Good Practices for the Collection of Biodiversity Baseline Data

Prepared for:

Multilateral Financing Institutions Biodiversity Working Group & Cross Sector Biodiversity Initiative

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Quick Guide to Developing a Biodiversity Baseline Study

A biodiversity baseline study is the work done to collect and interpret information on the biodiversity values occurring at a site, their current condition, and trends before a project commences. The biodiversity baseline study plays important roles in supporting the assessment of impacts and risks of a project, applying the biodiversity mitigation hierarchy, and designing the long-term biodiversity monitoring program (if one is required).

Biodiversity risks, management requirements, and information needs will vary according to the project, and therefore the biodiversity baseline study should be proportional and specific to the anticipated risk and significance of impacts from the project.

This Quick Guide section of the report provides a summary of the important "good practices" for biodiversity baseline studies that support biodiversity-inclusive impact assessment and management planning in environmental and social impact assessments (ESIAs).

Step 1: Identify the biodiversity baseline study area. The baseline study area should encompass the geographic area of anticipated project activities and impacts -- the project area of influence. In some cases, it is good practice to expand the study area to include some or all of the larger distribution of biodiversity and ecosystem values across the landscape.

CHECKLIST

- Have the project area of influence and the larger baseline study area been identified, and is the methodology and criteria that were used to determine it clearly described?
- Does the project area of influence include direct, indirect, and cumulative areas of influence?
- Does the baseline study area consider the larger occurrence or distribution of biodiversity values, particularly those values that are range-restricted, that may be especially important for the interpretation of project impacts?

Step 2: Identify the biodiversity values that will be included and potentially carried through the ESIA. The scope may also describe methodologies that should be used, define the spatial and temporal scale of the study, and identify the stakeholders to be consulted. The scope of the baseline study must be carefully defined to meet the needs of the ESIA, without wasting resources by collecting unnecessary information.

CHECKLIST

- Are the regulator, lender, and corporate requirements for the scope of the biodiversity baseline study clearly understood and stated?

Step 3: Review existing information on the biodiversity values that fall within the scope of the baseline study. It is possible that existing information is sufficiently current and comprehensive that field-based assessments are not necessary. To conduct the desk-based assessment, the project proponent should compile and evaluate available biodiversity information on the distribution and abundance of biodiversity values identified in the scoping stage, and summarize this information in a preliminary baseline report or in the main baseline report.

CHECKLIST

- Has current knowledge on biodiversity values that fall within the project scope in the baseline study area been summarized, based on a review of available literature, databases, unpublished studies, other relevant sources, as well as on consultation with key experts and other stakeholders?
- Does the summary include a Terms of Reference (ToR) for field-based assessment of biodiversity values sufficient to address any gaps that have been identified through desk-based assessment?
- Does the report list references and data sources used?

Step 4: If necessary, conduct a field-based assessment of biodiversity values to fill the information gaps identified from desktop analysis, stakeholder consultation, and other sources, as summarized in the preliminary assessment and Terms of Reference. For large projects operating in biodiversity-sensitive contexts, the field-based assessment may represent a large investment of time and resources. The field-based assessment may be a more modest effort, or may not be required at all, for smaller projects located in less biodiversity-sensitive contexts.

CHECKLIST

- Is a detailed description available of the methodology, fieldwork dates, sampling, list of stakeholders consulted, team composition and qualifications, and any other information that will allow reviewers and the general public to understand the baseline process?
- Are field surveys adequately designed to assess variation in biodiversity values over time and within the baseline study area? Does the methodology include a power analysis or another approach to assess whether the sampling effort is sufficient?
- Have species surveys been organized with respect to specific natural habitat types?
- Are maps available that show the distribution (and ideally abundance) of biodiversity values in the baseline study area?
- Are appropriate metrics identified to measure the viability and function for biodiversity values, and is it explained how they should be monitored over the long-term? Has an initial assessment been conducted of these metrics?

Step 5: Integrate the data into a baseline report. The report will combine the information from the preliminary baseline report with the information collected from the field-based assessment to describe the biodiversity values present in the baseline study area.

CHECKLIST

- Does the baseline report list and describe the natural habitats, species, and ecosystem services within the baseline study area, and include information on their current conservation status (subnational, national, and global, as appropriate)?
- Does the baseline report provide discussion and additional information on the importance of the potentially affected habitats and species relative to their global distribution?
- Does the baseline report provide quantitative measures of abundance, distribution, and other measures of viability and/or function, sufficient to support impact assessment, and if necessary, the application of the biodiversity mitigation hierarchy?
- Does the baseline report clearly identify and discuss limitations, uncertainties, and data gaps? And does it identify how to fill these gaps as part of the Environmental and Social Monitoring and Management Plan and Biodiversity Action Plan?

Throughout the baseline study: Engage stakeholders and experts. When developing a biodiversity baseline study, it is important to engage stakeholders and experts throughout the baseline study and other steps of the ESIA. Engaging stakeholders allows a project to better characterize biodiversity values including ecosystem services in the baseline study area. Similarly, experts familiar with the study area can be of tremendous help in identifying biodiversity values that should be included in the scope of the biodiversity baseline study, ruling out others that are not likely to be present, and reviewing the results of field-based assessments as they become available.

CHECKLIST

- Does the baseline study, on its own, or in combination with a social baseline study, identify ecosystem services and their beneficiaries, defined through consultation with experts, organizations, and communities?
- Have the priority biodiversity values been defined through sufficient consultation with experts, organizations, and communities?
- Is there evidence of stakeholder consensus on the scope of the biodiversity baseline studies and impact assessment?
- Does the baseline provide a list of experts and stakeholders consulted and supporting evidence?

As required: Long-term biodiversity monitoring. If necessary, design a long-term biodiversity monitoring program to verify the accuracy of predicted impacts and risks to biodiversity values posed by the project, and/or to verify the predicted effectiveness of biodiversity management actions. Biodiversity values that require monitoring will be identified in the project's Environmental and Social Monitoring and Management Plan (ESMMP) and/or the Biodiversity Action Plan (BAP).

CHECKLIST

- Does the long-term monitoring program fully address the requirements laid out in the project's Environmental and Social Monitoring and Management Plan and/or the Biodiversity Action Plan?
- Are the metrics that are monitored capable of providing meaningful and relevant information in a cost-effective manner?
- Does the monitoring program include both process and outcome metrics? Is the frequency of monitoring appropriate for each?
- Has the long term monitoring program been designed to achieve sufficient statistical rigor to support adaptive management of the project's mitigation program?

1 Introduction

1.1 Who is this document for?

This document is produced for corporations, lenders, regulators, and others involved in conducting Environmental and Social Impact Assessments (ESIAs). It summarizes "good practices" for biodiversity baseline studies that support biodiversity-inclusive impact assessment and management planning in ESIAs.

This document is based on a review and synthesis of various reports and guidance documents from multi-lateral financing institutions (MFIs), government regulators, industry associations, and non-governmental organizations (NGOs). It is not intended to replace ESIA guidance, but rather to supplement it where biodiversity is not adequately covered. This document is a companion to ***Good Practices for Biodiversity-Inclusive Impact Assessment and Management Planning***[1].

Biodiversity risks, management requirements, and information needs will vary according to the project, and should be proportional and specific to the anticipated risk and significance of impacts. Investments in developing thorough baselines, if properly scoped, are likely to be cost-effective as they may prevent costly delays and difficulties due to biodiversity-related issues that could become apparent at later stages of project development. This document offers a range of options for good practices, leaving it to the project developer to select the appropriate approach required for their context.

This guidance should help those involved in developing ESIAs to understand the technical concepts underpinning biodiversity baseline studies, specify the required studies/analyses to be undertaken by specialists, and help with the interpretation of results. Although this guidance emphasizes terrestrial ecosystems, the basic approach and principles described are applicable to any ecosystem.

For some projects, adequate biodiversity baseline studies may not be achieved by conducting a single field campaign. An iterative approach may be needed to respond to new information arising from the project site and to meet the evolving needs of the environmental assessment. As a result, it is good practice to begin the collection of biodiversity baseline information early in the project cycle, and for contingency funds to be available to cover the costs of additional studies should they be necessary[2].

[1] Hardner, J., R.E. Gullison, S. Anstee, M. Meyer. 2014. ***Good Practices for Biodiversity-Inclusive Impact Assessment and Management Planning.*** Prepared for the Multi-lateral Financing Institutions Biodiversity Working Group.

[2] The Cross-Sector Biodiversity Initiative Timeline Tool provides a helpful framework for aligning biodiversity baseline activities with project and financing timelines: http://www.ipieca.org/publication/cross-sector-biodiversity-initiative-timeline-tool

1.2 Key definitions

Before proceeding further, it is worth defining several key terms.

- **Biodiversity** is "the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems[3]".
- **Species** refers to the largest group of similar living organisms that are capable of mating and producing fertile offspring. Smaller groups of similar organisms that meet the same criteria may be referred to as populations, or sub-populations.
- **Habitats** are the place or type of site where an organism or a population naturally occurs[4].
- **Ecosystems** are a dynamic complex of plant, animal and micro-organism communities of species and their non-living environment interacting as a functional unit.
- **Ecosystem services** are benefits people obtain from ecosystems including provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other non-material benefits.
- **Biodiversity values** are specific species, habitats or ecosystems, and ecosystem services occurring at a project site that may be included in a biodiversity baseline study. For example, biodiversity values at one project site might include game species that play an important nutritional role in the diets of local communities. At another site, biodiversity values might include rare habitats that occur in only a few places in the world.
- **Biodiversity baseline study** is the work done to collect and interpret information on the biodiversity values occurring at a site, their current condition, and trends before a project commences[5].

This document minimizes the use of technical terms in order to improve readability. However, the use of some technical terms is unavoidable. Rather than having a lengthy glossary as an appendix to this document, we refer the reader to the A to Z Biodiversity Terms website for definition of technical terms [6].

[3] Convention on Biological Diversity website. Accessed August 18, 2014: http://www.cbd.int/convention/articles/default.shtml?a=cbd-02

[4] Convention on Biological Diversity (CBD) 1992

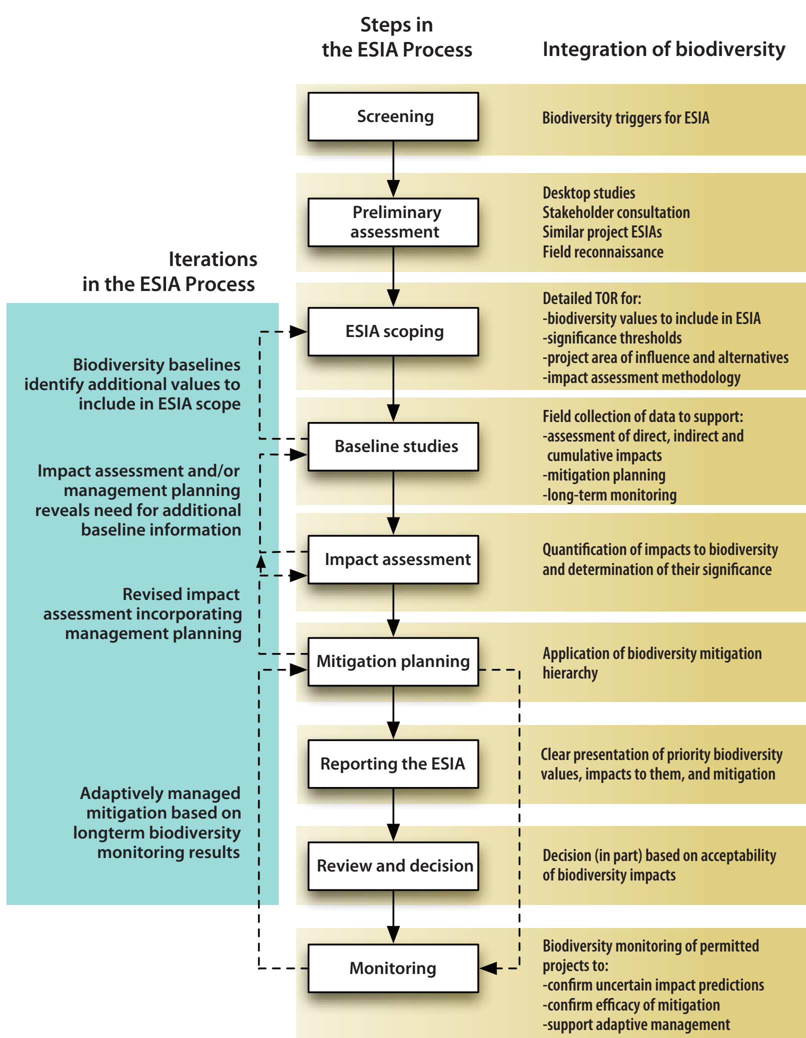
[5] Some prefer the terms "biodiversity survey" or "biodiversity assessment" for work done to characterize the biodiversity at site, reserving the term "biodiversity baseline" for the assessment of initial conditions at the commencement of long-term monitoring of project impacts.

[6] http://www.biodiversitya-z.org/themes/terms?s=menu//

1.3 Biodiversity baseline studies and the ESIA process

The biodiversity baseline is an essential component of the larger environmental management process. The baseline is necessary to inform impact assessment and management planning in the ESIA, as well as monitoring and adaptive management over the life of the project. The assessment process should characterize the baseline conditions to a degree that is proportional and specific to the anticipated risk and significance of impacts. **Figure 1.1** illustrates the integration of biodiversity in the ESIA process.

Figure 1.1: Outline of ESIA process and how biodiversity information is considered at different steps



In recent years the mitigation hierarchy has become accepted good practice for managing impacts to biodiversity, and biodiversity baseline studies play a vital role in enabling the application and implementation of the mitigation hierarchy. The mitigation hierarchy describes the sequence in which different types of management actions are applied, starting with actions to avoid impacts to biodiversity and ending with biodiversity offsets (see Table 1.1).

