of reporting will differ according to the needs of the company and the expectations of stakeholders and the purpose behind particular measures, i.e. to establish baseline, driving behavior change, etc. When externally reporting on biodiversity indicators, it is important to include why these particular measures have been adopted and what process was used to develop them in order to promote transparency.

Internal reporting is a priority – communicating throughout the site not only supports the purpose for which the indicators were developed, but also allows personnel not directly involved to better understand the project. In addition, employees in other parts of a larger organization can benefit from what has been learned and practiced by those at that site.

As noted in Action 3, stakeholder perceptions regarding the significance of impacts may need to be considered in any external reporting, irrespective of the degree of scientific basis for those perceptions.

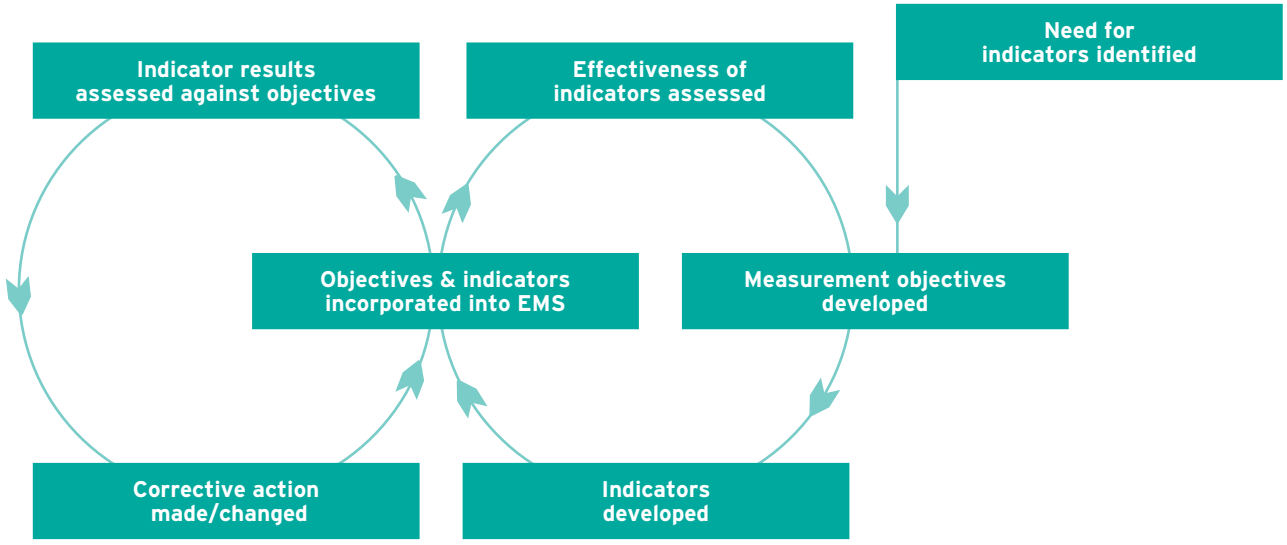
CASE STUDY – ACTION 8

The company uses indirect (months 1-8) and direct (8+ months) indicators to report against targets internally to determine progress and modifications required for remedial and preventative measures to achieve those targets. At 12 months, the indicators are also used to formally report to the local community, to supplement ongoing communications during the preceding 12-month period.

ACTION 9. Reviewing and Modifying Actions

It is important to assess the success of actions and indicators put in place. A clear feedback loop should be established between the information collected via indicators, and the success of actions put in place to improve performance where targets are not being met. If reporting (Action 8) indicates that performance is not in line with targets, then site- and company-level activities should be modified as appropriate. The company may also need to periodically assess if a more suitable indicator exists that will enhance the process of

FIGURE 7. INTEGRATION OF THE INDICATORS GENERATION AND EMS PROCESSES



monitoring and improving performance (see Actions 4 and 5). The combined process of modifying activities and indicator choice is shown in Figure 7.

CASE STUDY - ACTION 9

Within the first three months, the company begins to modify its activities, identifying major fixed and mobile sources of vibration on-site and implementing a program of remedial measures to damp specific frequencies from these sources. Based on continuing monitoring at the site boundary and one mile into the affected area, the three-month target of reducing vibration at the determined frequencies by 70 percent is not met (a 65-percent reduction is achieved) and the company implements an accelerated program of source identification and damping. Within the following three months, work is extended to identify and damp additional minor sources, meeting the overall target of 85-percent reduction at six months. In parallel with these activities, the company also begins to develop and implement the capacity to monitor species numbers, and switches from the indirect to direct indicator after eight months. Subsequent monitoring shows that the population in the affected area has recovered to 95 percent of that in the control area by 12 months, demonstrating that both the chosen indicators and remedial actions have been effective.

