Social and Biodiversity Impact Assessment (SBIA) Manual for REDD+ Projects

PART 3 – BIODIVERSITY IMPACT ASSESSMENT TOOLBOX

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CCBA[SM]
The Climate, Community & Biodiversity Alliance

FOREST TRENDS

In collaboration with:

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SOCIAL AND BIODIVERSITY IMPACT ASSESSMENT (SBIA) MANUAL FOR REDD+ PROJECTS:

PART 3 – BIODIVERSITY IMPACT ASSESSMENT TOOLBOX

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Conservation International is the convener of the Climate, Community & Biodiversity Alliance (CCBA).

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Please send feedback or suggestions about this manual to Michael Richards (mrichards@forest-trends.org) or Steve Panfil (spanfil@conservation.org).

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http://www.climate-standards.org/

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http://www.rainforest-alliance.org/

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List of Acronyms

A/R	Afforestation/Reforestation
CCB	Climate, Community and Biodiversity (Standards)
CCBA	Climate, Community and Biodiversity Alliance
CMP	Conservation Measures Partnership
GMO	Genetically Modified Organism
HCV	High Conservation Value
IAIA	International Association for Impact Assessment
IUCN	World Conservation Union
KBA	Key Biodiversity Area
PDD	Project Design Document
REDD	Reduced Emissions from Deforestation and forest Degradation
REDD+	Reduced Emissions from Deforestation and forest Degradation and the conservation, sustainable management of forests, and enhancement of forest carbon stocks
RIL	Reduced-Impact Logging
SBIA	Social and Biodiversity Impact Assessment
UNFCCC	United Nations Framework Convention on Climate Change
WWF	World Wildlife Fund

<u>Note:</u> Only acronyms that are used more than once are listed here.

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1. Introduction to Toolbox

1.1 Overview

In order to be validated under the CCB Standards, a terrestrial carbon project plan must provide compelling arguments that the project will benefit biodiversity[1] and must describe measures capable of justifying those benefits. Once the project has been validated, subsequent verification under the CCB Standards requires that biodiversity benefits be demonstrated with scientific evidence collected via a monitoring program. If the project's monitoring data succeed in showing that biodiversity in the project area and project zone has been maintained or enhanced, then the CCBA's biodiversity requirements are satisfied and the project is verified.

Although simple in summary, the biodiversity-related portion of the certification process requires at least 22 different steps (Appendix 1), each of which may mean different things to different project designers. At one extreme, some designers may assume that their project is so clearly biodiversity-friendly and the benefits for biodiversity are so obvious that they fail to invest enough time in designing effective monitoring plans and guarding against possible negative impacts. At the other extreme, some carbon project designers may get bogged down in the complexities of biodiversity monitoring and the many knotty questions associated with it.

The aim of this toolbox is to help project designers navigate between these two extremes by providing guidance on each of the biodiversity-related criteria required for certification under the CCB Standards. As is the case with Parts 1 and 2 of this Manual (Richards and Panfil 2011a, b), it is worth emphasizing that the goal here is not to establish additional standards or requirements that must be fulfilled for certification under the CCB Standards. None of the advice provided in this toolbox is mandatory, and none of the resources recommended here are obligatory. Instead, they are intended as broad guidance to help managers design a project that satisfies the biodiversity requirements of the CCB Standards.

The guidance provided in this Part 3: Biodiversity Impact Assessment Toolbox complements Part 1: Core Guidance for Project Proponents and Part 2: Social Impact Assessment Toolbox. Biodiversity impact assessment requires expert inputs in the design and other aspects of monitoring as described in **Section 5,** and local participation in identifying the biodiversity objectives of a project and understanding likely biodiversity effects of interventions is usually essential. Biodiversity impacts often result in livelihood impacts as well, and for these reasons the guidance in Part 2 is also relevant to Part 3. Social and Biodiversity Impact Assessment are best done in an integrated way.

1.2 How This Toolbox Is Organized

This toolbox is divided into four sections:

- A survey of typical biodiversity impacts of land-based carbon projects, both positive and negative;
- Guidance for describing initial biodiversity conditions, identifying risks to that biodiversity, and projecting a 'without-project' scenario for biodiversity;
- Guidance for designing project activities and estimating their biodiversity impacts; and
- Guidance for monitoring biodiversity impacts.

[1] In this document and in the CCB Standards in general, the term biodiversity refers to species diversity and ecosystem diversity (i.e., habitat types, biotic communities, ecoregions). Likewise, biodiversity impacts are considered at three nested spatial scales: 1) within the specific project area (land within the carbon project boundary and under the control of the project proponent); 2) within the broader project zone (the project area plus the land within the boundaries of the adjacent communities potentially affected by the project); and 3) offsite (beyond the project zone).

The guidance provided in the latter three sections is organized in the same sequential fashion as the 22 biodiversity-related criteria required by the CCB Standards. Users seeking guidance on a specific criterion may refer to Appendix 1 of this document, which indicates in which section of this toolbox the criterion is discussed. For example, the Appendix will direct a project designer who has a specific question about how to satisfy **Criterion G3.7** (e.g., 'What measures can my project take to maintain biodiversity benefits beyond the project lifetime?') to **Section 4.5**: Describing Measures to Maintain Biodiversity Benefits beyond the Project Lifetime.

Wherever possible, the guidance in this toolbox includes:

- Expanded discussion, clarification, and background of the relevant CCB Standards criterion or criteria;
- A case study showing how an actual project has satisfied the requirement, or an example of how a project might do so; and
- A list of websites and publications that provide information relevant to satisfying the requirement and a short description of potentially useful publications.

The toolbox includes another feature intended to allow users to skip directly to sections that specifically address the three most common types of carbon projects.[2] These sections, marked by colored boxes throughout the toolbox for easy identification and quick reference, are:

A/R Afforestation and reforestation (A/R) projects, in which biodiversity benefits are typically associated with the establishment or restoration of forests (or other vegetation) and the subsequent recolonization of the project area by forest-based plant and animal species;

Reduced Impact Reduced-impact agriculture, forestry, and other land uses, in which biodiversity benefits typically accrue from ending management practices that directly harm certain plant and animal species, or degrade soils and waterways; and

REDD Reduced emissions from deforestation and degradation (REDD), in which biodiversity benefits come from the long-term preservation of forest-based plant and animal species that would otherwise be removed from the project area by deforestation, hunting, and other similar threats.

[2] While these three broad categories include the majority of project types currently using the CCB Standards, there are several important but less common projects that do not fall into these categories (e.g., biochar, avoided conversion of natural non-forest vegetation). As the carbon sequestration field continues to evolve, future versions of this toolbox will address the potential biodiversity impacts of a larger range of projects.