Table 1.1: Some ways in which the biodiversity baseline study supports the application of the mitigation hierarchy

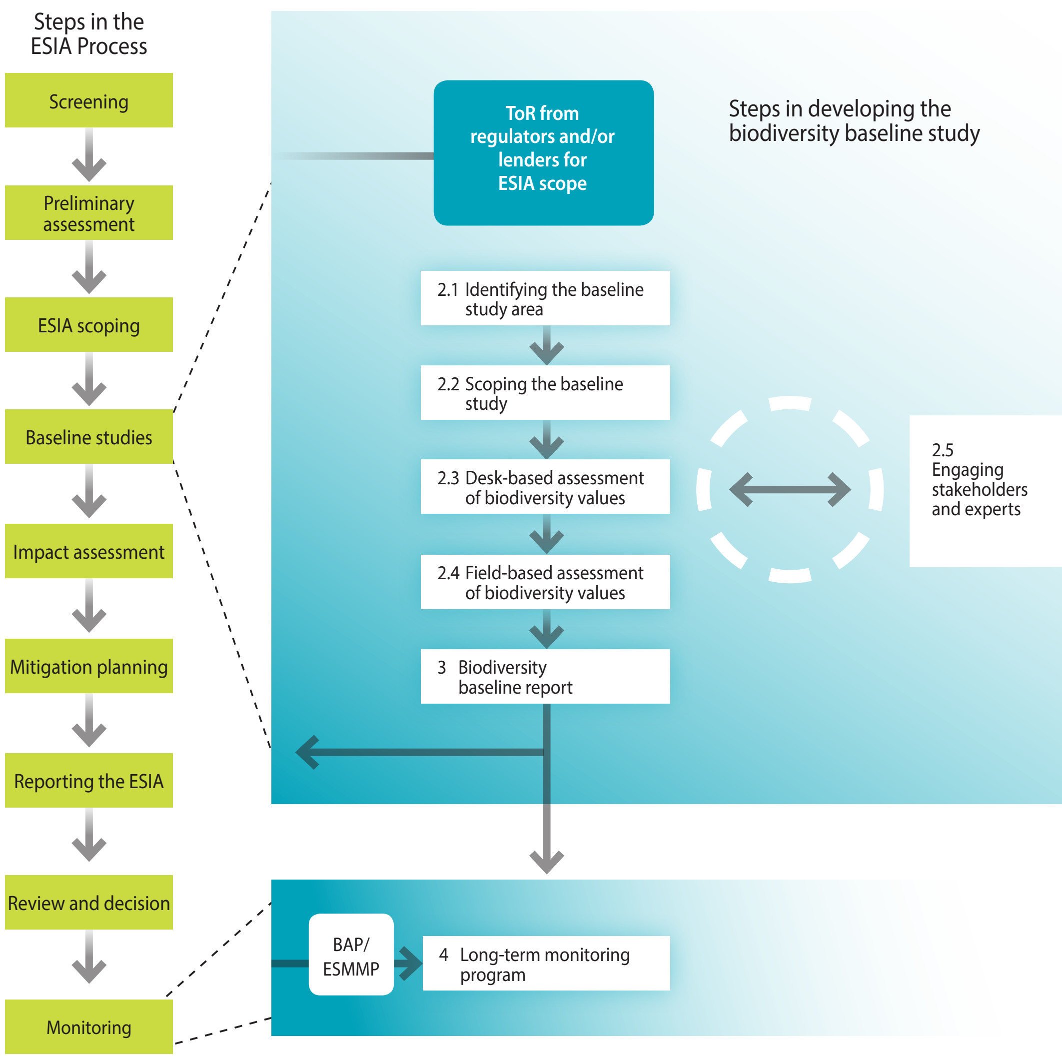
Biodiversity mitigation hierarchy	Biodiversity baseline activity
Avoid	
Actions taken to fully prevent impacts to biodiversity values, such as changing the spatial design of a project to prevent impacts in specific locations	Biodiversity values that are important enough to trigger consideration of avoidance measures, such as protected and/or extremely important habitats for highly threatened species
Minimize	
Actions taken to reduce the duration, intensity and/or extent of impacts that cannot be completely avoided	Biodiversity values that merit measures to minimize impacts - this includes most biodiversity values
Restore	
Actions taken to return areas to beneficial use, and if possible assist in the recovery of the ecosystem that has been degraded, damaged, or destroyed	Characterizes pre-project conditions to assist in identifying appropriate targets for restoration of the project site (for projects without a permanent project footprint)
Biodiversity Offsets	
Investments in offsite biodiversity offsets to address a project's residual impacts after implementing the prior steps of the mitigation hierarchy	Characterizes pre-project conditions to assist in identifying appropriate targets for compensation of residual impacts. Baseline studies can be expanded to include the characterization of potential offset sites

2 Developing the Biodiversity Baseline

This chapter describes the steps involved in developing a biodiversity baseline study (Figure 2.1). Whether a project must follow all steps will depend on the biodiversity values present at the project site, the sensitivity of these values to potential project impacts, as well as regulatory, lender, and corporate requirements.

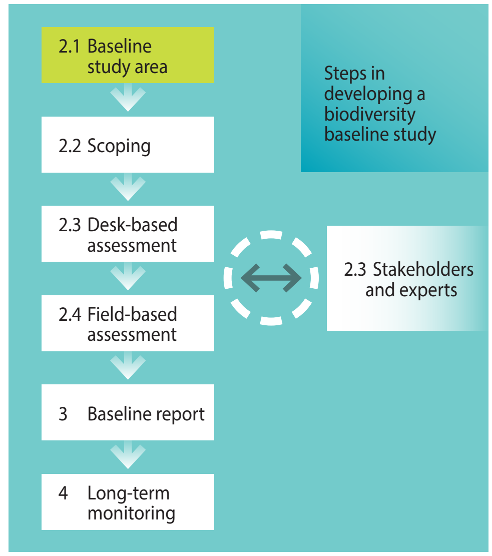
Figure 2.1: Basic steps involved in developing a biodiversity baseline study

Numbers correspond to chapter and sub-chapter headings where the step is described.



If a regulator or lender has already carried out a scoping exercise for the project, a detailed Terms of Reference for the baseline studies may be available, eliminating the need to carry out some of the early steps described here.

2.1 Identifying the baseline study area



Identifying the study area is the first step in developing the biodiversity baseline. The baseline study area should encompass the geographic area of anticipated project activities and impacts -- the *project area of influence*.

In some cases it is good practice to expand the study area based on the distribution of biodiversity and ecosystem values across the landscape.

Overlaying the proposed project footprint with spatial information of the landscape within which the project will be located is the first step in identifying the project area of influence and the larger baseline study area. Sources of spatial information include Google Earth, other types of satellite imagery, aerial photos, and existing mapping products from government sources and elsewhere.

It should be noted that the baseline study area may change during the ESIA process to respond to the need for additional information to support impact assessment and mitigation planning, or to include control and benchmark sites to support long-term monitoring *(see Chapter 4)*.

2.1.1 Project area of influence

It is good practice to take a comprehensive approach to defining a project's area of influence. The project area of influence is generally larger than the physical footprint of the project, and includes the area within which a project may potentially directly, indirectly, and cumulatively cause impacts to biodiversity values.

The area of influence may include the following, as appropriate:

- The area affected by the project activities and facilities that are directly owned and managed by the project. Examples include the physical project footprint, areas adjacent to the project site that are affected by emissions and effluents, power transmission corridors, pipelines, borrow and disposal areas, etc.
- The area affected by associated facilities that, although not part of the project that is being assessed by the ESIA, would not have been constructed in the absence of the project. Examples of associated facilities include railways, roads, captive power plants or transmission lines, pipelines, utilities, warehouses, ports, and logistics terminals.

- The physical footprint of non-project activities in the surrounding area that are caused or stimulated by the project plus the area affected by their emissions and effluents. These so-called indirect impacts to biodiversity are generally the result of changing economic or social patterns catalyzed by the project's presence, such as human settlement near a project site resulting in the destruction of natural habitat or increased pressure on biological resources (e.g., increased access to sensitive areas as a result of new roads, rights-of way, etc.). In some cases, a project's indirect impacts can greatly exceed its direct impacts.
- Cumulative impacts are the incremental impacts of a project to biodiversity values, when also considering current and reasonably foreseeable future stressors affecting a biodiversity value in the landscape. Cumulative impacts can be similar in type (e.g., emissions to air from multiple projects) or distinct (e.g., the cumulative effect of habitat loss, habitat fragmentation, and vehicular mortality on wildlife).

Some regulatory authorities, lenders, or corporate standards may also require a project to consider the impacts of its supply chains on biodiversity.

2.1.2 Perceived project impacts

Stakeholder consultation may reveal perceived impacts from a project that are different than those indicated by science, or by similar experience elsewhere. It is good practice to document perceived impacts, even if they appear technically unfounded. Maintaining a discipline of respectfully acknowledging and analyzing these concerns will contribute towards building trust with stakeholders and ensuring a complete analysis. It may be appropriate that the baseline study area include areas of stakeholder concern in order to confirm predictions of no impacts.

A related issue is that local communities may experience impacts to ecosystem services resulting from factors unrelated to the project (for example, landscape-scale habitat loss or climate change). It may be beneficial for baseline studies to attempt to characterize background trends and to communicate those results to local stakeholders as part of the ESIA process.

2.1.3 Spatial scales relevant to biodiversity

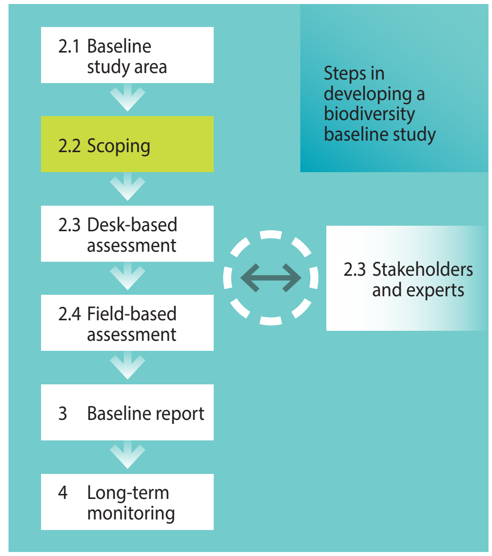
In some circumstances increasing the baseline study area will help to better understand the biodiversity context of the project. Following are cases where this may be useful:

- *Distribution of biodiversity values:* when the project may affect a biodiversity value that has a very limited distribution, it may be appropriate to include the entire occurrence of the value in the baseline assessment, particularly if the occurrence is very small, and/or if cumulative impacts are a concern.
- *Ecological function:* it may be appropriate to expand the boundaries of the analysis to encompass a functionally defined landscape, such as a watershed or plateau.
- *Migratory routes:* for migratory species, it may be appropriate for the baseline study to consider other sites utilized by the species along its migratory route. In particular, understanding whether there are functionally equivalent sites outside of the project area of influence (for example, alternative stopover or staging sites for a migratory bird species) can help in impact assessment.
- *In regions with poor existing knowledge:* where little is known about biodiversity, wider landscape-scale surveys may be needed to help assess the significance of project impacts.

CHECKLIST

- Does the baseline report indicate the area of influence and the larger baseline study area, as well as describe the methodology and criteria that were used to determine it?
- Does the project area of influence include direct, indirect, and cumulative areas of influence?
- Does the baseline consider the larger occurrence or distribution of biodiversity values, particularly those values that are range-restricted, that may be relevant to the interpretation of project impacts?

2.2 Scoping the baseline study



The ***scope*** of the baseline study refers to the biodiversity values that will be included and potentially carried through the ESIA. The scope may also describe methodologies that should be used, define the spatial and temporal scale of the study, and identify the stakeholders to be consulted.

The scope of the baseline study must be carefully defined to meet the needs of the ESIA, without wasting resources by collecting unnecessary information.

This section provides a general guide to the categories of biodiversity values that may fall within the scoping requirements placed upon a project by regulators, lenders, and corporate standards. Using desk-based assessment, expert and stakeholder engagement, and field reconnaissance to develop a full project scope are topics described in subsequent sections of the document.

2.2.1 Categories of biodiversity values that may be included in the scope

In general, biodiversity values are prioritized based on considerations of irreplaceability and vulnerability. Irreplaceability relates to the number of sites or the geographic extent where the value is present; if a biodiversity value (for example, a rare habitat type) occurs only at a few sites, then it is highly irreplaceable. Vulnerability relates to the impact and likelihood of existing and future threats; a vulnerable biodiversity value is one that has experienced rapid loss over recent history and/or is faced by current threats that will lead to rapid loss. Biodiversity values that have both high irreplaceability and high vulnerability are usually accorded the most threatened status and may be at most risk from project impacts.

2.2.1.1 Habitats

In the terrestrial environment, at the scale of landscapes, habitat mapping is usually based on vegetation types. Finer-scale habitat mapping within vegetation types can be carried out at the local scale, while at the regional or global scale, land cover may be used (for example, forest or non-forest cover). Due to challenges in collecting environmental information from aquatic environments, freshwater and marine habitats are not as well mapped as terrestrial habitats. Habitats are important in their own right, and in many cases are also able to serve as surrogates for the species that reside within them and the ecosystem services that the habitats help to provide.

Some lenders and regulators categorize habitats along a continuum of human disturbance intensity, ranging from natural habitats that have little or no human intervention, to highly modified habitats that have had their composition, structure or function greatly degraded by human activity but still provide some benefit to biodiversity.

Lenders, regulators, and corporate standards may emphasize the importance of certain habitats and require focused attention in the baseline study, such as:

- Highly threatened or unique habitats
- Habitats of significant importance to endangered or critically endangered species
- Habitats of significant importance to endemic or geographically restricted species
- Habitats supporting globally significant migratory or congregatory species
- Areas associated with key evolutionary processes

It may be appropriate for a baseline study to provide information on habitats at different scales, including the site level (condition or quality of habitats) and at the landscape scale (distribution of habitats across the baseline study area and larger landscape; connectivity, fragmentation and patchiness of habitats).

2.2.1.2 Protected areas

It is good practice to consider protected areas as an important biodiversity value that falls within the scope of a biodiversity baseline study, particularly those protected areas that have been established to fulfill objectives related to biodiversity conservation. Some examples of legally protected areas include, but are not limited to, national and sub-national protected areas with International Union for Conservation of Nature (IUCN) category I-VI designation[7].

[7] Project proponents should consult with lenders and/or regulators to understand their specific requirements with respect to supporting projects adjacent to or within protected areas.

2.2.1.3 Recognized biodiversity-sensitive areas

Some sites are recognized for their biodiversity values, but do not benefit from formal designation as a protected area. These sites may be referred to as recognized biodiversity-sensitive areas. Examples include:

- Key Biodiversity Areas
- Important Bird Areas
- Endemic Bird Areas
- Alliance for Zero Extinction sites
- Ecologically and Biologically Significant Areas
- High Biodiversity Wilderness Areas and other significant areas of natural habitat

It is good practice to include recognized biodiversity-sensitive areas within the scope of the baseline study.

2.2.1.4 Species

Project proponents may find that they are expected to conduct general surveys of all vertebrate groups (mammals, birds, reptiles, amphibians, and fish) and vascular plants in a biodiversity baseline study. Additional taxonomic groups, such as non-vascular plants, or invertebrates, may be included if they have been defined as an important biodiversity value.

Project proponents may also find that the baseline should include focused studies on individual species identified as conservation priorities by experts and stakeholders, including those species of special interest, protected by regulation, and with the highest conservation status accorded to them by IUCN. Examples of the types of species that may require focused studies include:

- Nationally or globally threatened species (e.g., IUCN Red List of Threatened Species)
- Species with restricted ranges (e.g., terrestrial fauna with a range < 50,000 km^2; marine fauna with ranges < 100,000 km^2; expert advice should be sought to identify range-restricted plant species)
- Migratory and/or congregatory species that utilize the site
- Other species that are considered a conservation priority by experts and stakeholders (see Section 2.5).

Species that have high local use value are categorized as ecosystem services and are treated in the next section.

2.2.1.5 Ecosystem services

Ecosystem services can be classified into four types:

- Provisioning services, which are the products people obtain from ecosystems
- Regulating services, which are the benefits people obtain from the regulation of ecosystem processes
- Cultural services, which are the nonmaterial benefits people obtain from ecosystems
- Supporting services, which are the natural processes that maintain the other services.

Biodiversity underpins all types of ecosystem services, but provisioning services, such as clean water, wildlife, and fuelwood, are the types of services that may have the greatest overlap with the biodiversity baseline report.

Only very recently have robust project-level methodologies for conducting baseline studies on ecosystem services been available. In part, this lack of methodologies is due to the relatively recent appreciation of the importance of ecosystem services. Perhaps equally or even more important is the diverse and multidisciplinary nature of ecosystem services assessment, meaning that social as well as general environmental and biodiversity expertise are needed to develop ecosystem service baselines.

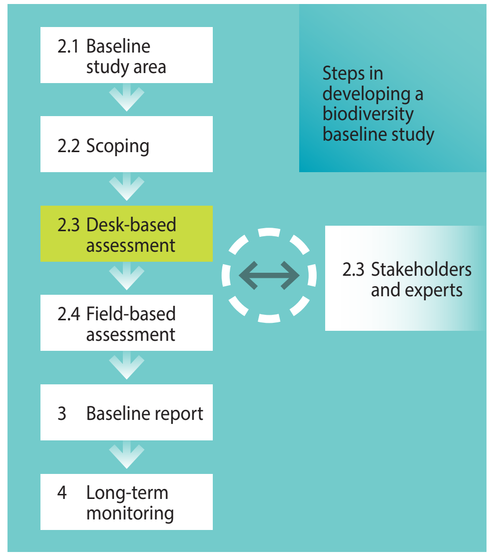
2.2.1.6 Biodiversity values based on specific criteria

Regulators, lenders, or corporate standards may emphasize specific biodiversity values that are not captured by the preceding categories. One example is ecological function in areas adjacent to the project site that are vital to maintaining the viability of biodiversity values occurring at the site. The scope of a baseline study should include biodiversity values based on specific criteria of regulators or lenders.