5. DIRECTORY OF EXAMPLE INDICATORS

Indicators must be able to show the effects of change. There must be clear, discernable, outcomes from the inputs made to the system. The reporting of changes occurs in a tiered way, from the overall approach of a company, down to site-level monitoring of impacts and their outcomes:

- *Company levels:* Here, change may be in the way that the company has taken the idea of biodiversity on board, and is seeking to reflect this in the way it operates. This would be reflected in the use of "corporate" or "management process" indicators. These tell of the way in which a company is approaching the issues at a high level, and the sorts of processes or mechanisms it is putting in place to achieve this cultural and operational change. Indicators here do not tell of direct biodiversity effects or outcomes.

- *Sub-company levels:* These are indicators that are summaries of action, but do not tell of the biodiversity impact of these actions. They record change, but do not allow direct understanding of its meaning – such as physical land-take or footprints, or hectares of land rehabilitated or fragmentation rates.

- *Site-levels:* The use of indicators here is based on direct questions of biodiversity importance for which there are expected outcomes. Typically, this may require the monitoring of two or more things: the factor/parameter that is causing the impact and the appropriately chosen response for the biodiversity component in question. From a direct biodiversity perspective, aggregations of data – such as numbers of species or number of habitats lost or altered – are too indirect. The need here is to recognize impacts on particular locations and their distinct components (defined species or habitats). Measures of change may well be of biologically important issues, such as changes in survival or recruitment, but would be expressed as an indicator in terms of changes in a population of a species for a given site or block. In this case, the indicator would be for population change within given thresholds when action might then be expected. For habitats, issues of changes in quality or composition would be measured, with the indicator reported as loss or degradation when thresholds are exceeded.

The directory tables on the following pages contain examples of indicators covering species, habitats, management commitment and process-output subject areas. Each has its own strengths and weaknesses. Some may be suitable for measurement of impact or actions at a site level, others also suitable for assessment of performance across the whole company. It is strongly recommended that these indicators should not be used "off-the-shelf." They are offered as examples only, and the process outlined in Section 4 is essential for the development of appropriate and relevant indicators that are optimized for monitoring impacts and conservation (and that take into account the specific circumstances relevant to particular sites or companies).

They are grouped according to the following category types:

- Species indicators.
- Habitat indicators.
- Management indicators.
- Industrial process indicators.

TABLE 1. SPECIES INDICATORS [these indicators should not be used "off-the-shelf" - they are offered as examples only]

INDICATOR	HOW THE INDICATOR WILL BE MEASURED	RELEVANT AT SITE LEVEL?	RELEVANT AT COMPANY LEVEL?	RATIONALE FOR USE	LIMITATIONS & SUITABILITY
Globally threatened and data deficient species in area	Conduct population studies, prioritizing most threatened species .	Y	Y	It is essential to know the key species that will be encountered on a site so management plans can be developed in accordance to minimize impact on the species. By comparing changes in population status over years, this indicator highlights to site management the local status of the globally threatened species within the site boundary.	By identifying the key/target species that need to be managed in an area, operation site managers can know what areas and species to focus studies on. These target species may possibly act as surrogates for demonstrating the health of the entire system. At company level, this indicator will highlight the target species for an area and allow management decisions to be made around those species. One drawback is that the indicator will not always reveal short-term changes. The indicator also shows local status of globally important species, and the species status in the particular project area may differ. A key limitation in using this indicator is that not all taxa have been comprehensively assessed.
Restricted-range species	Conduct population studies, prioritizing threatened species over restricted-range species that are not threatened.	Y	Y	Restricted-range species are especially important, because they are found only in certain ecosystems (even if abundant at some locations) and thus are often globally threatened.	This could provide evidence of what is being done to conserve various restricted-range species found on sites. At a site-level, this is very important to assess and monitor trends. As a comparison indicator between sites, it would need to be related to the size of various sites.
Invasive non-native species that are threatening to ecosystems, habitats, or species	List all of the invasives in your area that are in the global invasives database, and include regional and local lists where available. Conduct individual population studies to identify population trends for a given site.	Y	Y	A company's activities can provide the means by which invasive non-native species may colonize an area e.g. opening up new habitat with access routes or seismic lines or transporting those species.	The presence or absence of invasive non-native species may or may not be a result of the company's activities. It is important to consider the potential for this and to possibly include an indicator, which looks at the absence of particular species as a goal. Where invasive species are identified, monitoring population trends provide early warning and improve opportunities for site administrators to respond with appropriate management tactics.
Species used by local populations	Surveys and identification of species and studies on population trends.	Y	Y	The presence of some operations may increase the use of certain species (therefore decreasing the population size), because they are indirectly providing access for the local communities and nomadic people to reach the species.	If use of local species by the surrounding population can be indirectly attributed to the location of a facility, then the site should look to find ways to monitor the impact of this use on the local biodiversity by monitoring access points, markets, and villages. This will be very site-specific: often basic export record monitoring will be taking place through CITES/customs records, but this can be built on, especially to monitor trends of within-country trade, through targeted monitoring of wildlife trade at key links (airports, harbors, trade routes, markets, etc). Monitoring should also take place at the operation-site level to measure changes in species populations.