2. Typical Biodiversity Impacts of Land-Based Carbon Projects

2.1 Introduction

All land-based carbon projects have the potential to generate both positive and negative impacts on biodiversity in the project zone and project area.[3] Although many such impacts have been documented in the scientific literature, **there are few generalities that apply to all projects and all biomes**, or even to the same project at different stages of implementation. In other words, the biodiversity impacts of a given intervention or land use are not always consistent among taxonomic groups (i.e., birds may react differently than fungi), across different biomes (i.e., wet-forest bird communities may react differently than dry-forest bird communities), or over time (i.e., bird communities may be impacted negatively early in the intervention but positively later on). It is thus important to recognize that **documenting and understanding the biodiversity impacts of terrestrial carbon projects constitutes a young and active field of research**. Indeed, two recent reviews of conservation science have named it one of the field's highest research priorities (Chazdon et al. 2008; Sutherland et al. 2009).

Requiring carbon project managers to demonstrate positive, statistically significant trends in such a fluid and poorly understood system is without question a stiff challenge. In this first section of the toolbox we argue that in spite of these difficulties **the most common expected biodiversity impacts of carbon projects are relatively straightforward and thus amenable to tracking via well-designed monitoring programs**. And while we do not recommend ignoring the more complicated, harder-to-monitor impacts on a site's biodiversity, our bias is towards keeping things simple.

An overview of some common biodiversity impacts of carbon projects is provided in Table 1. The next sections offer an expanded discussion of those impacts for various kinds of carbon projects: afforestation, reforestation, revegetation, reduced-impact forestry, reduced-impact agriculture (more commonly known as sustainable agriculture, agroforestry, or agri-environment schemes), and reduced emissions from deforestation and degradation (REDD).

Table 1. Overview of Potential Biodiversity Impacts Anticipated for Various Kinds of Terrestrial Carbon Projects

'+'= positive impacts; '-' = negative impacts; '+/-' = positive or negative impacts, depending on context.

Type of Project	Potential Biodiversity Impacts in Project Area	Potential Biodiversity Impacts in Project Zone
Afforestation with native species	+ Local forest benefits[1] + Reduction of non-native herbaceous plant species + Plant and animal communities typically more diverse than those of original open habitat - Loss of plant and animal species specialized on certain open habitats (e.g., wetlands)	+ Regional forest benefits[1] +/- Downstream aquatic communities benefit from reduced erosion, or harmed due to chemical inputs - Biodiversity leakage[2] (e.g., grazing animals move elsewhere)
Afforestation with non-native species	+/- Plant and animal communities in plantations more or less diverse than those of original open habitat - Large-scale introduction of non-native species	+/- Downstream aquatic communities benefit from reduced erosion, or harmed due to chemical inputs - Biodiversity leakage[2] (e.g., grazing animals move elsewhere)

[3] The CCB Standards define the project area as the land within the carbon project boundary and under the control of the project proponent. The project zone includes the project area and the land within the boundaries of the adjacent communities potentially affected by the project.

	- High levels of anthropogenic disturbance, if plantation forestry - Loss of species specialized on certain open habitats (e.g., wetlands)	- Large-scale introduction of non-native species - Potential introduction of GMOs
Reforestation with native species	+ Local forest benefits[1] + Loss of invasive or non-native species - Loss of disturbance-loving species	+ Regional forest benefits[1] + Benefit downstream aquatic communities via reduced erosion + Increased habitat connectivity between regional forest patches - Biodiversity leakage[2] (e.g., grazing animals and loggers move elsewhere)
Reforestation with non-native species	- Loss of disturbance-loving species	- Spread non-native species to surrounding landscape - Potential introduction of GMOs - Biodiversity leakage[2] (e.g., grazing animals and loggers move elsewhere)
Revegetation with native species	+ Local vegetation benefits	+ Increased habitat connectivity between regional forest patches - Biodiversity leakage[2] (e.g., grazing animals and loggers move elsewhere)
Reduced-impact forestry	+ Fewer trees removed from forest + Reduced risk of forest fires + Local forest benefits[1] - Loss of disturbance-loving species	+ Regional forest benefits[1] + Aquatic communities benefit from less erosion and sedimentation in programs that disallow harvesting on steep slopes and along streams + Increased habitat connectivity between regional forest patches
Reduced-impact agriculture	+ Soil fauna benefits from fewer external chemical inputs (e.g., nitrogen fertilizer, pesticides) and no-till farming + Plant and animal communities benefit from trees planted for windbreaks, restored riparian areas, or agroforestry activities, and from longer-term crop rotations in synch with seasonal cycles, and higher crop diversity + Plant and animal communities benefit from less water-intensive farming practices - Loss of disturbance-loving species	+ Aquatic communities benefit from less erosion and sedimentation, fewer external chemical inputs (e.g., nitrogen fertilizer, pesticides), and less water-intensive farming practices + Trees planted for windbreaks, riparian strips, agroforestry activities, and other natural vegetation provide corridors for animal species + Plant and animal communities benefit from agricultural practices that maintain natural biological and ecological processes (e.g., nutrient cycling, nitrogen fixation, soil development) - Inputs of organic fertilizer (e.g., animal manure) pollute aquatic communities - Potential introduction of GMOs
REDD	+ Local forest benefits[1] - Narrow focus on avoiding deforestation may overlook damage to animal communities (e.g., via hunting)	+ Regional forest benefits[1] + Maintain habitat connectivity - Biodiversity leakage[2] (e.g., agents of deforestation move elsewhere)

[1] 'Local forest benefits' is shorthand for the large number of biodiversity benefits that typically accrue from the wide range of habitats that mixed-species forests provide for locally occurring plants and animals. 'Regional forest benefits' is shorthand for the large number of biodiversity benefits derived from forest cover at the watershed scale.

[2] 'Biodiversity leakage' refers to an increase in anthropogenic pressure on plant and animal communities outside the project area (e.g., hunting, gathering, logging) that is a direct result of increased protection of the project area.

2.2 Biodiversity Impacts of Afforestation[4] and Reforestation (A/R) Projects

A/R

Afforestation and Reforestation (A/R) projects encompass a diverse array of activities ranging from restoration of native forests to agroforestry to large-scale industrial monoculture plantations. In turn, these activities encompass a diverse array of management styles, ranging from substantial interventions involving large-scale and continuous inputs of chemicals and water to *laissez-faire* natural regrowth. Given this variety, it is inevitable that some A/R projects have positive impacts on biodiversity while others can seriously degrade it. Figure 1 summarizes some of the most common factors that determine the likeliness of positive and negative impacts in such projects.