CHECKLIST

- Does the biodiversity baseline report identify the requirements of regulators, lenders, and corporate standards (as relevant) with respect to the scope of the biodiversity baseline study?

2.3 Desk-based assessment of biodiversity values



Desk-based assessment of existing information is a cost-effective means of developing an understanding of the biodiversity values that fall within the required scope of the baseline studies. Desk-based assessment is often the primary source of information in the baseline study for low risk biodiversity areas. For high-risk biodiversity areas, desk-based assessment serves as a scoping exercise to define and plan field-based assessments (as described further in Section **2.4**). It is important to note that desk-based assessment should not replace actual field work where sensitive species and/or habitats are expected to be present.

In order to conduct the desk-based assessment, the project proponent should compile and evaluate available biodiversity information on the distribution and abundance of biodiversity values identified in the scoping stage described above.

2.3.1 Global and regional databases

Table 2.1 presents a list of global biodiversity databases that provide a good starting point for desk-based assessment [8]. Some databases contain detailed information on a single category of biodiversity values - for example, the UNESCO website on World Heritage Sites – while others aggregate spatial data from various prioritization schemes, providing an efficient means of determining whether any particular site overlaps or is within close proximity to areas that are important for conservation. The Proteus website (http://www.proteuspartners.org) is a good point of access for some of the most useful online databases, including IBAT, WDPA/Protected Planet, and Ocean Data Viewer.

Project proponents should be aware that the quality of these databases is variable. While the locations of existing legally protected sites are likely to be quite accurate, useful data on species richness, presence/absence of individual species, or the distribution of species, may be inaccurate or unavailable at a scale that is relevant to a project. This is due to a variety of factors, including:

- The resolution of mapping of the occurrence and distribution of species may be much coarser than the scale of the project.

[8] Note that IUCN Red List of Threatened Species, World Database of Protected Areas, and Key Biodiversity Areas, all have commercial use restrictions and should be accessed through IBAT. IBAT and some other websites incur a cost for commercial use.

- The databases may depend on outdated information.
- The databases may be based on incomplete information. For example, it is quite common while working in biologically diverse tropical countries to detect species that are new to science, or to document an occurrence that represents a considerable expansion in the known distribution of a species.
- Habitat quality, extent and species composition may shift due to human, climatic or other drivers, particularly at fine scales.

Recognizing these limitations, global databases provide a useful starting point for describing the biodiversity context of a project. Whenever possible, information obtained using these databases should be verified by fieldwork.

2.3.2 National and sub-national information

In many countries, substantial national and sub-national biodiversity information is available. Sources include:

- National and sub-national (e.g., provincial, state) lists of threatened (and candidate) species, species distributions, and recovery plans for legally protected high conservation value species and habitats
- National and sub-national (e.g., provincial, state) lists, locations, and management plans of legally protected areas (and candidate areas)
- Systematic conservation plans for landscapes produced by governments and/or science-based conservation organizations
- National and sub-national maps of soils, elevation, vegetation, land use and land use change
- A country's National Biodiversity Strategy and Action Plan, which describe national biodiversity priorities and conservation planning[9].

As is the case for global biodiversity databases, national and sub-national biodiversity information may be inaccurate because it is based on incomplete or outdated information, or because the scientific processes underpinning the data are not consistent with best practices. For example, some species that receive regulatory protection may be more widespread than actually documented, while others may not have been evaluated and therefore not included in the lists of protected species.

[9] http://www.cbd.int/countries/

Table 2.1: Example sources of desktop biodiversity information

Scope	Resources	URL	Comments
General Resources	Google Scholar	scholar.google.com	Searches the world's scientific literature, including grey literature
	Integrated Biodiversity Assessment Tool for Business	https://www.ibatforbusiness.org	Spatial layers of many conservation priorities, including: • IUCN Red List of Threatened Species • Birdlife International Important Bird Areas and Endemic Bird Areas • Alliance for Zero Extinction sites • World Database of Protected Areas • Key Biodiversity Areas • Biodiversity Hotspots • High Biodiversity Wilderness Areas
	A to Z Areas of Biodiversity Importance	www.biodiversitya-z.org	Definitions, information and links to many of the world's biodiversity prioritization frameworks
	The Nature Conservancy Biodiversity and Ecosystem Services Trends and Conditions Assessment Tool	bestcat.org.s3.amazonaws.com/index.html	Maps biodiversity and ecosystem service sensitivity for corporate sites
Habitats and ecosystems	World Wildlife Fund Global Ecoregions	wwf.panda.org/about_our_earth/ecoregions/about/	Science-based prioritization of the terrestrial, freshwater and marine habitats
	NatureServe conservation database of species and ecosystems	www.natureserve.org	Conservation assessments for species and habitats in the Americas
	The Nature Conservancy Ecoregional Assessments	www.conservationgateway.org/ConservationPlanning/SettingPriorities/EcoregionalReports/Pages/EastData.aspx	Conservation plans for >150 of the world's ecoregions
	IUCN Red List of Ecosystems	www.iucnredlistofecosystems.org	Conservation assessments for a small but growing number of ecosystems assessed in a manner analogous to IUCN species assessment methodology

Table 2.1: Example sources of desktop biodiversity information cont.

Scope	Resources	URL	Comments
Protected areas	International Union for the Conservation of Nature and United Nations Environment Programme	www.protectedplanet.net	Comprehensive global database of terrestrial and marine protected areas
	United Nations Educational, Scientific and Cultural Organization (UNESCO) List of World Heritage sites	whc.unesco.org/en/list/	Information on sites qualifying for World Heritage status
	World Network of Biosphere Reserves	www.unesco.org/new/en/natural-sciences/	PDF maps and information on the global network of Man and the Biosphere sites
	The Ramsar Convention on Wetlands	www.ramsar.org	Information on wetlands on Ramsar's List of Wetlands of International Importance
	Association for Southeast Asian Nations Heritage Parks	chm.aseanbiodiversity.org	Information on ASEAN's Heritage Parks designated to conserve areas of particular biodiversity importance
	Natura 2000 Sites	ec.europa.eu/environment/nature/natura2000/index_en.htm	European network of protected areas established under 1992 Habitats Directive and 1979 Birds Directive
	Protected Areas Data	gapanalysis.usgs.gov/padus/data/	National inventory of U.S. terrestrial and marine protected areas
Recognized biodiversity sensitive areas	Endemic Bird Areas	www.ibatforbusiness.org	Integrated spatial data on various potential critical habitats
	Important Bird Areas		
	Key Biodiversity Areas		
	Alliance for Zero Extinction		
	Biodiversity hotspots		
	Large intact landscapes		

Table 2.1: Example sources of desktop biodiversity information cont.

Scope	Resources	URL	Comments
Species	The IUCN Red List of Threatened Species	www.iucnredlist.org	Global conservation assessments for species
	NatureServe conservation database of species and ecosystems	www.natureserve.org	Conservation assessments for species and habitats in the Americas
	Global Biodiversity Information Facility Biodiversity Data	http://www.gbif.org	Freely available data on the occurrence of species. More than half a billion occurrences in database. These data can be used to understand the occurrence and occupancy (or distribution) of species, and to understand endemism and range-restriction.
	The Botanical Information and Ecology Network	http://bien.nceas.ucsb.edu/bien/	Standardized botanical observation records, geographic range maps, diversity maps, species lists, and a species-level phylogeny for all of the plants in the New World.
	Spatial Analysis of Local Vegetation Inventories Across Scales	www.salvias.net/pages/	Hosts vegetation plot data from around the world that can serve as reference or benchmark data for assessing habitat condition
	A Global Information System on Fishes	www.fishbase.org	The largest and most accessed online database of finfish including information on taxonomy, distribution and ecology.
Ecosystem services	Artificial Intelligence for Ecosystem Services	www.ariesonline.org	A suite of web-based tools to support ecosystem service assessment and valuation
	Toolkit for Ecosystem Service Site-based Assessment	www.tessa.tools	Technical support to the non-specialist for site-based assessment of ecosystem services

2.3.3 Scientific literature

The advent of Google Scholar (scholar.google.com) allows the efficient search of peer-reviewed and grey scientific literature on biodiversity values. Once a desktop search has been performed using the various databases discussed above, searching for scientific studies on Google Scholar can be conducted on specific biodiversity values that are possibly present within the baseline study area.

Search protocols can be as simple as entering the common name or the scientific name of a species and the country of occurrence. Links are provided to PDF files for many of the studies that the Scholar search will reveal; for the remainder, PDFs can be obtained by paying for the journal article or book, by accessing the material at a library, or by contacting the authors directly for a PDF reprint.

2.3.4 Other relevant desktop information

Other information that can help inform the desk-based assessment includes:

- Biodiversity baseline studies and ESIAs conducted for other projects in the vicinity of the baseline study area
- If the project site is near a protected area, information may be available about biodiversity values within the protected area that is relevant to the project site
- Stakeholder mapping of local communities, community groups, indigenous groups, etc. to structure the engagement process that supports the development of the baseline (Section 2.5)
- Consulting with relevant experts, including science-based NGOs, academic and research institutions, and individual experts.

Consultation of experts and stakeholders will likely reveal other sources of relevant desktop information that can be incorporated into the desk-based assessment.

2.3.5 Field Reconnaissance

Some projects may benefit from a reconnaissance trip to the baseline study area. The ways in which field reconnaissance can support the baseline study include:

- Verifying the presence of biodiversity values that have been identified from possibly outdated desktop information; for example, online databases may indicate the presence of intact high-conservation value forest, but a site visit may reveal that the forest has since been degraded or converted to other land uses
- Identifying new biodiversity values that were not identified by desktop analysis, but that should be included in the project scope

- Refining the baseline study area
- Conducting preliminary meetings with local stakeholders to understand their priorities and concerns (Section 2.5).

The reconnaissance team should include members with local experience and experience relevant to the biodiversity values identified through the scoping exercise.

The earlier that potentially important biodiversity values can be identified and integrated into the baseline study, the better. Late detection of important values can threaten the project schedule and reduce the effectiveness of mitigation planning.

2.3.6 Producing a preliminary baseline report and determining field survey needs

Once the baseline area identification, scoping, desktop analysis, stakeholder/expert consultation, and any field reconnaissance have been carried out, the information may be written up as a preliminary baseline assessment that includes the detailed ToR for fieldwork. This preliminary assessment might include[10]:

- Description of the baseline study area, including biogeographic and landscape settings
- Available habitat maps indicating the likely types and extents of terrestrial and aquatic habitats
- Identification of biodiversity values that fall within the project's area of influence
- Description of the context of biodiversity values, including ecosystem services
- Discussion of possible effects, both positive and negative, to biodiversity values from the proposed project
- A list of relevant experts, including NGOs, institutions, and individual researchers
- Identification of key biodiversity stakeholders
- A list of references and data sources used
- Discussion of the reliability of information and gaps in existing information
- Terms of reference for field-based assessments, including methodologies, to complete the biodiversity baseline.

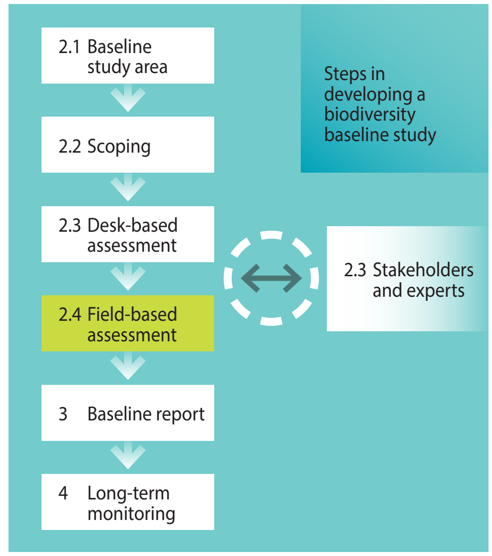
Preliminary findings can then be substantiated or complemented with field-based assessments before being used for impact assessment and project planning.

[10] The following list is based on IADB (2014).

CHECKLIST

- Does the preliminary baseline report synthesize and summarize current knowledge on biodiversity values that fall within the project scope in the baseline study area, based on review of available literature, databases, unpublished studies, other relevant sources, as well as on consultation with key experts and other stakeholders?
- Does the preliminary baseline report include a Terms of Reference for field-based assessment of biodiversity values sufficient to address any gaps that have been identified through desk-based assessment?
- Does the preliminary report list references and data sources used?

2.4 Field-based assessment of biodiversity values



Field-based assessment of biodiversity values should fill the information gaps identified from desktop analysis, stakeholder consultation, and other sources, as summarized in the preliminary assessment and ToR. For large projects operating in biodiversity-sensitive contexts, the field-based assessment may represent a large investment of time and resources. The field-based assessment may be a more modest effort, or may not be required at all, for smaller projects located in less biodiversity-sensitive contexts.

The following is an overview of some key issues associated with the design of field-based assessments and choices of methodologies. It is worth emphasizing the importance of engaging appropriate experts throughout the field-based assessment, either directly participating in surveys or reviewing the work that has been conducted.

2.4.1 Factors influencing field-based assessments

Field-based assessments will employ a variety of methodologies to understand the distribution, abundance, and conservation status of biodiversity values within the baseline study area. For each type of biodiversity value, various approaches to field-based assessments will be possible. The design of the assessment and choice of a methodology will be influenced by a number of considerations, including:

- *Regulatory requirements:* project proponents should ensure that the design of the field surveys meets relevant government regulatory requirements with regard to methodologies or other aspects of survey design (e.g., sampling intensity, or inclusion of taxonomic groups). However, projects should be aware that simply satisfying regulatory requirements may not be sufficient to comply with good practices or lender and corporate standards and that it may be desirable to supplement or improve on the methods required by regulators.
- *Efficiency/cost-effectiveness:* projects should consider the cost-effectiveness of different methodologies when designing field-based assessments.
- *Experience of contractors:* baseline contractors may have a particular method or methods with which they have experience. This experience should be taken into consideration, but should not override other considerations of appropriateness, cost-effectiveness, and scientific rigor when selecting the best methodologies.

- *Credibility/established good practices:* in all cases, the design of the assessment and the choice of methodologies should represent good practice and be credible in the eyes of the scientific community and other key stakeholder groups, as indicated by the use of similar approaches in the scientific literature and by recognized experts.
- *Comparability with available data from reference sites and potential offset sites*: in some cases it will be beneficial for baseline information to be collected in a manner that is consistent and comparable with information collected on the same biodiversity values in other locations, or previous information from the same site. For example, a project proponent may wish to compare data from the project site with publicly available information on plots installed in intact vegetation at other sites, or, a project proponent may anticipate supporting protected areas as part of the project's strategy to achieve a net gain for a biodiversity-sensitive habitat. In these examples, it would be advantageous for the project's impacts in the study area to be measured in a manner consistent with the way biodiversity monitoring is carried out at the benchmark or offset site.
- *Ability to provide information on required metrics:* the chosen methodology must be able to deliver data on the metrics chosen to reflect the viability and/or function of the biodiversity values. More discussion of metrics is presented in the next section.