TABLE 2. HABITAT INDICATORS [these indicators should not be used "off-the-shelf" - they are offered as examples only]

INDICATOR	HOW THE INDICATOR WILL BE MEASURED	RELEVANT AT SITE LEVEL?	RELEVANT AT COMPANY LEVEL?	RATIONALE FOR USE	LIMITATIONS & SUITABILITY
Operational site overlap with Conservation Priority Areas containing globally threatened or restricted range species	The % of operational sites within a country that are within the borders of a Conservation Priority Area, or are within an appropriate distance of a Conservation Priority Area	Y	Y	This kind of information should form a key part of a site's Environmental Management System.	It is important at a site and company level to understand how the area of operation overlaps Conservation Priority Areas, particularly as this is a significant point of contention between some oil and gas companies and conservation NGOs. Knowledge of the number of Business Units operating in or near these areas is valuable information to a head office trying to lessen the reputational risk to the company and begin to assess operational impacts on biodiversity. Where information is not available, it will be necessary to generate data in cooperation with municipalities, regional conservation organizations, etc.
Amount of land within the operational site that has a management plan with a biodiversity conservation focus	Ha or sq. km, or % of total site area	Y	Y	Active management of a portion of the operational site can contribute a great deal to its biodiversity value.	Of the total land area of the operational site, a certain proportion can be specifically managed for conservation. If a company's objective was to increase the amount of land set aside for conservation, then tracking this measure over time would indicate the degree of success in meeting the target .
Contribution to habitat conservation	Ha or sq. km set aside or dollars contributed to protected area management	Y	Y		Land set aside (bought or leased) for conservation, outside of the site operation, under the auspices of a site management plan. This would also be useful information at company level as it implies a certain quantity of land under protection (or a monetary contribution to conservation). If a company's objective were to increase the amount of land set aside for conservation, then tracking this measure over time would indicate the degree of success in meeting the target.

TABLE 3. MANAGEMENT INDICATORS [these indicators should not be used "off-the-shelf" - they are offered as examples only]

INDICATOR	HOW THE INDICATOR WILL BE MEASURED	RELEVANT AT SITE LEVEL?	RELEVANT AT COMPANY LEVEL?	RATIONALE FOR USE	LIMITATIONS & SUITABILITY
Is there a clear policy written into the site-management plan that outlines explicitly how biodiversity will be managed in the area, and is there evidence from past projects that management has committed itself to these policies?	Yes/No, Case studies	Y	Y	A site with a stated policy on biodiversity typically finds the implementation of biodiversity actions easier due to improved staff awareness of backing from senior management.	As a measure, this is a simple yes/no indicator, so it would possibly be a more logical indicator of progress if all site policies can be collated at company-level. This would then represent the level of site management commitment to biodiversity across the company and also the overall corporate commitment, giving clear guidance throughout the company as to expectations.
Biodiversity elements included in management system	Yes/No	Y	Y	As progress is made in establishing biodiversity within a new or existing site EMS, it would be useful to track incorporation to ensure it is fully integrated.	This indicator would provide a level of assurance that biodiversity impacts and actions are being fully integrated into a site's operation. At company level, it is not necessarily valuable to track progress of site integration (alternatively, some companies choose to implement the EMS at a company-wide level; in this instance the above applies and progress should be tracked).
Corporate / BU budget allocation	$ or % of total spend	Y	Y	It is valuable to track monetary spending at all levels of the company.	Financial expenditure information is always required, whether it is purely to track project costs or whether the biodiversity representative needs to be able to demonstrate that biodiversity benefit is being gained at the best cost.
Sites with biodiversity action plans (BAPs)	Number	N	Y	It is useful to monitor progress of sites developing and working with BAPs within their operations, especially if time bound by a target deadline.	Quality control is a significant issue, and external verification may be required. Initial emphasis should especially be placed on encouraging sites in areas of high biodiversity value to develop BAPs, so perhaps a phased approach is more realistic to begin with. This will then allow those sites with highest risk to biodiversity to develop plans first, with other lower-risk sites able to benefit from the knowledge gathered during the first phase. An alternative BAP measure is to identify how many BAPS or actions are aligned with national BAPs.
Ongoing biodiversity conservation projects either at site or collaborations at company level	Number	Y	N	Shows commitment to wider conservation issues and actions.	The number of projects may be less important than capturing the types and level of project, the objectives, anticipated outcomes, measures of success and financial expenditure.
Suppliers with EMS / sourcing materials from sustainable sources	Number or % total suppliers	Y	Y	Reflects consideration of supply chain in wider impact on biodiversity.	It is usually only following a supplier assessment where all materials are traced that the company/site has a proper indication of where its materials are sourced.