Figure 1. Factors that Commonly Influence the Direction and Scale of Biodiversity Impacts in A/R Projects

Continuous inputs of water, fertilizers, or pesticides
Monoculture plantations
Plantations of non-native species
Planting site already in good condition
Planting site far from intact native forest
Seed-dispersing animals rare to absent

Minimal inputs of water, fertilizers, and pesticides
Plantations incorporating many species
Plantations incorporating native species
Planting site extremely degraded
Planting site close to intact native forest
Seed-dispersing animals well-represented

Forests typically contain more biodiversity than non-forested sites because their greater structural complexity makes a broader array of niches and resources available for plants and animals (Tews et al. 2004). On the other hand, recent reviews have found little evidence that planted forests harbor higher levels of biodiversity than the non-forested sites they replace (see Box 1; Carnus et al. 2006, Brockerhoff et al. 2008, Felton 2010), largely because so many planted forests are monocultures. In the case of carbon projects based on A/R, the direction and intensity of biodiversity impacts will largely depend on:

- The intensity of management activities over the long term;
- The number of different tree species planted;
- The degree to which native tree species are planted;
- The conditions of the site to be forested; and
- The amount and location of forested land in the surrounding region.

[4] Official UNFCCC definitions: *Afforestation* is the direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources. *Reforestation* is the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For the first commitment period, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989. *Revegetation* is a direct human-induced activity to increase carbon stocks on sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the above definitions of afforestation and reforestation (UNFCCC 2002).

Where the primary objective of A/R is high-volume timber production, management activities are often intensive, long-term, and strongly detrimental to biodiversity (e.g., deep ripping of soils, application of chemical fertilizers and pesticides, intensive irrigation, the use of non-native species, the use of heavy machinery to harvest timber, very short harvest cycles). By contrast, where the primary objective is the establishment of forest cover, similarly aggressive management techniques may be used early in the project to accelerate forest establishment (with strongly negative impacts on biodiversity) but can then be tapered off or abandoned altogether once forest is capable of growing on its own (with consequently reduced negative impacts on biodiversity). Where planted stands are managed under internationally recognized environmental certification standards for sustainable forestry (Frumhoff & Losos 1998, Marjokorpi & Salo 2007, MCPFE 2009), biodiversity impacts will depend on the managers' ability to minimize the intensity and periodicity of required interventions (e.g., mechanized timber harvests).

Box 1. Impacts of Afforestation on Biodiversity in Northern Europe

The most comprehensive studies to date on how afforestation affects plant and animal communities come from Ireland and Scandinavia. In both regions, researchers have surveyed biodiversity in heathlands, grasslands, and bogs and compared the results with those from places that used to be heathlands, grasslands, or bogs until they were planted with native or exotic tree species.

Both studies found that afforestation decreased plant diversity, even at afforested sites that were decades old. Comparisons of animal diversity showed few consistent trends, showing higher diversity of some groups in afforested areas, and lower diversity of others. For example, while the Irish study recorded higher bird diversity in planted forests than in non-forest sites, the Scandinavian study found no difference; both studies, however, noted a complete shift in bird species composition between forest and non-forest sites. The Scandinavian study found higher diversities of fungi and soil invertebrates in afforested sites.

Likewise, the assumption of more positive biodiversity benefits at sites afforested with native tree plantations than at sites planted with exotics has proved difficult to support. The Scandinavian study concluded, for example, that fungal communities responded similarly to both types of afforestation, while earthworms were more diverse in native stands than in exotic stands. *Collembola* species responded one way in Iceland and another way in Norway.

Given that these complex and varying results were obtained in relatively species-poor temperate zone systems, it is to be expected that impacts will be even more complex in diverse tropical systems.

Sources: Gittings et al. 2004 and Smith et al. 2006 for Ireland; Halldorsson et al. 2007, 2008 and Elmarsdottir et al. 2008 for Scandinavia.

Likewise, where A/R projects are carried out with a mix of native species that reflects the diversity of natural forests in the surrounding region, biodiversity impacts are expected to be more positive than where they are carried out with a small number of economically important non-native species (Box 2). Fast-growing non-native tree species can, however, help jump-start the process of native forest restoration in non-forest sites by rapidly providing shade and microclimatic conditions that facilitate the subsequent planting of native forest species (Parrotta et al. 1997). Likewise, plantations may reduce pressure on natural forests for timber and other forest products that might otherwise be removed from natural forests.

Box 2. The Death and Rebirth of a Megadiverse Amazonian Forest

Bauxite, which is used to make aluminum, is common in the soils underlying some forests in eastern Amazonia. Mining this bauxite has catastrophic impacts on biodiversity at the local scale because it requires removing 100% of the forest and topsoil over large areas and, in the process, converting some of the most diverse ecosystems on Earth to lunar landscapes.

In the early 1980s, the Brazilian mining company Mineração Rio do Norte initiated a large-scale effort to reestablish native forest in sites devastated by mining activities. In some cases, aggressive management—including the wholesale removal, storage, and subsequent reapplication of a site's original topsoil, still rich in viable seeds, fungi, and microorganisms—has succeeded in restoring relatively diverse, native, closed-canopy forest to places that were fields of sun-baked clay just a few years earlier. After 9-13 years, some reforested sites contained half of the woody plant diversity and 33% of the basal area of old-growth forest nearby.

Although the company's reforestation program was not designed to sequester carbon, it does represent one of the longest-running attempts to monitor the biodiversity impacts of reforestation projects on severely degraded tropical lands. As such, it provides a good example of some of the recommendations highlighted in this toolbox for successful monitoring: 1) involve scientists; 2) track both plant- and animal-related indicators; and 3) monitor both control and treatment sites.

Source: Parrotta & Knowles 1999, 200).

Biodiversity impacts will also depend on the conditions of the site to be forested. Proponents of A/R often seek to enhance their projects' attractiveness by describing the lands where forest will be reestablished as degraded grasslands or degraded agricultural lands. Even where this is perfectly accurate, it does not automatically follow that planted forests will be more diverse (see Box 1). Open grasslands can be quite diverse and harbor specialized flora and fauna, especially if they include wetlands, and many of these species will not survive a transition from grasslands to forest (Smith et al. 2006; Barlow et al. 2007). Some of the species that will not survive the reestablishment of forest will be non-native weeds, and their removal will thus be a biodiversity benefit, but several others may be native and their loss a negative biodiversity impact. **It is thus essential that all A/R projects include an expert pre-project assessment of existing biodiversity at the site where trees will be planted**.