2.4.2 Design of field assessments

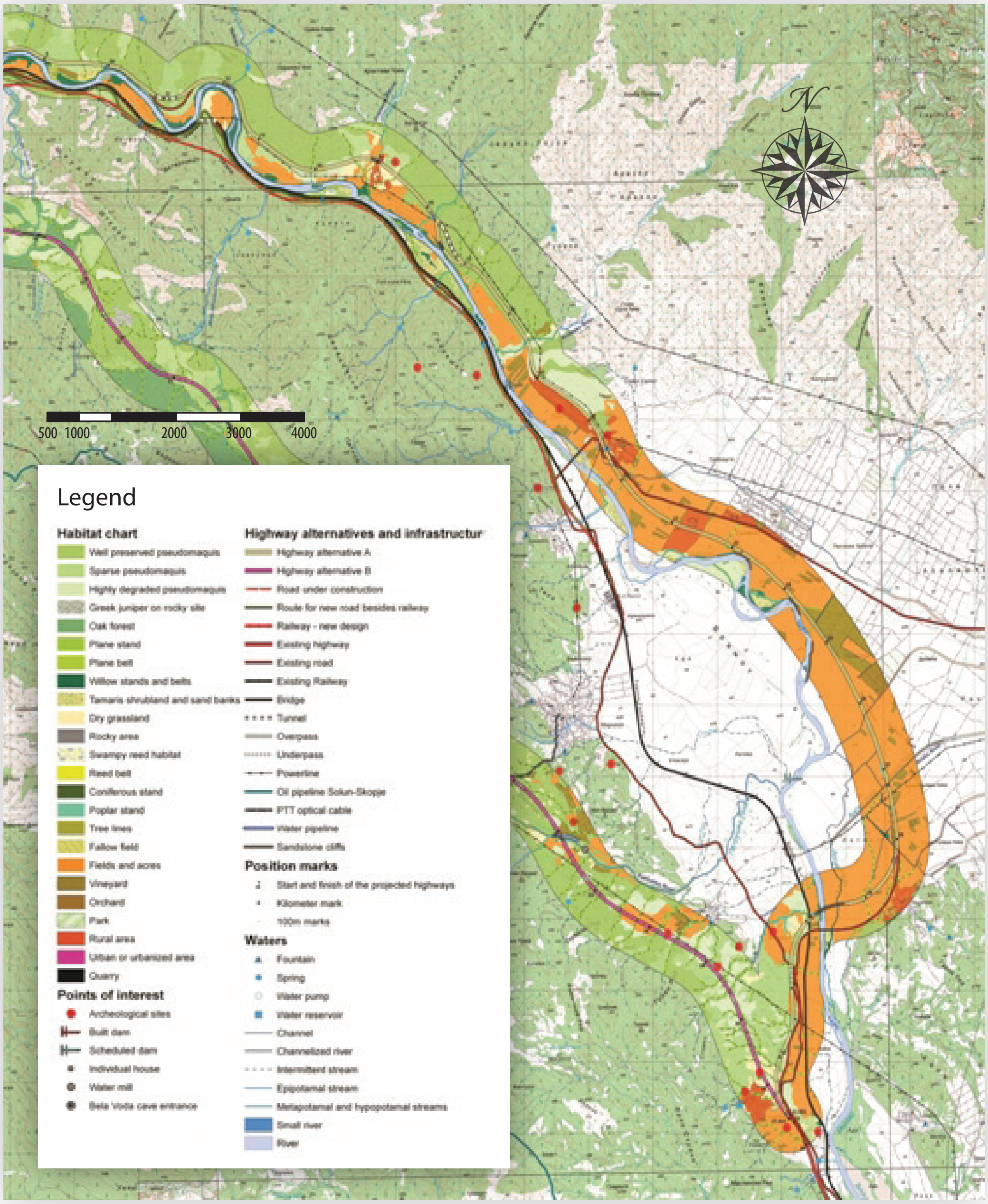
This section describes general good practices for the design of field-based assessments. Section 2.4.3 reviews methodological considerations for surveying and measuring different types of biodiversity values.

2.4.2.1 Developing a habitat map

Preparing a habitat map as early as possible in the baseline schedule is good practice, and it is strongly recommended that its preparation precede the design of field surveys for other types of biodiversity values. The habitat map can play the following roles:

- *Design of sampling strategy:* the map provides a basis for designing sampling strategies for the various biodiversity values to be surveyed.
- *Use of habitat surrogates:* by basing sampling for other types of biodiversity values on the habitat map, the likelihood that habitats can be used as a surrogate or proxy measure for other biodiversity values is greatly increased.
- *Impact measurement:* the map provides a basis for determining the area and quality of terrestrial and aquatic habitats impacted by a project, and thus plays a key role in supporting any loss-gain accounting that may be required to demonstrate achievement of performance targets such as "no net loss" of biodiversity.

Figure 2.1: An example of a habitat map prepared for a highway ESIA



If a habitat map is not already available for the baseline study area, a map can be produced using a Geographic Information System (GIS) to develop a supervised classification of the study area, based on remotely sensed imagery of an appropriate resolution. Habitats should be defined using a broadly accepted habitat classification, and should also identify land uses occurring within habitat types so that it is possible to discern the degree of human disturbance (for example, secondary versus primary forest of a given forest type).

To integrate aquatic habitats, a hydrological map should be used to include watershed boundaries, streams, and open water (e.g., lakes, potholes, ponds). Other aspects that are useful include topography to assess stream gradients, presence of any fish barriers (e.g., waterfalls, dams), and seasonality if some of the water features are ephemeral in nature.

The initial habitat map should be ground truthed by obtaining higher resolution imagery for a sample of sites, conducting site visits, or using information from other sources. This initial map of terrestrial and aquatic habitats will be refined and improved in an iterative fashion as information becomes available from fieldwork.

2.4.2.2 Determining where to survey

The preliminary baseline report and ToR may identify information gaps for specific types of biodiversity values. To address these gaps, surveys of the baseline study area can be conducted to understand the distribution and ideally the abundance of these biodiversity values within the baseline study area. As it is usually impractical to survey the entire baseline study area for each of the biodiversity values, a balance must be found that ensures the area is adequately covered, but that fieldwork is not excessive.

Surveys can be divided into general surveys and focal surveys. General surveys are used to characterize biodiversity values such as communities of species, or habitat types. For example, a biologist might walk timed transects, recording all the bird species she observes, in order to characterize the bird community within different habitats. The data obtained would allow a comparison of the number of species present in each of the habitat types and provide estimates of the relative abundance of at least the most common species.

There are various ways in which general surveys can allocate their sampling effort over the baseline study area. Three approaches to locating sampling sites for general surveys, in increasing order of preference, are:

- ***Systematic:*** an evenly spaced grid of sampling points can be laid out over the study area, with the location of the first point randomly located. This approach may be relatively easy to implement in the field, but may not achieve the goal of adequately sampling all of the biodiversity values that occur on the landscape. It may also bias results if some biodiversity values occur with the same systematic distribution as the sampling points, or if there are small localized patches of specialized or distinctive habitat.
- ***Random:*** sampling points can be located in a completely random manner, but for low sampling

intensities, some types of biodiversity values may not be adequately sampled.

- *Stratified random:* a map of habitats provides the ideal basis for deciding where to locate general surveys. Sampling points can be randomly located within each of the habitat types and broken down further by considering degree and type of disturbance within each habitat type. It is important that all habitat types are sampled. By locating sampling sites in a random manner, the results can be reliably extrapolated to the study area as a whole.

It is important to note that subjective selection of "representative" sampling sites is vulnerable to bias and is not a valid approach for locating sampling sites for general surveys.

In contrast to general surveys, focal surveys are designed to maximize the chance of detecting rare or threatened species or habitats. Because of the rarity of these biodiversity values, general survey methods may fail to detect them. Focal surveys use as much as possible about what is known about the biology of the target species or habitat to design a survey method that maximizes the chance of encountering it. Instead of locating sampling sites in a random or stratified random manner, focal surveys will involve more extensive but unstructured or semi-structured surveys of sites where the species or habitat types are most likely to occur. The rarity of species or habitat that is being searched for, and the informal manner in which the surveys are carried out, means that reliable estimates of density or relative density are generally not possible. Rather, a simple assessment of whether a species or habitat is present or not is frequently all that can be ascertained.

2.4.2.3 Determining when to survey

The detectability and abundance of biodiversity values may vary temporally, including time of day, time of month (e.g., in relation to phase of moon), time of year (e.g., local or large scale movements or migration), seasonally, annually, and over periods of multiple years. Variation on longer scales is also possible, for example, caused by climatic phenomena such as El Niño events.

It is good practice for baseline surveys to be structured in such a way as to help understand regular large changes in detectability and abundance of biodiversity values that may occur in the baseline study area over time (e.g., wet and dry seasons at tropical sites; some combination of spring/summer/autumn/winter at temperate sites).

Focal surveys for priority values should target times when those values are most easily detected (for example, in the peak flowering or fruiting season for a plant species). Because detectability will vary among species, multiple field campaigns may be required if focal surveys are required for more than one species.

The importance of documenting temporal variation in biodiversity values in the baseline study will vary depending on the size of the project and the anticipated impacts to sensitive biodiversity values. Small projects with limited impacts to sensitive biodiversity may only require a single, short field campaign, whereas larger projects in more sensitive contexts may require up to several years of baseline studies.

2.4.3 Methodologies, metrics and reporting results of field-based assessments

This section provides a brief overview of appropriate methodologies for surveying different types of biodiversity values, as well as discussing the choice of metrics and how to report survey results. As mentioned above, there are many different ways in which biodiversity may be measured, and the selection of the most appropriate methodology will be based on many factors. Readers should see the suggested references for methodologies provided in Appendix 1 for more detail.

2.4.3.1 Habitats

In addition to producing a habitat map, it may be appropriate for some projects to measure the ***quality*** or ***condition*** of terrestrial and aquatic habitats within the baseline study area. Measures of condition typically consider some combination of information on the structure, composition, and ecological function of habitats, and assess the condition of the habitat at a particular site in relation to benchmark sites[11]. Measures of condition may also incorporate landscape considerations, for example, the size of the habitat patch, or degree of habitat fragmentation in the vicinity of the survey site. Approaches may be qualitative, using expert judgment to assign habitat to broad categories of condition (e.g., intact, somewhat degraded, severely degraded), or quantitative, for example, using plots or transects to produce a numeric score of the condition of a habitat.

Measuring habitat quality may benefit the ESIA in a number of ways. The information:

- Can be used to test and refine the habitat map
- Can contribute to the development of flora species lists (at least of the common species)
- Can increase the likelihood that habitat can be used as a surrogate or proxy measure for other biodiversity values
- Is useful for determining the significance of impacts
- Is a useful input for management planning to determine appropriate actions within the mitigation hierarchy (e.g., project planners may choose to avoid impacting pristine habitats over degraded habitats of the same type) and to set performance targets (e.g., understanding what is required to restore a site to its pre-project state, or how to compensate for what was lost at the site).

[11] Quality-hectares, habitat-hectares, BioCondition, and habitat equivalency frameworks are some of the terms used to describe frameworks that provide a credible reference system for determining the "quality" of vegetation or habitats.

Projects should adopt any framework for assessing vegetation condition that is specified by regulators. In Australia, for example, the use of different variations of "habitat-hectares" approaches for measuring the condition of native vegetation is a regulatory requirement in some states.

If there is no regulatory requirement, then a project may consider developing its own approach following a credible approach developed elsewhere. If information is not available on undisturbed habitats, then examples of the best available condition should be used. Some references describing different approaches for measuring habitat condition are presented in Appendix 1[12].

Metrics and reporting results: baseline information on habitats is typically presented in the baseline report both in gross terms (i.e., total areal extent of different habitat types), as well as area adjusted for condition of habitat. If habitat condition is assessed qualitatively, then the number of hectares of habitat in each condition category should be presented (for example, 50 ha of degraded montane forest, and 50 ha of intact montane forest). If habitat condition has been assessed quantitatively, then the area can be adjusted for habitat quality by multiplying area by the condition coefficient to obtain the number of habitat units for each habitat type (for example, 100 ha of montane forest X an average quality of 0.75 = 75 habitat units). The occurrence of habitats may be broken down by project footprint, area of influence, and baseline study area.

2.4.3.2 Species

The preliminary baseline report and ToR may identify gaps that require filling with respect to species occurring in the baseline study area. For example, if the species that occur within the project area of influence are not well documented, the ToR may require general surveys that aim to identify as many of the species as possible and to characterize the communities of each taxonomic group in terms of species richness and diversity. If a certain species has been identified through scoping as being of particular conservation concern, targeted or focal surveys of that species may be required to support impact assessment and mitigation planning. The following provides a brief discussion of some considerations for different taxonomic groups. A detailed description of methodologies is beyond the scope of this document, and the reader should refer to methodological references provided in Appendix 1 for more information.

- ***Non-vascular plants:*** the main groups of non-vascular plants include algae, fungi, lichens and bryophytes. Non-vascular plants are typically small and often difficult to see. Identification to species level is challenging and may require the skills of a specialist. Non-vascular plants are outside the scope of most baseline studies. Due to the variety of life forms and habitats that non-vascular plants occupy, there is a tremendous range of survey methodologies involved in

[12] Statistical power is an important consideration when determining how many samples are needed to characterize different habitat types that are present in the study area. However, it is important to remember that vegetation plot data should first be converted to the overall measure of vegetation quality adopted in the baseline, and the analysis of variance conducted on the overall composite score, rather than on the individual metrics that contribute to the condition score, as the variances and sampling needs are likely to differ between the two.

their study. Methods range from photography and remote sensing of large areas, to the use of line intercept and plot methods for finer scale analysis. Surveys of aquatic algal communities require microscopic techniques.

- ***Vascular plants:*** the main groups of vascular plants include horsetails, ferns, gymnosperms and flowering plants. Vascular plant surveys are typically conducted when the majority of plants are flowering, easing detection and identification. Multiple surveys within a year may be required to capture the plant species in distinct seasons (e.g., wet versus dry seasons) and to document plants occupying temporary habitats, such as spring seeps and ephemeral wetlands. If the objective of the vascular plant surveys is to maximize the number of species detected, then some combination of unstructured or semi-structured collecting may be appropriate. If the objective is to provide a quantitative description of the plant communities of the various habitats present within the baseline study area, then plots or transects should be located randomly within habitat types.
- ***Invertebrates:*** invertebrates include sponges, echinoderms, arthropods, molluscs, and annelids. Invertebrates are estimated to represent approximately 97% of all animal species. Despite this fact, invertebrates are not typically included within the scope of terrestrial baseline studies; and baseline studies need not consider invertebrates unless required to do so by the preliminary baseline report and ToR. Freshwater invertebrates *are* often included in aquatic baselines because they serve as effective indicators of water quality. Benthic organisms can also be studied to determine water quality in the marine environment, particularly in areas where effluents are discharged. Survey methods for invertebrates include active searching, flight interception, pitfall traps, and trapping using light or bait as attractants.
- ***Birds:*** a variety of techniques are used to survey birds, including transects, point counts, mist nets, and camera traps for larger ground-dwelling birds. Observations may be visual or made by identifying vocalizations. Because birds are small and mobile, in some habitats the ability to reliably detect certain species is a challenge. Distinct surveys must be carried out for diurnal versus nocturnal birds. Surveys are typically carried out during both the breeding and the non-breeding seasons and usually early in the morning when activity levels and detectability are greatest.
- ***Large mammals:*** mammal inventory methods include walking transects of fixed length to obtain either direct or indirect measures of mammal abundance, conducting aerial surveys, and setting out systematic grids of camera traps over large areas. Large mammals may exhibit large-scale seasonal movements, and so it is important that surveys are carried out during the time or times of year when they are most likely to be present.

- *Small mammals (rodents, bats, and other insectivores < 1 kg)*: Bats are usually surveyed using mist nets and harp traps, or with sonograms. A variety of capture techniques are used to survey non-flying small mammals, including non-lethal baited box-type traps; snap traps, which kill the animal; and drift fences to direct small mammals to pitfall traps.
- *Amphibians and reptiles:* amphibians and reptiles are surveyed along transects or within plots of fixed area. Survey methods include active searches as well as trapping including the use of drift fences and pitfall traps. Diurnal and nocturnal surveys are required to provide a complete picture of the amphibian and reptile communities. Most amphibians have an aquatic larval stage and so surveys may look for eggs and larvae in aquatic habitats. In temperate locations surveys should be carried out between spring and fall. In tropical systems surveys are ideally carried out in both the wet and dry seasons.
- *Fishes:* fishes are surveyed at specific sampling locations using a standardized effort of active or passive collecting techniques, including the use of seine nets, dip nets, trap nets, short-set gillnetting, push nets, visual counts (snorkeling) and electrofishing. In temperate locations fish surveys are not generally conducted between late fall and early spring due to low water temperatures and corresponding low activity levels. In tropical systems ideally surveys are carried out in both the wet and dry seasons.