TABLE 4. INDUSTRIAL PROCESS INDICATORS [these indicators should not be used "off-the-shelf" - they are offered as examples only]

INDICATOR	HOW THE INDICATOR WILL BE MEASURED	RELEVANT AT SITE LEVEL?	RELEVANT AT COMPANY LEVEL?	RATIONALE FOR USE	LIMITATIONS & SUITABILITY
Emission / discharge outputs	These can be reported as absolute values (e.g. total tonnes of sulphur dioxide emitted, total volume of water discharged) or normalized per unit of production.	Y	Y	These should be basic building blocks for sites reporting their emissions and discharges, both locally and upwards through the company for collation at a company-wide level.	This would be a more relevant indicator if it were tied into what the primary impacts of these emissions were on the local environment. There has been a move toward more local reporting, as many now acknowledge that collation of emission statistics at a company level provides no information about impact. Therefore, increased local reporting of emissions, sensitivities and impacts is a more responsible direction to take than just emission/discharge output indicators.
Water consumption	This can be reported as an absolute value (e.g. total volume of water consumed) or normalized per unit of production.	Y	Y	Depending on the location of the site and the scarcity of water in the vicinity, water consumption may be a critical aspect of operations.	All sites should monitor their water consumption, as oil and gas companies tend to use large amounts of clean water. But those sites in water-scarce areas have a responsibility to minimize their consumption, not just for the impact that that use may have on biodiversity, but also for its impact on local communities and other users. At a company level, aggregation of water use statistics would be a useful indication of a baseline water use, from which it could target a reduction across various key sites. However, as an indicator for biodiversity impact, aggregation of this information at a company-level would not add particular value.

APPENDIX 1. THEORETICAL CASE STUDY

CONTEXT

Indigenous people living in a village five miles from an oil operation are concerned that a natural habitat supporting a range of endemic animal life central to their diet is being impacted by an adjacent oil project, to the extent that their access to food is diminishing. The company – which has not yet completed an ESIA – wishes to assess the nature and significance of the impacts and identify suitable indicators, if appropriate, to manage site operations to prevent any such impacts.

ACTION 1

Building on the case study introduction above, the principal stakeholders in this case have been clearly identified, and the engagement focus will remain with them throughout the process. Other stakeholders have also been consulted, including local and national government departments with responsibilities for indigenous peoples and national conservation NGOs. Biodiversity values have been established through discussions with the local indigenous people, a review of published literature relating to the area and discussions with local and regional academic institutions. The historic presence of the endemic animal species within the specified habitat has been confirmed from these exercises. The company has completed a desktop risk assessment and drawn up a list of potential impacts from the project based on available literature. Major pathways linking the operation to the habitat area have been identified as air, surface water, noise and vibration, and possible disposal and subsequent dispersal of solid wastes. Other potential pathways such as groundwater have been discounted on the basis of existing geological and hydrogeological data.