When reforestation projects were first proposed for inclusion in the Clean Development Mechanism (CDM) as tools for carbon sequestration, there were concerns that they could have a significant negative impact on biodiversity, since some early projects included proposals to cut down native forests and replace them with plantation monocultures for carbon sequestration (Niesten et al. 2002). It is precisely this sort of concern that prompted the CCB Standards to incorporate measures to protect and monitor biodiversity in terrestrial carbon projects. This is yet another reason why all A/R carbon projects should provide detailed information on pre-project biodiversity in the areas to be planted; under the CCB Standards plantations, should never replace existing native vegetation.

Finally, the expected biodiversity impacts of A/R projects depend to a large extent on the presence of native forests in the surrounding region and the long-term suitability of a site for maintaining forest cover. More significant positive impacts are expected where large blocks of native forest grow nearby, because they will assist direct management activities by contributing colonizing plants and animals to the newly reforested site. Conversely, where native forests are small, far away, or absent (or present but with severely degraded animal communities), little natural assistance is expected. It is also important to note that in biomes where trees grow very slowly or in regions where native forests are too small or too far away to contribute large numbers of colonizing seeds, some biodiversity benefits of reforestation and revegetation programs may take decades to be detected (Dwyer et al. 2009).

2.3 Biodiversity Impacts of Reduced-Impact Forestry and Reduced-Impact Agricultural Projects

Reduced Impact

Reduced-Impact Agriculture and Forestry projects generate biodiversity impacts by mitigating or eliminating environmentally damaging practices that emit carbon in agricultural and forestry operations. In the case of reduced-impact agriculture, for example, the application of organic fertilizers, shallower plowing, the establishment of windbreaks, and other emissions-reducing measures offer direct benefits to soils and aquatic ecosystems. While sustainable agriculture presumably also provides significant benefits for plant and animal communities, these can be challenging to document (see Box 3).

Box 3. In Search of the Biodiversity Impacts of Sustainable Agriculture in Europe

Since 1985 the European Union has encouraged member nations to compensate farmers who implement sustainable agricultural practices. While several dozen published studies have examined the biodiversity impacts of such practices—often by comparing the abundance and diversity of wild plants and animals on sustainably managed and traditionally managed farms—few consistent trends have been detectable.

One study in Ireland, for example, found that average plant diversity was higher on traditionally managed farms, while no difference was found in the diversity of ground beetles. A similar study of plant, bird, hover fly, and bee diversity on Dutch farms failed to document significant positive biodiversity impacts of sustainably managed farmland in that country. By contrast, many studies have found increased species diversity or abundance of invertebrates on sustainably managed farms—unsurprisingly, perhaps, given the presumably lower use of insecticides there.

Reviewing 62 such studies, Kleijn and Sutherland (2003) concluded:

> "We are unable to say how effective agri-environment schemes are in protecting and promoting biodiversity on farmland. A limited number of well-designed and thoroughly analysed studies demonstrate convincing positive effects measured in terms of increased species diversity or abundance, while other studies show no effects, negative effects, or positive effects on some species and negative effects on others."

Such critiques have helped spur efforts to improve the quality of monitoring programs. The authors' recommendations include rigorous experimental design and data analysis, careful descriptions of initial conditions, and monitoring of long-term trends.

Sources: Kleijn et al. 2001;, Kleijn and Sutherland 2003;, Feehan et al. 2005.

In Reduced-Impact Logging (RIL) projects, positive biodiversity impacts typically derive from lower levels of habitat destruction and degradation (i.e., fewer trees destroyed as collateral damage during timber extraction) compared to conventional logging. Using RIL techniques, environmental damage can be further minimized via harvest plans that protect soils, facilitate natural regeneration of trees (i.e., by protecting seedlings and saplings), maintain critical ecosystem processes (e.g., hydrological flow, nutrient cycling; Nepstad et al. 1999), and use low-impact skid trails and landing sites (for storage of harvested trees). As an example, a study of the effects of low-harvest RIL on bat communities in Amazonian Brazil suggested that RIL had only minor effects on biodiversity over the short term (Castro-Arellano et al. 2007). Specifically, population-level responses were minor, with 10 of 15 bat species showing no change in mean abundance. Some aspects of bat community composition differed between uncut (control) forests and those cut under RIL, with the latter showing increased bat diversity due to decreased dominance of certain bat species.

As with REDD projects, the same mechanisms that reduce carbon emissions in RIL also reduce negative biodiversity impacts, which means that measurements of reduced carbon emissions in logging operations can serve as proxies for reduced biodiversity impacts. In contrast to REDD projects, however, offsite impacts are less likely to be caused by RIL projects, since implementing conservation-friendly timber extraction practices in a logging operation typically provides little incentive for loggers to intensify harvests elsewhere (Putz et al. 2008).

While the preceding paragraphs emphasize the positive biodiversity impacts of RIL projects, it is worth noting that these necessarily refer to **improvements in existing operations** (e.g., reducing impacts in an already logged forest) and not the initiation or expansion of operations (e.g., extending reduced-impact logging to previously unlogged forest), which can generate significant negative impacts for biodiversity.

2.4 Biodiversity Impacts of REDD Projects

REDD

Given their goal of actively stopping deforestation by protecting existing forest, REDD projects are the most obviously conservation-friendly of terrestrial carbon projects; the same interventions and land uses that protect standing carbon stocks also protect habitat for plants and animals. But while the positive biodiversity benefits of REDD projects are obvious, two negative impacts are also expected to be common in REDD projects and should be kept in mind during the project design stage.

First, the displacement of deforestation from the project site to other areas (leakage) is a risk for all REDD projects, and this carries a corresponding risk for biodiversity. There is also a risk of displacement of the economic activity that would have caused deforestation, such as agriculture or mining, to a site with fewer trees, such as grasslands or wetland areas with high biodiversity value. Second, even if management activities are successful in preventing deforestation, a too-narrow focus on preventing trees from being cut down in the project area may overlook other negative biodiversity impacts there, most commonly the degradation of large vertebrate communities due to hunting.

Box 4. …But What about <u>Specific</u> Biodiversity Impacts?

Having looked over this first section of the toolbox, some readers may have grown impatient with the repeated and rather vague references to *positive* and *negative* biodiversity impacts. Some readers may be wondering:

> Can't we be a little more specific? Can't we get down to details? Will bird diversity increase or decrease once my site is reforested? Do plant species benefit from reduced-impact logging or not? Aren't monoculture timber plantations always bad for amphibians? Won't stream communities automatically benefit from reduced-impact agriculture? Won't large mammal communities automatically benefit from REDD?

As noted earlier in this section, answers to these questions are rarely consistent enough to be broadly applicable to all types of carbon projects in all stages of implementation and across all biomes—which is why we have kept the discussion broad up to this point. Readers looking for a selection of more specific impacts associated with different kinds of carbon projects should refer to Table 1 of this toolbox.