A more complete mapping of some species or habitats within the project footprint may be required to support the impact assessment, as well as additional off-footprint work to understand its distribution within the larger study area. Survey methods will likely occur when detectability of the focal species is greatest. It is good practice to record the location of all occurrences of priority species with a geographic positioning system (GPS).

Metrics and reporting results: the way in which results of general surveys are presented in the baseline study may include the following:

- Lists of species found within the baseline study area, usually broken down by taxonomic group and by habitat type
- Comparisons of species richness, composition and diversity by taxonomic group and habitat type.

For individual species that have been prioritized in the baseline scope, it is good practice for the baseline report to present a habitat map for each species indicating where the species was surveyed in the study area, the locations of individuals documented, and some measure of abundance of the species in the different habitat types.

There are different metrics that can be used to reflect the abundance of species within the baseline study area. Possible metrics include:

- ***Measures of absolute density:*** absolute density – the number of individuals per unit area – can be derived from total counts of a species or by estimating its abundance through sampling. There are few cases where measures of absolute density are possible.
- ***Measures of relative density:*** measures of relative density are based on variables that vary in a relatively constant but unknown way with absolute density. As a result, they do not provide an estimate of absolute density. Instead, they provide an index of abundance that is (hopefully) a reliable means to compare the relative density of a species among sites or over time. Some examples of measures of relative density include number of individuals trapped over a given period of time, number of fecal pellets encountered in quadrats or along transects, number of individuals detected during a fixed period of searching, or Habitat Suitability Indices (HSI) that represent the capacity of a given habitat to support a species.

Sampling estimates of absolute density and the use of indices of abundance are both based on statistical sampling. As such, it is important to consider the statistical power of these estimates. For common species, it may be possible to get statistically robust estimates of abundance. For rare species, the variance in samples may be so high that it is not practical or even possible to produce reliable estimates of abundance. If the latter is true, then simple estimates of presence or absence of the species in different habitat types will have to suffice.

For species with low population numbers, or that have a small distribution, it can be very helpful for the impact assessment to portray the numbers of individuals or area of habitat encountered in the baseline study in relation to the overall population or distribution of the species.

2.4.3.3 Ecosystem services

If the scoping exercise indicates that ecosystem services generate potentially important benefits within the baseline study area, then neighboring communities should be engaged directly in an exercise to prioritize the importance of the ecosystem services. To be useful at the site scale, methods for quantifying ecosystem services need to produce data relevant to decisions affecting that site, be practical and affordable (in terms of expertise, equipment, and time), and provide results in an accessible form. The best ecosystem service assessment tools work sequentially through a number of discrete steps to identify, assess, prioritize, manage, and then monitor ecosystem service impacts and management actions.

A team with expertise relevant to the ecosystem service will need to be assembled to conduct the baseline study and may involve social specialists and other types of specialists (e.g., agronomists, geologists, hydrologists and hydrogeologists, soil and erosion control specialists, water management specialists, etc.) depending on the ecosystem service in question. The expertise required to conduct such an assessment will be beyond what is possessed by the team of biologists who are conducting the biodiversity baseline, and so it is likely that the ecosystem services assessment study will be contracted and conducted separately from the biodiversity baseline study.

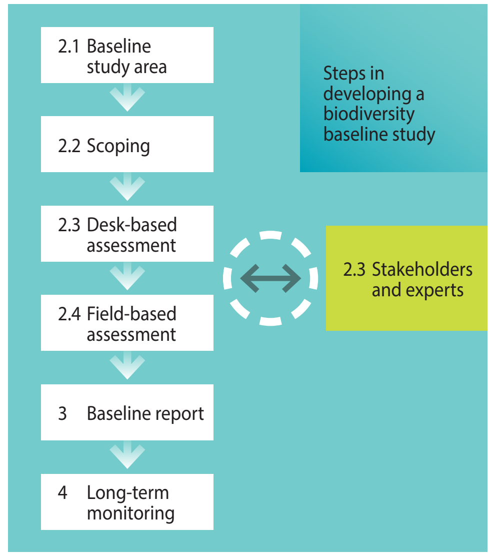
References on appropriate methodologies for conducting ecosystem service assessments are presented in Appendix 1.

Metrics for ecosystem services will be highly specific to the service in question. Some examples might be the number of hunting opportunities provided by a local ungulate population, or quantity and quality of fresh water available for local communities.

CHECKLIST

- Does the baseline report describe the methodology, fieldwork dates, sampling, list of stakeholders consulted, team composition and qualifications, and any other information that will allow reviewers and the general public to understand the baseline process?
- Are field surveys adequately designed to assess variation in biodiversity values over time and within the baseline study area? Does the methodology include a power analysis or another approach to assess whether sampling effort is sufficient?
- Have species surveys been organized with respect to specific natural habitat types?
- Does the baseline report include maps that show the distribution (and ideally abundance) of biodiversity values in the baseline study area?
- Does the baseline report identify appropriate metrics of viability and function for biodiversity values, and indicate how they should be monitored over the long-term? Does the baseline report include an initial assessment of these metrics?

2.5 Engaging stakeholders and experts



It is good practice for projects to engage stakeholders and experts throughout the baseline study and other steps of the ESIA. Engaging stakeholders allows a project to better characterize biodiversity values including ecosystem services in the baseline study area. Similarly, experts familiar with the study area can be of tremendous help in identifying biodiversity values that should be included in the scope of the biodiversity baseline study, ruling out others that are not likely to be present, and reviewing the results of field-based assessments as they become available. For these reasons and others, engaging stakeholders and experts will help improve the quality of the baseline study and/or reduce the costs of producing it.

2.5.1 Stakeholders

It is important that stakeholder consultation on biodiversity is integrated into the larger stakeholder engagement process for the project; otherwise fatigue caused by frequent or duplicative consultations can impact relations between the project and its stakeholders. Good practice in stakeholder engagement relevant to baseline studies includes:

- Identifying and analyzing stakeholders
- Engaging in meaningful consultation to understand stakeholder concerns
- Disclosing relevant information to different groups for their feedback in a proactive manner – in particular, the scope and ToR for the baseline studies, and when available, the draft baseline study for comment.

It is good practice to show that the feedback received from stakeholders is recorded, considered, and reflected in project documents where appropriate. Without this, the engagement loop is not closed.

Consultation with stakeholders can play a critical role in all stages of the baseline, from scoping onwards. Early consultation can help identify biodiversity values that are important to stakeholders for inclusion in the scope of the baseline study. Local knowledge can reveal important information relevant to understanding the biodiversity values within the project area of influence and the dependence/use of this biodiversity value and/or ecosystem services by project-affected communities. Stakeholder consultation can help ensure that stakeholders support the scope and

design of
the biodiversity baseline, increasing the likelihood that they will support the results of the environmental assessment.

The following types of stakeholders may be relevant to the biodiversity baseline:

- Indigenous groups
- Community groups
- Recreational users within the baseline study area
- Hunters/fishers
- Farmers
- Governments
- Scientists and academics not serving as expert advisors
- NGOs that are locally active on the issues of biodiversity, community development, and other related concerns.

There is extensive guidance on stakeholder engagement available, and some sources are presented in Appendix 1.

2.5.2 Experts

Expert consultation plays a critical role in developing biodiversity baselines, particularly in areas of the world where biodiversity is complex and poorly documented. In such contexts there may be little published literature on biodiversity values, and the baseline and environmental assessment will need to depend heavily on expert judgment.

Biodiversity experts can be found in:

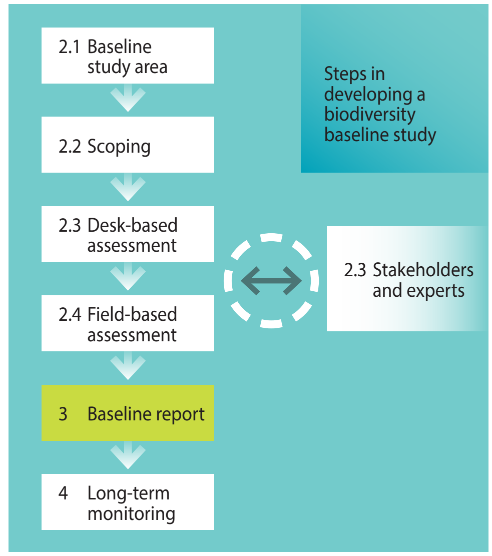
- Relevant government agencies (protected areas, agriculture, land-use planning, forestry, marine, environment, etc.)
- Science-based conservation organizations, including those with relevant online information and small local NGOs, which may have useful local knowledge
- Universities or research institutions (universities, museums of natural history, herbaria, conservation data centers, IUCN Specialist Groups, etc.).

The results of expert consultation should be captured in a format that allows them to be made available to third parties.

CHECKLIST

- Does the baseline, on its own, or in combination with a social baseline study, identify ecosystem services and their beneficiaries, defined through consultation with experts, organizations, and communities?
- Was the baseline study area modified to reflect areas of perceived project impacts, even if these were beyond the limits of those indicated by science or experience elsewhere?
- Have the priority biodiversity values been defined through sufficient consultation with experts, organizations, and communities?
- Is there evidence of stakeholder consensus on the scope of the biodiversity baseline studies and impact assessment?
- Does the baseline provide a list of experts and stakeholders consulted and supporting evidence?

3 Biodiversity baseline report



Once necessary field surveys have been completed, the biodiversity baseline report can be prepared. The report will integrate the information from the preliminary baseline report with the information collected from the field-based assessment to describe the biodiversity values present in the baseline study area. The following are suggested topics for inclusion in the baseline report[13]:

- Scope and objectives of study
- Baseline study area
- Review of criteria used in scoping, including identification of biodiversity values based on specific criteria from regulators, lenders, or corporate standards
- Desk-based assessment of existing biodiversity information
- Identification of data gaps
- Delineation of natural habitats and mapping
- Field-based assessment sampling design and methodology
- Results from field surveys
- Presentation of data on biodiversity values, including maps of occurrence within the baseline study area
- Details of expert and stakeholder consultations
- Qualifications of baseline personnel
- Species lists
- Coordinates of sampling unit locations.

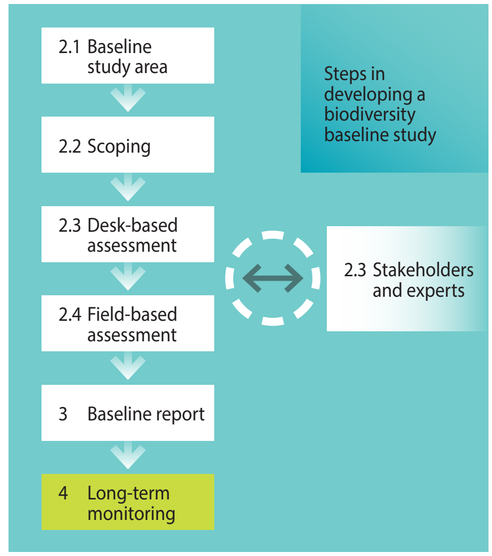
It is important to review the requirements of regulators, lenders and/or corporate standards to ensure that the baseline report is prepared in a manner that will meet their expectations.

[13] This list of suggested topics is a slightly modified version of that presented in: IADB (2014). Guidance for assessing and managing biodiversity impacts and risks in Inter-American Development Bank supported operations. Working Document Version 1. February 4, 2014.

CHECKLIST

- Does the baseline report list and describe the natural habitats, species, and ecosystem services within the baseline study area and include information on their current conservation status (subnational, national, and global, as appropriate)?
- Does the baseline report provide discussion and additional information on the importance of the potentially affected habitats and species relative to their global distribution?
- Does the baseline report provide quantitative measures of abundance, distribution, and other measures of viability and/or function, sufficient to support impact assessment, and if necessary, the application of the biodiversity mitigation hierarchy?
- Does the baseline report clearly identify and discuss limitations, uncertainties, and data gaps? And does it identify how to fill these gaps as part of the Environmental and Social Monitoring and Management Plan and Biodiversity Action Plan?

4 Long-term monitoring



After the ESIA is completed and the project is permitted, long-term biodiversity monitoring may be required in order to validate the accuracy of:

- Predicted impacts and risks to biodiversity values posed by the project
- Predicted effectiveness of biodiversity management actions.

Biodiversity values that require monitoring will be identified in the project's Environmental and Social Monitoring and Management Plan and/or the Biodiversity Action Plan.

The strength of the linkage between the baseline study and the long term monitoring program will vary from one project to the next. At one extreme, the biodiversity baseline study may serve only to provide general information about the occurrence of biodiversity values within the baseline study area; but the long-term monitoring program will use different field-based methods and metrics to monitor the biodiversity values, and may develop its own baseline estimates of distribution and abundance within the baseline study area against which to measure future project impacts. At the other extreme, there may be seamless integration between the baseline study and the long-term monitoring program, with the monitoring program continuing with the same methods and some of the same survey sites, and using data from the baseline report as the baseline against which to measure future project impacts. Most long-term monitoring programs will fall somewhere in between these two extremes.

The general principles of design and methodology discussed above will also apply to the design of the long term monitoring program. The following are some additional considerations when designing the long-term monitoring program.

Choice of metrics for species: there are various ways in which biodiversity values can be measured. Section 2.4.3 reviews the use of measures of absolute abundance and indices of abundance. In some cases, it is also possible that the abundance of a species can be inferred by using measures of its habitat. This approach can be justified if a reasonable association between the abundance of a species in different habitats (or attributes within those habitats) has been demonstrated, either through the baseline survey, or in the scientific literature. In other cases, it may also be possible to monitor the status of other more readily observed "indicator" species whose abundance is presumably correlated with the abundance of the species of interest (however, it should be noted that in general, the use of indicator species is not well substantiated by science). The choice of metrics will have a large influence on the choice of field methodology, which in turn will influence the cost of the monitoring program. Careful thought must go into choosing metrics that are affordable to measure, but that provide credible and relevant information.

Leading and lagging indicators: direct measures of biodiversity values such as those described above are referred to as "outcome" or "state" measures. Such indicators may be considered as "lagging" because it may take considerable time for the negative or positive effects of a project to be detected in the status of the biodiversity value. Therefore, it may also be beneficial to measure leading indicators that reflect either threats to the biodiversity value or management responses to these threats. Leading indicators can provide an early warning that adaptive management is required to head off negative impacts to the biodiversity values of interest.

Control sites: in some instances, biodiversity monitoring programs may require the establishment of "control sites" beyond the project's area of influence. Control sites are subject to the same monitoring protocols as sites within the project area of influence, but since the control sites are not influenced by the project, they provide information on external or background trends in the status of biodiversity values. Control sites may play a useful role in understanding the long-term impacts of a project to sensitive biodiversity features, help refine the biodiversity baseline once a project has commenced, and help understand the effectiveness of experimental management measures. Control sites can also play an important role in helping stakeholders understand the importance of external factors such as the impacts of hunting on the viability of local populations of listed game species. Without control sites, a project may be held responsible for these impacts.

Statistical power: it is important to ensure that the monitoring program will have sufficient statistical power to detect the desired magnitude of impact. For example, if a monitoring program needs to be capable of detecting a decline of 25% in the population of a threatened species in the project area of influence, a power analysis using existing survey data should be conducted to determine the sampling intensity needed to achieve this level of sensitivity.

The results of the monitoring program should be reviewed regularly. If they indicate that the actions specified in the management plan are not being implemented as planned, the reasons for failure need to be identified (e.g., insufficient staff, insufficient resources, unrealistic timeline, etc.) and rectified. If outcome monitoring results indicate that impacts to biodiversity values were underestimated or that the benefits to biodiversity from offset measures were overestimated, it is good practice to update the impact assessment, risk analysis, and management plan through the process of adaptive management.

CHECKLIST

- Does the long-term monitoring program fully address the requirements laid out in in the project's Environmental and Social Monitoring and Management Plan and/or the Biodiversity Action Plan?
- Are the metrics that are monitored capable of providing meaningful and relevant information in a cost-effective manner?
- Does the monitoring program include both process and outcome metrics? Is the frequency of monitoring appropriate for each?
- Has the long term monitoring program been designed to achieve sufficient statistical rigor to support adaptive management of the project's mitigation program?