ACTION 2

The company has brought in external experts in order to compare habitat quality and identify and numerate relevant species in two areas. The first area is that considered by the local indigenous people to be affected by the oil operation, and the second is a similar area remote from the operation and other human influence. The latter is used as a control to determine the baseline. The company has also sought information from the local people regarding change in hunting patterns and intensity and has determined that no significant local human population increase or increased hunting activity have taken place during the period of apparent decline of food resources. The external experts' studies have shown that there is no significant difference with respect to habitat quality in the two areas, but there is a significant depression in animal numbers in the area adjacent to the oil operation relative to the control, and that some other mammalian species are present in lower numbers than noted in the control.

ACTION 3

The company has determined from the baseline studies that only land-based animals appear to be affected, and that it is therefore unlikely that a water-based pathway is involved in any potential impact. Therefore, it has focused on the other principal pathways (air, noise and vibration, and dispersion of wastes). Air quality monitoring data indicate that there are no significant discharges of either gases or particulates, and sampling and analysis shows there are no discernable contaminants in the soil or flora in the area where species numbers are depressed. Noise and vibration monitoring at the local community's village five miles from the oil operation indicates that the levels are well within acceptable limits and have not been considered an issue by the village's occupants. However, further monitoring in the intermediate area between the village and the operation shows that there is significant noise and vibration within one mile of the operation's boundary, although this drops rapidly with increasing distance beyond this point. Noise levels and vibration frequencies are accurately determined, and the data assessed by relevant experts who conclude from existing scientific studies that the noise is unlikely to have a physiological or other impact on the affected animals, but certain vibration frequencies present are likely to deter the presence of species for which a decline in numbers has been noted. The wider implications of deterrence include reduced mating and offspring. Based on this information, the company sets a preliminary target of returning populations of affected species to 90 percent of the baseline noted in the control area within six months.

ACTION 4

The company determines that potential biodiversity indicators include:

- Ratio of species numbers per hectare in affected area and baseline area for each impacted species (a ratio of 1 indicating that there is no difference between the two areas).

- Ratio of mating pairs in affected area and baseline area for each impacted species.

However, the company also recognizes that it might take longer than its target period of six months to acquire data relevant to these indicators and therefore also chooses an additional indirect indicator to use in the short-term:

- Percentage decline in vibration magnitude at problem frequencies at the site boundary and one mile into the affected area (the target set for this is 70 percent at three months, rising to 85 percent at six months, based on advice from animal experts regarding the changes likely to reduce deterrence).

ACTION 5

Following engagement with the local indigenous community, the company determines that the most appropriate biodiversity indicator is the ratio of species numbers per hectare in affected area and baseline area for each impacted species (a ratio of 1 indicating that there is no difference between the two areas). The second indicator candidate is rejected on the basis of the delay in acquiring data beyond direct enumeration of species numbers and also concerns regarding the non-linear relationship between mating pairs and total population.

Recognizing that it will take some time to acquire suitable data to use these indicators, the company agrees with the local community to use the indirect indicator (noted in Action 4) in the short-term to allow it to immediately begin to modify its activities to reduce impacts on the affected species. The company agrees with local people that this indicator should not be used for more than 12 months without additional consultation.

ACTION 6

The company integrates the outcome of the process of indicator generation and activity modification into an overall assessment of the performance of this specific site. This overall assessment may include measures such as percentage of significant issues addressed within six or 12 months of identification

ACTION 7

The company monitors vibration frequency and magnitude at the site boundary and one mile into the affected area and compares data with the targets established under Action 4 for the first eight months, after which it has acquired sufficient monitoring capacity and data to switch to the direct indicator.

ACTION 8

The company uses indirect (months 1-8) and direct (8+ months) indicators to report against targets internally to determine progress and modifications required for remedial and preventative measures to achieve those targets. At 12 months, the indicators are also used to formally report to the local community, to supplement ongoing communications during the preceding 12-month period.

ACTION 9

Within the first three months, the company begins to modify its activities, identifying major fixed and mobile sources of vibration on-site and implementing a program of remedial measures to damp specific frequencies from these sources. Based on continuing monitoring at the site boundary and one mile into the affected area, the three-month target of reducing vibration at the determined frequencies by 70 percent is not met (a 65-percent reduction is achieved) and the company implements an accelerated program of source identification and damping. Within the following three months, work is extended to identify and damp additional minor sources, meeting the overall target of 85-percent reduction at six months. In parallel with these activities, the company also begins to develop and implement the capacity to monitor species numbers, and switches from the indirect to direct indicator after eight months. Subsequent monitoring shows that the population in the affected area has recovered to 95 percent of that in the control area by 12 months, demonstrating that both the chosen indicators and remedial actions have been effective.