Project designers do eventually have to select specific attributes of their project sites that will serve as indicators of the biodiversity impacts of their projects (e.g., the extent of forest cover, the abundance or diversity of certain plants and animals). That process is discussed in detail in **Section 5** of this toolbox.

2.5 Main Sources and Further Guidance

General Biodiversity Impacts

- The biodiversity impacts of a given project will depend on the biodiversity present in the project zone and its surroundings. Numerous resources to describe that biodiversity are listed in **Sections 3.1.1–3** of this toolbox.
- The International Association for Impact Assessment (IAIA) provides several resources relevant to biodiversity impact assessments, available online at http://www.iaia.org**.** Of particular interest is the website's 'Resources and Networking' page, which hosts a large number of documents that offer guidance on biodiversity impact assessments in different countries, regions, and biomes.
- The Environmental Evidence Library (EEL), managed by the Collaboration for Environmental Evidence, hosts a small but growing collection of case studies documenting the biodiversity impacts of specific conservation interventions, several of which are relevant to carbon projects. The EEL is available online at http://www.environmentalevidence.org/Library.htm. A similar resource is available at http://www.conservationevidence.com.
- Businesses developing multiple carbon projects may find it worthwhile to use the Integrated Biodiversity Assessment Tool (IBAT) for Business. IBAT is an online tool that provides businesses with a single source for globally recognized biodiversity information and a user-friendly mapping application, to inform decision-making processes and address any potential biodiversity impacts. IBAT for Business is available to companies on a subscription basis. For more information on how to obtain access please visit the website at http://www.ibatforbusiness.org. The data in IBAT is also offered through another platform "IBAT for Research and Conservation Planning" to NGOs, universities, and researchers at no cost at the following site: https://www.ibat-alliance.org/ibat-conservation/.

Biodiversity Impacts of Afforestation and Reforestation A/R

- A large number of studies have documented the impacts on biodiversity of specific afforestation or reforestation projects, and many are easily found on the Internet. Broad reviews that summarize the results of these studies (e.g., Felton 2010) are harder to find, perhaps because site-to-site differences are so important. Until a broad overview is available, readers are encouraged to seek out studies relevant to conditions in their project zone.

Biodiversity Impacts of Reduced-Impact Agriculture and Forestry Reduced Impact

- The Sustainable Agriculture Network, a coalition of several conservation groups, maintains a set of social and environmental standards for certifying conservation-friendly farming and ranching projects, and these provide a broad framework for addressing the impacts on biodiversity of reduced-impact agriculture. More information is available online at http://sanstandards.org/sitio/.
- The Forest Stewardship Council is a multi-stakeholder organization that develops and maintains internationally recognized standards for responsible forest management that include social, environmental, and economic components. Information about FSC policies and standards is available online at http://www.fsc.org/policy_standards.html.
- Valuable sources of information on reduced-impact agriculture include Gascon et al. (2004) and Dudley et al. (2005).
- Valuable sources of information on reduced-impact logging include Kuusipalo & Kangas (1994) and Putz et al. (2007).

Biodiversity Impacts of REDD REDD

- Most of the vast literature on REDD now available online focuses on policy contingencies and practical challenges rather than REDD's fairly straightforward impacts on biodiversity. Readers seeking an introduction to the policy implications of REDD for biodiversity may consult Dickson et al. (2009), Ebeling and Fehse (2009), Karousakis (2009), Harvey et al. (2010), and Pistorius et al. (2010).
- The UNEP World Conservation Monitoring Centre (UNEP-WCMC) maintains a series of online interactive tools concerning REDD+ and biodiversity. While these are currently limited to a few regions of the world, coverage is expected to improve. More information is available online at http://www.carbon-biodiversity.net/.

3. Describing Initial Biodiversity and Threat Conditions and Establishing a "Without-Project" Scenario

3.1 Describing Initial Conditions

To describe the initial conditions of the project area prior to the start of the project, the General Description (**G1**) section of the CCB Standards includes three criteria specifically related to biodiversity:

- Describe the types and condition of vegetation within the project area (**G1.2**)
- Describe current biodiversity and threats to biodiversity in the project zone (**G1.7**)
- Describe High Conservation Values if present (**G1.8**)

While some project managers may initially assume that this section is simply a snapshot to establish the geographic and biological context of the project, doing so represents a missed opportunity and in some cases a serious mistake. The reason is that **tracking changes in the project area's vegetation, biodiversity, and threats will figure prominently in most projects' programs to monitor impacts on biodiversity**. For this reason, the initial conditions in the project area represent an important reference point against which impacts on biodiversity will be measured during a project's lifetime and are thus a key foundation of most monitoring programs.

3.1.1 Describing the Initial Condition of Vegetation

Criterion G1.2 of the CCB Standards asks for two things:

- A description of the project area's vegetation before the start of the project; and
- An assessment of how intact or affected by human impacts that vegetation is before the start of the project.

Ideally, project developers should aim not only for a detailed description of the project area vegetation but also for a quantitative assessment of the specific attributes of that vegetation that will be tracked by the project's monitoring program. For example, if the proportion of the project area covered by closed-canopy forest is considered an indicator of the project's impacts on biodiversity (see **Section 5** of this toolbox), then the description of the initial vegetation conditions should include a careful measurement of that proportion, carried out in such a way that it can be repeated in future years as part of the project's monitoring program. Likewise, project designers who select the abundance of an invasive plant species as an indicator of their project's impacts on biodiversity would be wise to include in the description of the initial vegetation conditions a rigorous measurement of that plant's abundance, carried out in such a way that it can be repeated in future years as part of the project's monitoring program. In a very real sense, **the initial description of vegetation is the first step of the project's biodiversity monitoring program**.

Satisfying this criterion typically requires:

- **A description of the major ecoregion(s) where the project area is located** (e.g., Panamanian dry forests, Orinoco wetlands). This is one attribute of vegetation that is not expected to change over the lifetime of a project. The description should be based on a recent map of ecoregions or vegetation types at the global or continental scale, such as Olson et al. 2001 (see resources section below). National-level vegetation maps produced by government agencies may also be useful. Continental-scale satellite mosaics (see resources section below) are useful visual aids for placing the project site and its vegetation in a regional context.