5 Some baseline problems (and how to deal with them)

This section discusses some problems that may arise while designing and implementing a biodiversity baseline study. Problems with baselines are more likely in regions where knowledge of biodiversity values is not well developed. Although this chapter offers suggestions as to how to overcome these problems, some challenges may be beyond the ability of a project proponent to rectify. Instead, overcoming these challenges may require conservation planning and biodiversity science at the landscape or regional level, which may be outside the scope of an ESIA.

5.1 What if a project commences before adequate baseline studies are conducted?

It is not uncommon to revisit a baseline study after a project has commenced. This may be the result of additional requirements placed on an existing project, or a project modification or expansion requiring environmental analysis. If the existing baseline study is not adequate to meet these requirements, some possible solutions include:

- Reconstructing natural habitat maps from historic aerial photos or remotely-sensed imagery
- Creating a surrogate baseline from surveys of nearby habitats similar to what was likely present at the project site before construction began
- Adopting the current condition as the biodiversity baseline (even though some impacts have occurred), and conducting rapid biological assessments to characterize it.

None of these solutions are ideal and the final approach will be project specific.

5.2 Should invertebrates be included?

Invertebrates are incredibly diverse but poorly studied in most parts of the world. It is important to engage professionals with the appropriate expertise to determine whether invertebrates should be included in the baseline study. Although invertebrates are typically excluded from biodiversity baseline studies, the following situations may be cause for inclusion:

- Invertebrates protected by legislation or international convention should be included.
- If invertebrate species of known high conservation priority potentially occur within the study area, then the baseline should survey for them. Caves may be a particularly appropriate habitat within which to search for invertebrates.
- If there is potential for a project to introduce invasive invertebrate species, baselines of the current invertebrate communities may be required.

- Freshwater and marine invertebrates are often included in aquatic baselines because they serve as effective indicators of water quality and as a food base for fisheries. Historically, taxonomic identification was sometimes only to the family or genus level, but this is improving with time.

If invertebrates are included, contractors with the appropriate expertise should be contracted to help with the design and implementation of the studies.

5.3 What if specimens can't be readily identified?

It is good practice for a baseline study to make a credible effort to identify to species level all individuals of plants and animals documented by the baseline. Furthermore, regulators, lenders and corporate standards may require the identification of all individuals collected to species level within certain taxonomic groups (for example, vertebrates). Baseline surveys can take the following steps to minimize the likelihood of having specimens that they are unable to identify to species level:

- Ensure that the baseline team includes the participation of taxonomic specialists that have appropriate expertise in the taxonomic groups in question to minimize the number of unidentified specimens that result from fieldwork and to increase confidence in the identifications that have been made.
- Ensure that the terms of reference for baseline studies require contractors to conduct the follow up work required to identify any unidentified specimens after fieldwork is complete (for example, forwarding specimens to appropriate experts).
- Design the survey to adequately sample taxonomic groups over time and space to help ensure that sufficient individuals of each species are documented, and that variation in physical characteristics over time is understood (for example, sex and age differences in plumage for birds, or collecting plants when they have reproductive structures at certain times of the year).
- If appropriate, apply emerging genetic technologies such as "DNA barcoding" to help identify species that demonstrate extreme morphological variation in different environments, or cryptic species, which are genetically distinct but morphologically similar to other species.
- If the foremost experts in the taxonomic groups in question are not already involved in the baseline, seek their input to help identify unidentified specimens. In some cases, experts will be familiar with the species in question and will be aware of collections made in other places, even if it has not been formally described and named. In other cases, the expert will be able to determine that the collections represent a species that is new to science.

5.4 What if a species doesn't have a valid conservation assessment?

A conservation assessment provides an objective evaluation of the cumulative degree of threat faced by a species and is of fundamental importance when determining whether the species will require an impact assessment and possible mitigation planning within the ESIA. Of particular relevance are global conservation assessments carried out under the auspices of the IUCN using their widely recognized Red List criteria, or national assessments that follow the IUCN assessment protocol.

For species that have not been assessed using the IUCN criteria, and for those whose assessments are out of date, it could be appropriate to perform an assessment (or reassessment) if they are known from a small number of localities and/or have a restricted range, or if they are new to science. If it is appropriate to update the conservation assessments for a species or habitat, experts with experience in applying the IUCN criteria can be engaged in a reassessment carried out in collaboration with the relevant IUCN-mandated Species Survival Commission Specialist Groups.

5.5 What if the distribution of the species is poorly understood?

For species that are suspected or known to have very restricted ranges, it may be necessary to collect additional information to gain a more precise understanding of their distribution. This information is useful for determining whether the impacts and risks to the species created by a project are great enough to affect its viability.

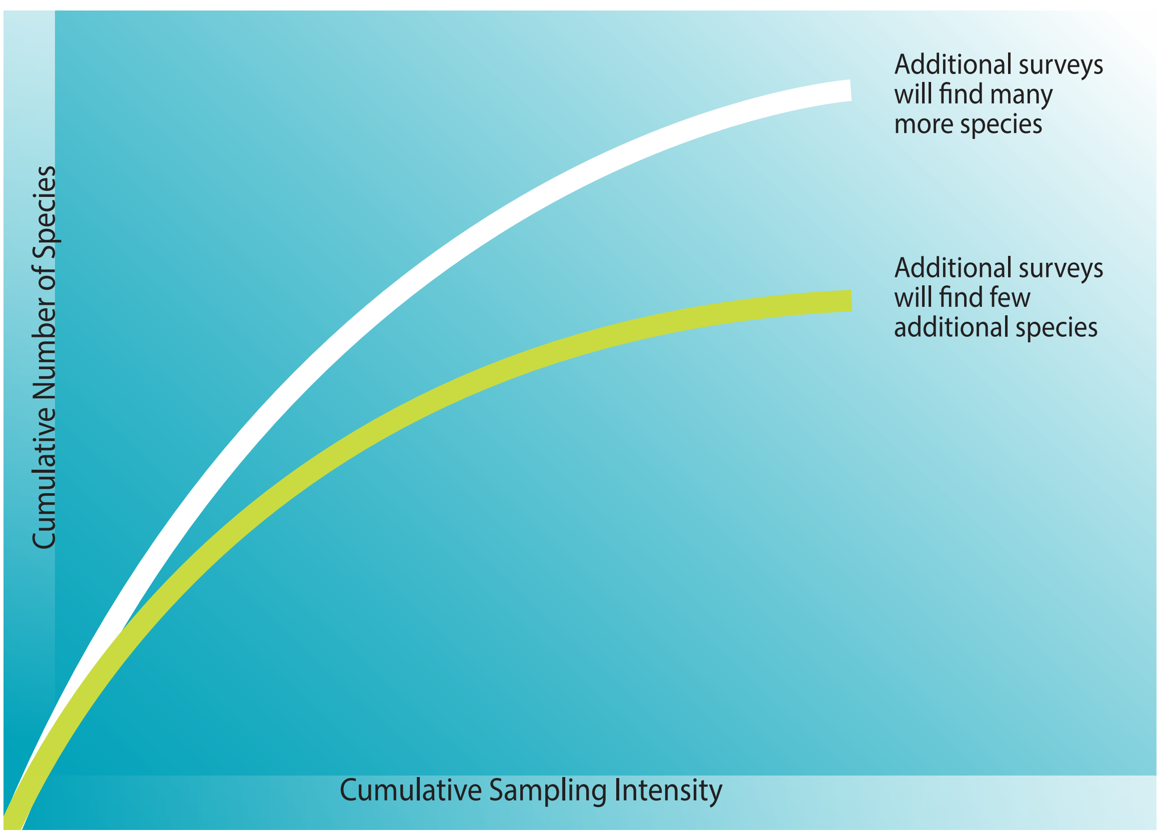
A better understanding of the factors that influence a species' conservation status (e.g., extent of occurrence, area of occupancy, number of locations, etc.) can be obtained in different manners. At one extreme, it may be enough to show that a species that is potentially severely range-restricted occurs at other sites (for example, a species of fish new to science occurs in various watersheds and is not solely limited to the project site). At the other extreme, a combination of additional, targeted fieldwork and species distribution modeling using methods such as Maxent[14] can be used to generate regional distribution maps. Species distribution models relate known occurrences of a species to environmental variables such as elevation, slope, aspect, and land cover, and then use an understanding of how these variables are distributed on the larger landscape to predict where the species is likely to occur beyond the areas in which fieldwork has taken place. The predicted distribution from the model can then be used as a basis to search for additional populations.

[14] Maxent software for species habitat modeling. Accessed December 2, 2014: http://www.cs.princeton.edu/~schapire/maxent/

5.6 How to determine an appropriate level of effort in species-rich areas

In areas with high species richness, simply developing a list of the species of plants and animals that are present within the baseline study area can be a formidable challenge. If a project represents a possible large risk to the environment, it may be appropriate to identify as many of the species as possible that occur within the baseline study area. Species accumulation curves (**Figure 5.1**) - made by graphing the cumulative number of species detected versus the cumulative sampling intensity – can be used to help understand how complete is current knowledge of the species that are present within the baseline study area. A species accumulation curve that begins to level off indicates that few additional species are likely to be found with additional sampling. Species accumulation curves that are not leveling off indicate that additional sampling is likely to encounter many additional species not previously documented on site. Note that the timing of surveys and survey methodology can influence the shape of curves.

Figure 5.1: A 'species accumulation curve' plots cumulative number of species against cumulative sampling intensity.



Some steps that project proponents can take to improve understanding of the species that are present within the baseline study area include:

- Develop species accumulation curves for distinct habitats, and focus sampling effort on those habitat types where the curves have not saturated.
- Use methodologies that are most effective for detecting rare species. For example, vegetation plots installed to characterize the general structure and composition of vegetation can be complemented with plots designed to encounter rare species. A method such as Whittaker plots should be used, where search effort scales inversely with the relative abundance of species[15]. Expert knowledge can be used to direct surveys toward species and species groups that are likely to be present.

Statistical techniques are available to determine how much sampling is required to understand how many species are likely to present within the baseline study area, and as a result, how complete is present knowledge of the flora and fauna based on how many species have been documented by field surveys[16] . For very diverse sites, it may not be possible for the project proponent to develop complete species lists in a time frame that is relevant to the environmental assessment. Additional surveys may be conducted as part of biodiversity monitoring during operations.

[15] Shmida, A. 1984. Whittaker's Plant Diversity Sampling Method. Israel Journal of Botany 33: 41-46.

[16] Chao, Colwell, et al.2009 "Sufficient sampling for asymptotic minimum species richness estimators." Ecology 90: 1125-1133.

6 Administration of the Biodiversity Baseline Study

6.1 Consultant selection

Most projects will depend upon contractors to carry out many or all of the biodiversity baseline studies. As such, contractor selection will play a critical role in determining the quality of the biodiversity baseline[17]. Contracts should not be awarded solely on the criterion of cost. The following are additional criteria to consider:

- *Regulatory experience:* it is important that contractors are familiar with relevant host country legislation and standards, and have demonstrated their ability to conduct baseline studies that meet these requirements.
- *Taxonomic experience:* as noted above, certain taxonomic groups such as amphibians and plants may be very diverse and challenging to identify, so the contractor's team should include relevant expertise in problematic taxonomic groups occurring in the region.
- *Local familiarity:* contractors should be familiar with how local biodiversity values fit within national and international conservation status assessments, prioritization and plans.
- *Professional qualifications:* in countries with professional associations, membership in professional societies (e.g., Registered Professional Biologist) can indicate that the person not only has scientific expertise but also the professional skills to conduct the work in a reliable manner.
- *Familiarity with local/regional stakeholder issues:* ensuring that the baseline is adequately scoped means incorporating stakeholder concerns around biodiversity, which is made easier if the contractor is knowledgeable of these concerns.
- *Familiarity with lender requirements:* contractors should understand lender requirements or applicable corporate standards and be able to apply them correctly.
- *Respectability and credibility:* the credibility of the biodiversity baseline will be influenced by the credibility of the contractor and sub-contractors.

Deficiencies in any of the preceding considerations can compromise the value of the baseline work, which may require costly additional studies to remedy. Slight differences in the initial cost of baseline bids should be weighed against the overall quality of the proposal, as indicated by these considerations. Finally, a "beyond regulatory compliance" approach needs to be well communicated to contractors when soliciting bids for the baseline so that they can fully price the required work into their bids.

[17] Contractors may include for-profit consultancies, but may also include NGOs. It is important to note that there are constraints placed on NGOs by their charitable status; for example, their activities should be oriented towards public benefit, which may dictate the types of work they conduct with private companies.

6.2 Need for an iterative approach

For projects operating in areas of sensitive biodiversity, preparing a good biodiversity baseline is likely to be an iterative endeavor. Before the initial baseline studies are scoped there will usually be uncertainties with respect to the biodiversity values that are present in the study area, the risks that the project poses to these features, and the regulatory and voluntary mitigation actions to which the project will commit. This makes it difficult to develop a single, comprehensive scope for biodiversity baseline studies prior to the studies commencing, and also have the baseline proceed in a linear manner. Some examples of circumstances that could occur following initial field-based surveys that would require additional studies include:

- Documentation of new or little studied species or habitats
- Documentation of biodiversity values with no or outdated conservation assessments
- Discovery of biodiversity values for which the initial field surveys did not provide adequate information to support risk/impact assessment or mitigation planning
- Changes to project design
- Changes in regulatory requirements.

The fact that baseline studies should be administered in an iterative manner has significant implications for their administration, including:

- Baseline studies should begin early in the project schedule, leaving as much time as possible for supplementary studies that will have to be conducted.
- The budget for baseline studies should be flexible and include contingency funding because, as mentioned above, at the onset of baseline work it is not possible to anticipate all the directions that the baseline study will ultimately take.

Environmental managers supervising baseline work must actively monitor the baseline progress and be prepared to rapidly expand or modify the baseline work in response to circumstances like those listed above.

7 Baseline data quality, storage, and sharing

The collection of baseline information represents a significant investment – in some cases millions of dollars for a single project. Experience has shown that contractors cannot be counted upon reliably to retain biodiversity baseline data after the studies have been completed. Projects must take ownership of baseline information and manage it as an important resource, including maximizing data quality and ensuring that data are properly stored for the long-term.

7.1 What types of data should be stored?

Projects should obtain and store all of the data from the biodiversity surveys in their various forms.

Raw data: projects should obtain all of the raw data from the baseline surveys, including copies of the original field forms, and data entered into databases or spreadsheets. This should also include unprocessed aerial photos and/or digital imagery that were used to develop land use/land cover maps, and shapefiles used for any GIS analyses.

Processed data: contractors should be required to supply the calculations supporting the processed data that show how key parameters such as species diversity or abundance were obtained. In the case of vegetation classifications, contractors should supply all shapefiles and uncropped processed imagery.

Metadata: the term '*metadata*' refers to information describing how, when, where, and why biodiversity baseline data were collected. Without metadata it may not be possible to use the biodiversity baseline data in the future, reducing the value of a costly and irreplaceable dataset to zero. A number of factors may lead to a critical loss of metadata over time, including poor documentation of how and why baseline studies were done, and the fact that most people will have difficulties recalling details of the studies after a few years have passed. Turnover in project and/or contractor personnel will further compound problems.

As biodiversity baseline studies are performed and submitted, raw and processed data files should be obtained and stored. Each dataset should also be reviewed to ensure that it is accompanied by appropriate metadata. Key elements include:

- Title of study and date
- Description
- Contractor contact information
- Contractor personnel and roles
- Geographic location of study area

- Study area description
- Type of biodiversity feature (habitats, species, ecosystem services, etc.)
- Details on the biodiversity feature (e.g., species names)
- Temporal coverage of study
- Sampling or study methods
- Explanation of data fields in accompanying datasets

7.2 How should data be stored?

At a minimum data should be stored on site in hard copy and in digital formats as provided by contractors. Backups should be stored off site. Storage media should be upgraded as appropriate to ensure that the data remain readily accessible over time. Ideally individual contractor studies should be integrated into a biodiversity database for the site that can also house other types of biodiversity data (e.g., monitoring reports) as the project develops.