- **A description of the smaller-scale vegetation type(s) present in the project area** (e.g., swamp forest, open grassland). Unlike the description of vegetation at large scales discussed in the previous section, this description of vegetation at the project area scale is likely to change over the project lifetime and will probably require some field work by a professional familiar with local vegetation. A map of vegetation types within the project area is ideal, even if limits are approximate rather than exact. If a map is not available, project designers should summarize or estimate the coverage of each vegetation type in the project area (e.g., 50% forest, 50% savanna). Satellite images, aerial photographs, photographs taken on-site, and mention of especially common or dominant plant species are also extremely helpful for describing vegetation types at this scale. As discussed above and in **Section 5** of this toolbox, measurements of vegetation attributes considered key to the area's biodiversity should be made in such a way that they can be repeated periodically throughout the project's duration as part of its biodiversity monitoring program.
- **A description of the current condition of the vegetation in the project area.** This may include a variety of different techniques, including:
    - Qualitative observations of the vegetation (e.g., photographs, visual descriptions);
    - Quantitative field surveys of vegetation structure (see Table 7);
    - Qualitative or quantitative descriptions of the abundance of plant species of local interest (e.g., invasive species, threatened species, economically important species, common species);
    - Qualitative or quantitative analyses of vegetation change in satellite imagery (see resources section below); and
    - Interviews with local residents and experts regarding the history of the local vegetation.

Note that there is some potential overlap between **Criterion G1.2** (describe vegetation types) and **Criterion G1.7** (describe current biodiversity, including ecosystems). One solution for project designers is to provide a brief overview of vegetation types in section **G1.2** and a more detailed description in section **G1.7**. Another possibility is to describe vegetation types in detail in section **G1.2** and to describe other habitat types (e.g., aquatic systems) in section **G1.7**.

Main Sources and Further Guidance

Resources for Describing Ecoregions and Vegetation Types

- A map of Earth's terrestrial ecoregions (Olson et al. 2001) is available online at http://www.worldwildlife.org/science/ecoregions/item1267.html.
- Several systems for classifying vegetation across continent-sized regions of the planet are available (e.g., NatureServe 2009 for the northern and central Andes and Josse et al. 2007 for the western Amazon).
- The United States Geological Service maintains interactive online maps to help users identify and download satellite images available for given areas of the world, available at http://glovis.usgs.gov/ and http://edcsns17.cr.usgs.gov/NewEarthExplorer/. The University of Maryland's Global Land Cover Facility maintains a similar site at http://glcfapp.glcf.umd.edu:8080/esdi/index.jsp.
- Continental-scale panoramic aerial images are available online at http://130.166.124.2/world_atlas/.

- Carbon projects in areas with significant wetlands should explore the Ramsar Convention Handbooks, available online at http://www.ramsar.org/cda/en/ramsar-pubs-handbooks-handbooks4-e/main/ramsar/1-30-33^21323_4000_0__.

Resources for Assessing Vegetation Condition or Quality

- Table 7 of this document lists several variables that are commonly used to monitor vegetation condition or quality.
- Several countries and regions have developed specific protocols for assessing vegetation quality in different types of landscapes. One example is the United Nations' *Temperate and boreal forest resource assessment* (UNECE& FAO 2000), available online at http://live.unece.org/fileadmin/DAM/timber/fra/pdf/fullrep.pdf.
- The Global Invasive Species Database and associated resources for assessing the extent to which invasive species have affected the project area are available online at http://www.issg.org/database/welcome/.

3.1.2 Describing the Initial Condition of Biodiversity and Threats to Biodiversity

Criterion G1.7 of the CCB Standards asks for two things:

- A description of current (pre-project) diversity of species and ecosystems within the project zone; and
- A description of threats to that biodiversity.

The most common question from project designers regarding these requirements is "How much detail is required?" While there is no precise answer to that question, a few considerations should be kept in mind. It is preferable, for example, to err on the side of too much biodiversity information as opposed to not enough biodiversity information. Likewise, it is just as important to indicate which aspects of the region's biodiversity and which biodiversity threats are not known (or are poorly known) as it is to indicate which aspects are well known.

It is also important to recognize that one part of **Criterion G1.7** (Describe current biodiversity) overlaps to a significant extent with **Criterion G1.8** (Evaluate whether the project zone includes biodiversity-relevant High Conservation Values), since at many sites a general description of biodiversity will include a discussion of HCVs (see next section). Another part of **Criterion G1.7** (Describe threats to biodiversity) overlaps to some extent with **Criterion G2** (Describe the most likely land-use scenario in the absence of the project). In this case, it is helpful to keep in mind that the first criterion requires description of threats to biodiversity while the second addresses how those threats would be likely to affect biodiversity in the "without-project" projection.

In general, project designers working on this section should answer some of the following questions about the project area and zone.

Biodiversity Questions:

- How well known is the site's biodiversity?
- Have biologists studied the site in the past, or have they studied similar sites in the same region?
- Which taxonomic groups (e.g., plants, birds, fish, butterflies) are considered well-documented in the region?
- Do species lists or reference volumes exist for any taxonomic group, and how complete are they?

- What types of terrestrial ecosystems are present? As noted in the previous section, the answer to this question may overlap somewhat with **Criterion G1.2**.
- What sorts of plant and animal communities are particularly associated with each terrestrial ecosystem?
- What types of aquatic habitats (e.g., streams, lakes, coastal inlets) are present?
- What plant communities are associated with these aquatic habitats (e.g., gallery forest along streams, swamp forests, salt marshes)?
- What animal communities are associated with these aquatic habitats?
- Does the project zone contain landscape features that are especially important for the region's biodiversity (e.g., waterholes, clay licks, caves)?
- Which of the prominent biodiversity features of the ecoregion where the project is located, as described by ecoregional atlases (like Olson et al. 2001), are present in the project zone?
- Which HCVs are present at the site (see next section)?

Threats to Biodiversity Questions:

- Have any published articles, books, or reports described threats to biodiversity at the site or in the region?
- Which threats are considered well documented or well understood and which threats are considered poorly known?
- What are the most serious and immediate threats to biodiversity?
- What are the lesser or potential threats?
- Which taxonomic groups are most impacted by or at risk from these threats?
- Which HCVs are most impacted by or at risk from these threats?
- How are biodiversity threats in the project zone changing, or expected to change, over time?
- Are these trends in line with global (e.g., Butchart et al. 2010) or national (e.g., Bradshaw et al. 2010) trends?
- Have any threats to biodiversity been quantified in the project zone? This may be spatial (20% of the forest has been logged), temporal (500 kg of firewood are removed from the forest per year), or other (residents report an average of one large forest fire on the site per year).
- How do threats compare in intensity to those at a regional scale (e.g., is firewood collection especially intensive in the project zone)?
- What are the links between threats and local communities?
- How are threats to biodiversity perceived by local residents?

Main Sources and Further Guidance

Resources for Describing Biodiversity

- The World Wildlife Fund maintains a useful online tool to identify species that are potentially present at any given site on Earth, available at http://www.worldwildlife.org/wildfinder.

- Information on Earth's freshwater ecoregions (Abell et al. 2008) is available online at http://www.worldwildlife.org/science/ecoregions/freshwater.html
- Information on internationally important wetland sites is available online at http://ramsar.wetlands.org. Carbon projects in areas with significant wetlands should explore the Ramsar Convention Handbooks for the wise use of wetlands, available online at http://www.ramsar.org/cda/en/ramsar-pubs-handbooks-handbooks4-e/main/ramsar/1-30-33^21323_4000_0__.
- Information on global biodiversity hotspots is available online at http://www.biodiversityhotspots.org/Pages/default.aspx.
- Information on globally important areas for bird conservation is available online at http://www.birdlife.org/datazone/index.html.
- Guidance on describing biodiversity and current impacts is provided with the Conservation Action Planning tools, available online at http://conserveonline.org/workspaces/cbdgateway/cap/index_html.
- Shapefiles and other resources for the global protected areas system are accessible on the online searchable site http://protectedplanet.net.
- Appendix II of Langhammer et al. (2007) provides a long list of useful resources for describing biodiversity.

Resources for Describing Threats to Biodiversity

- Table 1 of this toolbox provides a list of potential negative biodiversity impacts associated with different types of carbon projects.
- Salafsky et al. (2008) provide a comprehensive classification of threats to biodiversity, which should include most threats in carbon sequestration project areas; their article is available online at http://www.conservationmeasures.org/resources. An updated version of the same scheme is available online at http://www.iucnredlist.org/technical-documents/classification-schemes/threats-classification-scheme-ver3.
- The CMP Open Standards for the Practice of Conservation (CMP 2007), available online at http://www.conservationmeasures.org/resources.
- Rayden (2008) provides specific guidance for identifying threats to HCVs in a report available online at http://www.proforest.net and http://www.hcvnetwork.org.
- Carbon projects in areas with significant wetlands should explore the Ramsar Convention Secretariat's useful series of handbooks for assessing threats to wetlands (Handbooks 13, 15, and 16), available online at http://www.ramsar.org/cda/en/ramsar-pubs-handbooks-handbooks4-e/main/ramsar/1-30-33^21323_4000_0.
- Global-level trends of environmental impacts are described by Butchart et al. (2010).
- National-level trends of environmental impacts are described by Bradshaw et al. (2010).

3.1.3 Describing High Conservation Values (HCVs)

The use of the High Conservation Value (HCV) framework is required by the CCB Standards. HCVs are defined as "six distinct attributes that give an 'area-critical' conservation significance" (Rayden 2008). **Criterion G1.8** of the CCB Standards requires a description of all the HCVs that are present in the project zone, or an indication that no HCVs are present. This section of the toolbox includes specific guidance on the three HCVs that are related to biodiversity (Table 2). Identifying and describing the other three HCVs, which are related to environmental services, will typically involve careful consultation with local stakeholders; for guidance see Part 1 of this Manual (Richards and Panfil 2011a) or the resources section below.

Table 2. Biodiversity-Related HCVs and Components to be Included in Project Design Documents (PDD)

If the project zone is found to include this High Conservation Value…	…then the project design document should include (where relevant):
HCV 1. Areas containing globally, regionally or nationally significant concentrations of biodiversity values (e.g. endemism, endangered species, refugia)	A map, satellite image, or aerial photograph showing the project zone's geographic location with respect to nearby protected areas
	A list of globally threatened plant and animal species known or expected to occur in the project zone and the places they occur there
	A list of nationally threatened plant and animal species known or expected to occur in the project zone and the places they occur there
	A list of endemic plant and animal species known or expected to occur in the project zone and the places they occur there
HCV 2. Globally, regionally or nationally significant large landscape-level areas where viable populations of most ,if not all, naturally occurring species exist in natural patterns of distribution and abundance	A map, satellite image, or aerial photograph showing the project zone's geographic location within a larger matrix of relatively intact native vegetation
	An estimate or direct measurement of the extent of the larger matrix of native vegetation
	A discussion of the age and current use level of the larger matrix of native vegetation, including evidence that it has not been extensively logged or hunted
	Evidence from field observations or consultations with local residents that a large proportion of natural forest species still exist in the larger matrix of native forest at relatively natural abundances
HCV 3. Areas that are in or contain rare, threatened or endangered ecosystems	Evidence that habitats or ecosystems present in the project zone are a recognized priority for conservation at the national, regional, or international level

Main Sources and Further Guidance

- The High Conservation Value Resource Network maintains a clearinghouse of useful HCV-related tools online at http://www.hcvnetwork.org. Especially helpful for determining whether or not a project zone contains HCVs are Proforest's guides *Good practice guidelines for High Conservation Value assessments: A practical guide for practitioners and auditors* (Stewart et al. 2008) and *Assessment, management and monitoring of High Conservation Value Forest (HCVF): A practical guide for forest managers* (Rayden 2008).
- Information on threatened species relevant to HCV 1 is available from the IUCN Red List of Threatened Species, online at http://www.iucnredlist.org. Users of the Red List are encouraged to consult the

Guidelines for appropriate use of Red List data, available online at http://iucn.org/about/work/programmes/species/red_list/resources/technical_documents/.

- Additional information on threatened species relevant to HCV 1 is available from the World Wildlife Fund's useful online tool to identify species that are potentially present at any given site on Earth, available at http://www.worldwildlife.org/wildfinder.
- Information on large, landscape-level forests relevant to HCV2 is available in the Global Forest Watch (http://www.globalforestwatch.org, World Intact Forest Landscapes (http://www.intactforests.org/) and the Last of the Wild (http://sedac.ciesin.columbia.edu/wildareas/downloads.jsp) datasets.

3.1.4 Describing a High Biodiversity Conservation Priority (Exceptional Biodiversity Benefits, CCB Gold Level)

Criterion GL3 of the CCB Standards asks project designers to demonstrate that the project zone includes a site of high biodiversity conservation priority. Addressing this criterion is only required for projects seeking gold level validation.

Satisfying this requirement requires showing either that the project zone lies within a previously determined Key Biodiversity Area (KBA) or that it meets the vulnerability or irreplaceability criteria for KBAs as defined by Langhammer et al. (2007). Previously determined KBAs include Alliance for Zero Extinction sites, Important Bird Areas, and Important Plant Areas (see below for resources to locate such areas). For sites that are not currently recognized as KBAs but may merit that status, Langhammer et al. (2007) provide detailed instructions for assessing vulnerability and irreplaceability.