7.3 Data sharing

It is good practice (and often a requirement) for projects to share their raw biodiversity baseline data with the regulatory agencies in the countries where the project is located. However, it is best practice to share baseline data more broadly. For example, recently the Global Biodiversity Information Facility (GBIF) and International Association of Impact Assessment (IAIA) have joined forces to encourage corporations to share their primary biodiversity data from impact assessments with the broader scientific and conservation community[18]. GBIF and IAIA note that the following benefits may accrue to a company by doing so:

1. Adopting GBIF's standardized formats for data recording will improve the quality of the environmental impact assessment (EIA) and potentially streamline the EIA process.
2. Comparable data may be available from other EIAs conducted in the area which could support cumulative effects assessment.
3. Conforming to the GBIF standards and sharing primary data through GBIF will enhance the reliability, credibility and transparency of the EIA process.
4. Comparable data may be available that can support the development of the site's mitigation strategy.

[18] Cadman, M., et al. 2011. Improving EIA practice: Best Practice Guide for publishing primary biodiversity data. Accessed December 11, 2012: http://www.gbif.org/orc/?doc_id=2989&l=en

GBIF is not the only potentially relevant biodiversity database for data sharing. Some countries have national biodiversity databases that may be appropriate for hosting a project's biodiversity data. If a project engages an internationally renowned botanical institution such as the Missouri Botanical Garden or Royal Botanic Gardens, Kew to participate in baseline studies, these institutions will register plant specimen records collected on site in their own institution's database[19]. Also of note are the online global databases BIEN[20] and SALVIAS[21], which house data from vegetation plots around the world, and Fishbase[22] for finfish of the world. Any significant information on IUCN threatened species should be shared with the IUCN.

Biodiversity databases are a potentially useful source of information on "benchmark" or "reference" vegetation plots that can support the development of frameworks to measure habitat condition. Projects may find that there is a reasonable expectation that if they benefit by accessing information from a global database, they should also support these databases by contributing their own biodiversity baseline information.

When sharing data, care should be taken to ensure it will not be used in a way that creates additional pressures on biodiversity values (e.g., by making public the locations of overhunted threatened species) or in a way that creates conflicts (e.g., by providing unequal access to different groups).

If a project decides to share its biodiversity baseline information, or even if it simply wishes to keep such an option open, it should ensure that contractors are familiar with the requirements of the institution that will receive the data. Most supply extensive guidance on the format that data should take in order to be compatible.

[19] MBG - http://www.tropicos.org; Kew - http://apps.kew.org/herbcat/navigator.do

[20] http://bien.nceas.ucsb.edu/bien/

[21] http://www.salvias.net/pages/index.html

[22] http://www.fishbase.org

7.4 Communicating the baseline

It is good practice for the project proponent to share the biodiversity baseline with interested parties, with the relevant results and implications highlighted for each party. The following are some examples of communicating baseline results.

7.4.1 Demonstrating compliance with regulatory, lender, or corporate requirements

If a project proponent is seeking to comply with regulatory, lender, or corporate requirements, communicating regularly with the relevant entities as the biodiversity baseline progresses is good practice. Topics of specific interest may include:

- *Documentation of the occurrence of specific biodiversity values.* It is good practice to inform regulators, lenders, and corporate supervisors about biodiversity values found in the project area of influence that may have major implications for impact assessment and management. This might include biodiversity values that are protected by law or considered a high priority for conservation by lender and corporate standards.
- *Technical challenges in developing a comprehensive baseline* (such as those described in Chapter 5). If a project is located in a landscape where biodiversity values are poorly understood, it may be difficult to comply with all regulator, lender, and corporate requirements. For example, in a highly diverse but poorly studied landscape, it may be very difficult for the baseline study to develop a complete list of flora and fauna species within the baseline study area, and even if it were possible, it would still be difficult or impossible to interpret the conservation significance of every species documented on site. In cases such as this, the project proponent should engage their regulatory, lender, or corporate supervisor, as well as relevant experts and stakeholders, to determine an acceptable approach to completing the baseline study.

It is beneficial to raise any problems as early as possible in order to maximize the time available to respond to them.

7.4.2 Supporting the adaptive management of the baseline

Producing a baseline to support impact assessment and management planning may be an iterative process, and as such, good communication is essential between all relevant parties involved in the development of an ESIA. The environmental manager for the project needs to ensure that he or she is kept up to date as the baseline studies and the impact assessment and mitigation steps are carried out, and that any additional baseline studies that are required are identified and implemented efficiently.

Environmental managers should ensure that qualified specialist subcontractors involved in the baseline study also review the results of the impact assessment and management plan. Although this may seem an obvious point, it does not always take place.

7.4.3 Supporting impact assessment and management planning

The topic of impact assessment and management planning is covered in the companion document, *Good Practices for Biodiversity-Inclusive Impact Assessment and Management Planning*[23]. In order for the biodiversity baseline to be used correctly, its contents must be communicated effectively to the specialists charged with impact assessment and management planning. This may appear obvious, but in large projects the complexity of contractor relationships may lead to poor communication of critical information.

7.4.4 Sharing baseline data with the scientific and conservation community

If a decision has been made to share biodiversity baseline data more broadly with the scientific and conservation community, the environmental manager and/or their contractors should take the necessary steps to ensure that the appropriate data reach the right people. In some cases this may mean actually providing a copy of the data to the organization administering a database. In other cases it may mean providing information about the data (i.e., the metadata) to an individual or organization and agreeing to provide the data to interested and qualified third parties. In all cases care should be taken to collect, format, and present the data in a useable manner.

It is important to note that projects should ensure that sensitive data (for example, the location of nesting sites or breeding areas of species threatened by trade or by illegal hunting) is shared only with responsible agencies or organizations and not disseminated indiscriminately.

[23] Hardner, J., R.E. Gullison, S. Anstee, M. Meyer. 2014. *Good Practices for Biodiversity-Inclusive Impact Assessment and Management Planning*. Prepared for the Multi-lateral Financing Institutions Biodiversity Working Group.

Appendix 1 – Annotated Resources

1 Introduction

- The Cross Sector Biodiversity Initiative has produced a useful document that shows the alignment of biodiversity information needs with respect to a project timeline. CSBI (2013). CSBI Timeline Tool. ***A tool for aligning timelines for project execution, biodiversity management and financing***. Accessed August 18, 2014: http://www.equator-principles.com/resources/csbi_timeline_tool_jan_2014.pdf
- Key general references on the integration of biodiversity into the environmental assessment process include:
  - o Secretariat of the Convention on Biological Diversity, Netherlands Commission for Environmental Assessment (2006). Biodiversity in Impact Assessment, Background Document to CBD Decision VIII/28: ***Voluntary Guidelines on Biodiversity-Inclusive Impact Assessment***, Montreal, Canada. Accessed September 7, 2014 at: https://www.cbd.int/doc/publications/cbd-ts-26-en.pdf
  - o International Association for Impact Assessment, (2005). ***Biodiversity in Impact Assessment***. Special Publication Series No. 3. Accessed September 7, 2014 at: http://www.iaia.org/publicdocuments/special-publications/sp3.pdf?AspxAutoDetectCookieSupport=1
  - o Council on Environmental Quality (CEQ). (1993). ***Incorporating Biodiversity Considerations Into Environmental Impact Analysis Under the National Environmental Policy Act.*** CEQ, Executive Office of the President, Washington, DC. http://energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/G-CEQ-BiodiversityConsiderations.pdf
  - o World Bank (1997). ***Biodiversity and environmental assessment.*** Environmental Assessment Sourcebook Update. Number 20. October 1997. Accessed September 7, 2014: http://siteresources.worldbank.org/INTSAFEPOL/1142947-1116497123103/20507396/Update20BiodiversityAndEAOctober1997.pdf

2 Developing The Biodiversity Baseline

2.1 Delineating The Study Area

- IFC PSC GN17 describes the importance of taking a landscape perspective to environmental assessment and mitigation planning. GN65 discusses the concept of a Discrete Management Unit and its application to biodiversity baseline studies. IFC (2012). ***Biodiversity Conservation and Sustainable Management of Living Natural Resources. Guidance Note 6.*** Accessed September 7, 2015: http://www.ifc.org/wps/wcm/connect/a359a380498007e9a1b7f3336b93d75f/Updated_GN6-2012.pdf?MOD=AJPERES.
- Asian Development Bank GN68 provides guidance on defining the project area of influence. ADB Policy Paper (2012). ***Environment Safeguards. A good practice sourcebook (draft working document)***. Accessed September 1, 2014: http://www.adb.org/documents/environment-safeguards-good-practice-sourcebook.

2.2 Scoping The Baseline Study

- IADB's draft guidance provides for detailed considerations of assessing the importance of habitat for species on the IUCN Red List, endemic and range-restricted species, migratory species, and other types of habitat highly suitable for biodiversity conservation. IADB (2014). ***Guidance for assessing and managing biodiversity impacts and risks in Inter-American Development Bank supported operations*** (Draft document).
- IFC PSC GN13 describes how to use the concepts of irreplaceability and vulnerability to prioritize biodiversity features that do not benefit from having formal conservation assessments. IFC (2012). ***Biodiversity Conservation and Sustainable Management of Living Natural Resources. Guidance Note 6***. Accessed September 7, 2014: http://www.ifc.org/wps/wcm/connect/a359a380498007e9a1b7f3336b93d75f/Updated_GN6-2012.pdf?MOD=AJPERES.

- IFC PSC GN55-97 provide detailed guidance on the steps involved in critical habitat determination and guidance by criterion. IFC (2012). ***Biodiversity Conservation and Sustainable Management of Living Natural Resources. Guidance Note 6***. Accessed September 7, 2014: http://www.ifc.org/wps/wcm/connect/a359a380498007e9a1b7f3336b93d75f/Updated_GN6-2012.pdf?MOD=AJPERES.

- IFC PSC GN113-115 describe the appropriate treatment of different categories of protected areas, and other areas recognized for high biodiversity values but that are not legally protected. IFC (2012). ***Biodiversity Conservation and Sustainable Management of Living Natural Resources. Guidance Note 6***. Accessed September 7, 2014: http://www.ifc.org/wps/wcm/connect/a359a380498007e9a1b7f3336b93d75f/Updated_GN6-2012.pdf?MOD=AJPERES.

- Very specific guidance on aquatic biodiversity features, critical habitat, and biodiversity prioritization, along with mitigations for New South Wales is provided in Fairfull, F. (2013). ***Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management***. Accessed July 7, 2015: www.dpi.nsw.gov.au/fisheries/habitat/publications/policies,-guidelines-and-manuals/fish-habitat-conservation

- While focused on wetlands RAMSAR's guidance provides a good description of developing biodiversity baseline, including the planning and different stages. RAMSAR. (2010). ***Guidelines on biodiversity-inclusive environmental impact assessment and strategic environmental assessment. Handbook 16 for the wise use of wetlands***, 4th ed. Accessed July 7, 2015: http://www.ramsar.org/sites/default/files/documents/pdf/lib/hbk4-16.pdf.

- Recent guidance on identifying and prioritizing ecosystem services is provided in:

  o Landsberg, F., J. Treweek, m. Mercedes Stickler, N. Henninger and O. Venn. (2014). ***Weaving Ecosystem Services into Impact Assessment: a step-by-step method***. Version 1.0. World Resources Institute. Washington DC. 38 pp.

  o Peh, K. S.-H., Balmford, A. P., Bradbury, R. B., Brown, C., Butchart, S. H. M., Hughes, F. M. R., Stattersfield, A. J., Thomas, D. H. L., Walpole, M., & Birch, J. C. (2014). ***Toolkit for Ecosystem Service Site-based Assessment (TESSA)***. Version 1.2 Cambridge, UK.

  o Waage, S. (2014). ***Making Sense of New Approaches to Business Risk and Opportunity Assessment. Integrating Ecosystem Services into Investor Due Diligence and Corporate Management. Business for Social Responsibility.*** 29 pp.

2.3 Desk-based assessment of biodiversity values

- CIEEM (2013). ***Guidelines for preliminary ecological appraisal*** Technical Guidance Series. Accessed September 1, 2014: http://www.cieem.net/guidance-on-preliminary-ecological-appraisal-gpea-.

- IFC PS6 GN9 and GN10 provide guidance on desktop analysis. IFC (2012). ***Biodiversity Conservation and Sustainable Management of Living Natural Resources. Guidance Note 6***. Accessed September 7, 2015: http://www.ifc.org/wps/wcm/connect/a359a380498007e9a1b7f3336b93d75f/Updated_GN6-2012.pdf?MOD=AJPERES.

Lists of online biodiversity information sources

- Energy and Biodiversity Initiative (2003). Online Biodiversity Information Sources. Accessed September 1, 2014: http://www.theebi.org/pdfs/sources.pdf.

- The Annotated Bibliography provides links to many biodiversity resources. IFC (2012). Biodiversity Conservation and Sustainable Management of Living Natural Resources. Guidance Note 6. Accessed September 7, 2015: http://www.ifc.org/wps/wcm/connect/a359a380498007e9a1b7f3336b93d75f/Updated_GN6-2012.pdf?MOD=AJPERES.

Field reconnaissance

- CIEEM provides guidance on field reconnaissance and its contribution towards a preliminary ecological appraisal in advance of detailed field surveys. (CIEEM) (2013). Guidelines for Preliminary Ecological Appraisal. Accessed September 7, 2014: http://www.cieem.net/data/files/Resource_Library/Technical_Guidance_Series/GPEA/GPEA_April_2013.pdf.

Producing A Preliminary Report And Determining Field Survey Needs

- CIEEM provides guidance on desktop assessment and field reconnaissance to produce a preliminary ecological appraisal in advance of detailed field surveys. (CIEEM) (2013). ***Guidelines for Preliminary Ecological Appraisal***. Accessed September 7, 2014: http://www.cieem.net/data/files/Resource_Library/Technical_Guidance_Series/GPEA/GPEA_April_2013.pdf.

2.4 Field-based assessment of biodiversity values

Survey design

- An excellent review of potential pitfalls with inventory and monitoring programs as well as how to overcome them. Chapter 4**.** ***Developing a protected area biodiversity monitoring programme***. Tucker, G., Bubb P., de Heer M., Miles L., Lawrence A., Bajracharya S. B., Nepal R. C., Sherchan R., Chapagain N.R. (2005). Guidelines for Biodiversity Assessment and Monitoring for Protected Areas. KMTNC, Kathmandu, Nepal. Accessed September 7, 2014: http://www.forestrynepal.org/images/publications/PA_Guidelines_BMA.pdf.
- Chapter 14 provides a good overview of the principles of sampling design and data collection. Gardner, T. (2010). ***Monitoring forest biodiversity: improving conservation through ecologically-responsible management***. Earthscan, New York, 360pp.

Comprehensive guidance

- Chartered Institute of Ecology and Environmental Management website provides survey methods for range of taxonomic groups and habitat types. Accessed September 1, 2014: http://www.cieem.net/sources-of-survey-methods-sosm-.
- CBD. (2006). ***Guidelines for the rapid ecological assessment of biodiversity in inland water, coastal and marine areas***. Secretariat of the Convention on Biological Diversity, Montreal, Canada, CBD Technical Series no. 22and the Secretariat of the Ramsar Convention, Gland, Switzerland, Ramsar Technical Report no. 1. provides an extensive list of sampling techniques, including guidelines for types of habitats, time required, and costs. This includes methods for fish, macroinvertebrates, and aquatic plants. Accessed September 7, 2014: https://www.cbd.int/doc/publications/cbd-ts-22.pdf.
- Conservation International. (2015) (Expected). ***A Handbook for Rapid Biological Field Assessment.*** Draft chapters available on vascular epiphytes, bird sound recordings, ants, reptiles, and amphibians. Full manual expected in 2015.
- Eymann, J., Degreef, J., Häuser, C., Monje, J. C., Samyn, Y., & Van den Spiegel, D. (2010). ***Manual on field recording techniques and protocols for all taxa biodiversity inventories***. ABC Taxa. Belgian National Focal Point for the GTI, Brussels. Accessed September 1, 2014: http://www.abctaxa.be/volumes/volume-8-manual-atbi.
- Gardner, T. (2010). ***Monitoring forest biodiversity: improving conservation through ecologically-responsible management***. Earthscan, New York, 360pp.
- Hill, D., M. Fasham, G. Tucker, M. Shewry and P. Shaw. (2005). (Editors) ***Handbook of Biodiversity Methods. Survey, evaluation and monitoring.*** Cambridge University Press, Cambridge, UK. 573 pp.
- Sutherland, W.J. (Ed.) (1996) ***Ecological Census Techniques. A handbook.*** Cambridge University Press. Cambridge, UK. 332 pp.

Developing A Habitat Map

- For a review of ecosystem classification and mapping approaches, see: Vreugdenhil, D., Terborgh, J., Cleef, A.M., Sinitsyn, M., Boere, G.D., Archaga, V.L., Prins, H.H.T., (2005), ***Comprehensive Protected Areas System Composition and Monitoring,*** WICE, USA, Shepherdstown, 106 pp. Accessed September 7, 2014: https://portals.iucn.org/library/efiles/documents/2003-031.pdf.

- Chapter 3 of Tucker et al. reviews the use of remote sensing data in vegetation mapping and species distribution modeling. Tucker, G., Bubb P., de Heer M., Miles L., Lawrence A., Bajracharya S. B., Nepal R. C., Sherchan R., Chapagain N.R. (2005). ***Guidelines for Biodiversity Assessment and Monitoring for Protected Areas***. KMTNC, Kathmandu, Nepal**.** Accessed September 7, 2014: http://www.forestrynepal.org/images/publications/PA_Guidelines_BMA.pdf.

Vegetation inventories

- There is a diversity of approaches to vegetation inventories. The following references describe some of the most common approaches.
    - Elzinga, C. L., Salzer, D. W., & Willoughby, J. W. (1998). ***Measuring & Monitoring Plant Populations***. BLM Technical Reference 1730-1. Accessed September 7, 2014: http://www.blm.gov/nstc/library/pdf/MeasAndMon.pdf.
    - Godínez-Alvarez, H., Herrick, J. E., Mattocks, M., Toledo, D., & Van Zee, J. (2009). ***Comparison of three vegetation monitoring methods: their relative utility for ecological assessment and monitoring***. Ecological Indicators, 9(5), 1001-1008.
    - Herrick, J. E.; Zee, J. W. Van; Havstad, K. M.; Burkett, L. M.; Whitford, (2005). W. G. ***Monitoring manual for grassland, shrubland and savanna ecosystems. Volume I: Quick Start. Volume II: Design, supplementary methods and interpretation.*** The University of Arizona Press, 200 pp.
    - Minnesota Department of Natural Resources. (2007). ***A handbook for collecting vegetation plot data in Minnesota: The relevé method***. Minnesota County Biological Survey, Minnesota Natural Heritage and Nongame Research Program, and Ecological Land Classification Program. Biological Report 92. St. Paul: Minnesota Department of Natural Resources.
    - Peet, R. K., Wentworth, T. R., & White, P. S. (1998). ***A flexible, multipurpose method for recording vegetation composition and structure.*** Castanea, 262-274.
    - Phillips, O. L., Vásquez Martínez, R., Núñez Vargas, P., Lorenzo Monteagudo, A., Chuspe Zans, M. E., Galiano Sánchez, W., ... & Rose, S. (2003). ***Efficient plot-based floristic assessment of tropical forests***. Journal of Tropical ecology, 19(06), 629-645.

Measuring vegetation/habitat quality

- Australia in particular has made considerable progress in developing quantitative frameworks to assess vegetation condition. Some key references include:
    - Eyre, T. J., Kelly, A., Neldner, V. J., Wilson, B. A., Ferguson, D. J., Laidlaw, M. J., & Franks, A. J. (2011). ***BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland***. Assessment Manual. Version 2.1. Environment. Brisbane.
    - Gibbons, P., Ayers, D., Seddon, J., Doyle, S., & Briggs, S. (2008). ***Biometric 2.0: A Terrestrial Biodiversity Assessment Tool for the NSW Native Vegetation Assessment Tool - Operational Manual***. Assessment. Canberra.
    - Gibbons, P., & Freudenberger, D. (2006). ***An overview of methods used to assess vegetation condition at the scale of the site. Ecological Management and Restoration***, 7(s1), S10–S17. doi:10.1111/j.1442-8903.2006.00286.x.
    - McCarthy, M., & Parris, K. (2004). ***The habitat hectares approach to vegetation assessment: An evaluation and suggestions for improvement. Ecological Management & Restoration***, 5(1), 24–27. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1442-8903.2004.00173.x/full.
    - Parkes, D., & Lyon, P. (2006). ***Towards a national approach to vegetation condition assessment that meets government investors' needs: A policy perspective. Ecological Management & Restoration***, 7(June), 3–5. doi:10.1111/j1442-8903.2006.00283.x.
    - Parkes, D., & Newell, G. (2003). ***Assessing the quality of native vegetation: the "habitat hectares" approach. Ecological Management & Restoration***, 4(February), 29–38. Retrieved from http://onlinelibrary.wiley.com/doi/10.1046/j.1442-8903.4.s.4.x/full.

- For a review of some approaches to measuring habitat quality for temperate habitats, see Chapter 6.3.1 in Byron, H. (2000) ***Biodiversity and Environmental Impact Assessment: A Good Practice Guide for Road Schemes.*** The RSPB, WWF-UK, English Nature and the Wildlife Trusts, Sandy. Accessed September 1, 2014: http://www.rspb.org.uk/Images/BiodiversityImpact_tcm9-257019.pdf.

Amphibians

- Heyer, W.R., Donnelly, M.A., McDiarmid, R.W., Hayek, L.C., Foster, M.S. (1994). ***Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians***. Smithsonian Institution Press, Washington.

Birds

- Bibby, C., Jones, M., & Marsden, S. (2000). ***Bird Surveys (Expedition Field Techniques Series)***. BirdLife International, Cambridge, 134. Accessed September 1, 2014: http://www.conservationleadershipprogramme.org/UserDataWEB/ProjectManuals/Bird_Surveying_Manual.pdf.
- Sutherland, W.J., I. Newton & R.E. Green (Eds.) (2004). ***Bird ecology and conservation: a handbook of techniques.*** Oxford University Press, Oxford, 386 pp.

Fish

- Passive and active fish sampling methods, along with discussion of advantages and disadvantages is provided in Appendix 1 of B. Pidgeon. (2004). ***A review of options for monitoring freshwater fish diversity in the Darwin Harbour Catchment.*** Prepared for Water Monitoring Branch, Department of Infrastructure, Planning and Environment. Accessed September 1, 2014: http://www.environment.gov.au/resource/review-options-monitoring-freshwater-fish-biodiversity-darwin-harbour-catchment.
- Additional specific fish collection guidance is listed in Kennard, M.J. et al. (2011). ***Field Manual- including protocols for quantitative sampling of fish assemblages, habitat, water quality, and sample preservation. Tropical Rivers and Coastal Knowledge.*** Accessed September 1, 2014: http://www.track.org.au/publications/registry/track973.
- Guidance for sampling streams can be found in David, B. and M. Hamer. (2010). ***Regional Guidelines for Ecological Assessments of Freshwater Environments- Standardised Fish Monitoring for Wadeable Streams***. Prepared for Environment Waikato. (http://www.waikatoregion.govt.nz/Services/Publications/Technical-Reports/TR-201009/) and Collier, K. and J. Kelly. 2005. ***Regional Guidelines for Ecological Assessments of Freshwater Environments-Macroinvertebrate Sampling in Wadeable Streams***. Prepared for Environment Waikato. Accessed September 1, 2014: http://www.waikatoregion.govt.nz/Services/Publications/Technical-Reports/Regional-guidelines-for-ecological-assessments-of-freshwater-environments-Macroinvertebrate-sampling-in-wadeable-streams/) as well as very extensive guidance from the USEPA.
- Springate-Baginski, O., Allen, D. and Darwall, W.R.T. (eds.) (2009). ***An Integrated Wetland Assessment Toolkit: A guide to good practice.*** Gland, Switzerland: IUCN and Cambridge, UK: IUCN Species Programme. xv+144p. includes sampling methods for fish and specific protocols for invertebrates like molluscs, damselflies and dragonflies.

Invertebrates

- New, T.R. (1998). ***Invertebrate surveys for conservation***. Oxford University Press, Oxford, 240 pp.
- Springate-Baginski, O., Allen, D. and Darwall, W.R.T. (eds.) (2009). ***An Integrated Wetland Assessment Toolkit: A guide to good practice.*** Gland, Switzerland: IUCN and Cambridge, UK: IUCN Species Programme. xv+144p. includes sampling methods for fish and specific protocols for invertebrates like molluscs, damselflies and dragonflies.

Mammals

- H. Kühl, F. Maisels, M. Ancrenaz and E.A. Williamson (2008). ***Best Practice Guidelines for Surveys and Monitoring of Great Ape Populations***. Gland, Switzerland: IUCN SSC Primate Specialist Group (PSG). Accessed September 1, 2014: https://portals.iucn.org/library/node/9226.
- Wilson, D.E. et al. (Eds.) (1996). ***Measuring and monitoring biological diversity: standard methods for mammals***. Smithsonian Institution Press, Washington, 409 pp.

Arctic

- Christensen, T., et al. (2013). ***The Arctic Terrestrial Biodiversity Monitoring Plan***. CAFF Monitoring Series Report Nr. 7. CAFF International Secretariat. Akureyri, Iceland. ISBN 978-9935-431-26-4.
- J.M. Culp, et al. (2012). ***The Arctic Freshwater Biodiversity Monitoring Plan***. CAFF International Secretariat, CAFF Monitoring Series Report Nr. 7. CAFF International Secretariat. Akureyri, Iceland. ISBN 978-9935-431-19-6 (http://www.caff.is/monitoring-series/view_category/4-freshwater-monitoring).

Wetlands

- RAMSAR includes a good summary of methods for wetland baselines from several OECD countries, as well as available wetland databases. RAMSAR (2010). ***A Ramsar framework for wetland inventory and ecological character description.*** Handbook 15 for the wise use of wetlands, 4th ed.). Accessed September 7, 2014: http://www.ramsar.org/sites/default/files/documents/pdf/lib/hbk4-15.pdf.

Metrics

The following sources provide good guidance on the selection of biodiversity indicators or metrics for baselines and long-term monitoring.

- Chapter 5. ***Environmental values, associated components, and indicators***. In: British Columbia Ministry of the Environment (2014). Policy For Mitigating Impacts On Environmental Values (Environmental Mitigation Policy) and Procedures For Mitigating Impacts On Environmental Values (Environmental Mitigation Procedures). Working documents. Accessed September 1, 2014: http://www.env.gov.bc.ca/emop/docs/EM_Procedures_WD_20140109.pdf.
- Chapter 5 ***Monitoring biodiversity impacts.*** In: Pitman, N. (2011). Social and Biodiversity Impact Assessment Manual for REDD+ Projects: Part 3 – Biodiversity Impact Assessment Toolbox. Forest Trends, Climate, Community & Biodiversity Alliance, Rainforest Alliance and Fauna & Flora International. Washington, DC. Accessed September 1, 2014: https://s3.amazonaws.com/CCBA/SBIA_Manual/SBIA_Part_3.pdf.
- Energy and Biodiversity Initiative (2003). ***Biodiversity Indicators for Monitoring Impacts and Conservation Actions***. Accessed September 1, 2014: http://www.theebi.org/pdfs/indicators.pdf.
- OECD (2013), ***OECD Compendium of Agri-environmental Indicators***, OECD Publishing. Accessed September 1, 2014: http://www.oecd-ilibrary.org/agriculture-and-food/oecd-compendium-of-agri-environmental-indicators/biodiversity-farmland-bird-populations-and-agricultural-land-cover_9789264186217-15-en;jsessionid=3qo9vtnu9lk07.x-oecd-live-02.
- Chapter 3 in: World Bank (1998). Guidelines for monitoring and evaluation for biodiversity projects. Global Environment Division. Accessed July 7, 2015: http://www.blm.gov/nstc/library/pdf/MeasAndMon.pdf
- For a review of compositional, structural and functional metrics for different scales of biodiversity, see Chapter 6.4 in Byron, H (2000) ***Biodiversity and Environmental Impact Assessment: A Good Practice Guide for Road Schemes***. The RSPB, WWF-UK, English Nature and the Wildlife Trusts, Sandy. Accessed September 1, 2014: http://www.rspb.org.uk/Images/BiodiversityImpact_tcm9-257019.pdf.

2.5 Incorporating Stakeholders And Experts

Comprehensive guidance is available for stakeholder engagement during environmental assessments. See:

- International Finance Corporation (2007). ***Stakeholder engagement: a good practice handbook for companies doing business in emerging market***s. Washington, D.C.
- Chapter 6. ***Stakeholder engagement tools and processes.*** In: ICMM (2006). Good practice guidance for mining and biodiversity. International Council on Mining and Metals. Accessed September 1, 2014: http://www.icmm.com/document/13.
- PR10 Information disclosure and stakeholder engagement in EBRD (2014). Environmental and social policy Accessed September 1, 2014: http://www.ebrd.com/downloads/research/policies/esp-final.pdf.

3 Biodiversity Baseline Report

- For more details on a suggested structure for a biodiversity baseline report, see IADB (2014). ***Guidance for assessing and managing biodiversity impacts and risks in Inter-American Development Bank supported operations***. Working Document Version 1. February 4, 2014.

4 Long-term monitoring

- The annotated resources presented above for ***2.4 Field-based assessment of biodiversity values*** should be consulted for guidance on long-term monitoring of different types of biodiversity values. For an excellent overview of key issues, the reader should see Chapt. 4. ***Developing a protected area biodiversity monitoring programme***. Tucker, G. Bubb P., de Heer M., Miles L., Lawrence A., Bajracharya S. B., Nepal R. C., Sherchan R., Chapagain N.R. (2005). Guidelines for Biodiversity Assessment and Monitoring for Protected Areas. KMTNC, Kathmandu, Nepal. Accessed September 7, 2014: http://www.forestrynepal.org/images/publications/PA_Guidelines_BMA.pdf.

5 Common Baseline Problems (And How To Deal With Them)

Conservation assessment methodologies

- Technical documents for the IUCN Red List methodology and process are available at: http://www.iucnredlist.org/technical-documents/assessment-process.
- Technical documents for the NatureServe methodology and process are available at: http://www.natureserve.org/conservation-tools/standards-methods/natureserve-core-methodology.

Species distributions

- A good overview of approaches to species distribution models is found in: Elith, J., & Leathwick, J. R. (2009). ***Species distribution models: ecological explanation and prediction across space and time.*** Annual Review of Ecology, Evolution, and Systematics, 40(1), 677.
- Resources and software for MAXENT Species Distribution modeling available at: http://www.natureserve.org/conservation-tools/standards-methods/natureserve-core-methodology.

Systematic conservation planning

- GN34 discusses the importance of integrated land use planning and steps that project proponents might take if these plans do not exist. IFC (2012). ***Biodiversity Conservation and Sustainable Management of Living Natural Resources.*** Guidance Note 6. Accessed September 7, 2015: http://www.ifc.org/wps/wcm/connect/a359a380498007e9a1b7f3336b93d75f/Updated_GN6-2012.pdf?MOD=AJPERES.

Power analysis

- Green, R. H. (1989). ***Power analysis and practical strategies for environmental monitoring***. Environmental Research, 50(1), 195–205. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/2676509.
- Peterman, RM (1990). ***Statistical power analysis can improve fisheries research and management***. Canadian Journal of Fisheries and Aquatic Science. 47:2-15.