Main Sources and Further Guidance

- A large number of valuable KBA resources are provided by Langhammer et al. (2007), available online at http://www.iucn.org/about/union/secretariat/offices/iucnmed/iucn_med_programme/species/key_biodiversity_areas/.
- The Integrated Biodiversity Assessment Tool (IBAT) is available for businesses at http://www.ibatforbusiness.org, and for non-profit use at https://www.ibat-alliance.org/ibat-conservation/. A list of Alliance for Zero Extinction sites is available online at http://www.zeroextinction.org/.
- A list of Important Bird Areas is available online at http://www.birdlife.org/datazone/index.html.
- A list of Important Plant Areas is available online at http://www.plantlife.org.uk/html/important_plant_areas/important_plant_areas_index.htm.

3.2 Establishing a "Without-Project" Projection for Biodiversity Impacts

The "without-project" scenario—also referred to in the literature as a reference scenario, a baseline scenario,[5] or a business-as-usual scenario—is a narrative that describes what is expected to happen to the project zone's biodiversity if the project is not undertaken. Building this narrative satisfies **Criterion G2.5** of the CCB Standards (Describe how biodiversity would be affected without the project) and at the same time establishes the baseline against which the biodiversity impacts caused by the project will be measured. It bears repeating that

[5] In other contexts, the term "baseline" sometimes refers to original (pre-project) conditions. In the context of the CCB Standards, however, the baseline against which project impacts are measured is the "without-project" scenario.

in the context of the CCB Standards, a project's impacts on biodiversity are not measured by comparing the post-project conditions with the pre-project conditions, but rather with **the conditions predicted to have occurred if the project had never taken place** (but see **Section 3.2.2** for a more detailed discussion).

3.2.1 Quantitative vs. Qualitative Scenarios

In projects where the link between carbon emission impacts and biodiversity impacts is obvious, the "without-project" scenario for biodiversity may be partly based on quantitative predictive models of habitat degradation. For example, since reduced-impact logging (RIL) practices decrease the number of non-timber trees that are destroyed during timber harvests, that number can be used to predict the scale of habitat destruction that would occur if such practices were not implemented. Likewise, predictive tools like the GLOBIO model (see resources section below) can generate quantitative predictions about how much forest is likely to be lost in a given region.

Even where such quantitative models are available, building the "without-project" scenario will also require qualitative techniques; for example, hard numbers on the extent of habitat destruction do not easily translate into hard numbers on how animal communities will react to that destruction. Many projects will lack quantitative models altogether and thus rely entirely on a qualitative narrative. The repeated use of the word "narrative" in this section is not merely ornamental; in these cases, the "without-project" scenario is simply a story that project designers tell about how their site's current biodiversity (described in **Criteria G1.6–G1.8**) is likely to change over time, based on their best understanding of current impacts (**G1.7**) and future risks to biodiversity (**G3.5**).

And while it is perfectly acceptable to tell a story that is 100% qualitative, project designers should avoid constructing scenarios that are also 100% vague or unsubstantiated (e.g., predictions of an across-the-board worsening of biodiversity conditions). The reason, of course, is that the "without-project" scenario represents the baseline against which future conditions must be compared, and those comparisons must be both specific and rigorous. Constructing an adequate "without-project" scenario will thus require knowing which biodiversity indicators are to be tracked over the lifetime of the project (see **Section 5.2**). For example, if project managers plan to monitor erosion rates or the diversity of aquatic invertebrates in streams, then the "without –project" scenario should include predictions about the likely trends in erosion and stream invertebrate diversity in the project's absence.

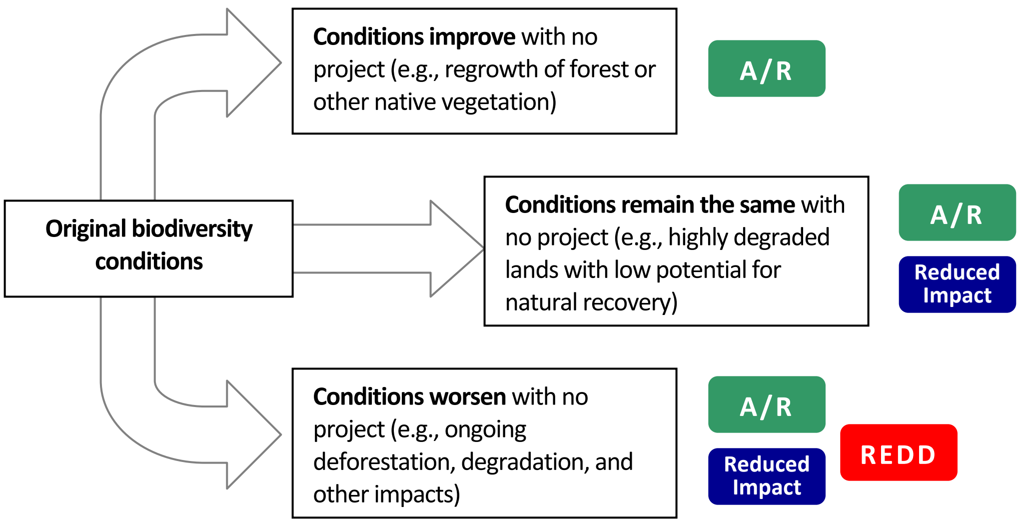
<u>Main Sources and Further Guidance</u>

- The Global Biodiversity model (GLOBIO; Alkemade et al. 2009), which generates some broad-scale predictions for global vegetation, is available online at http://www.globio.info/.
- A similar example at the regional scale is Soares Filho et al. (2008) modeling of various deforestation scenarios for the Amazon basin through the year 2050. The data set is available online at http://lba.cptec.inpe.br/.

3.2.2 Will Biodiversity Conditions Get Better, Get Worse, or Stay the Same?

Most of the carbon project design documents submitted to the CCBA (and available on the CCBA website) are based on the assumption that the "without-project" reference scenario is negative, i.e., that without any intervention biodiversity conditions will worsen over time. While this may often be the case, the two other scenarios—that biodiversity conditions improve or remain the same—should also be considered (Figure 2).

Figure 2. Three "Without-Project" Reference Scenarios and the Types of Terrestrial Carbon Projects Commonly Associated with Them



A/R Where **biodiversity conditions are expected to improve** without any intervention, the monitoring program must show that the status of biodiversity after project implementation is better than it would have been with natural improvements. This will typically require monitoring biodiversity conditions both in areas that are directly affected by project activities and in similar areas that are not affected. For example, a project that aims to restore the forest on a deforested hillside embedded in a native forest matrix will likely need to monitor biodiversity both on the hillside being managed and on similarly deforested hillsides that are not being reforested. In such cases, a rigorous comparison of "with;project" and "without-project" conditions will require pairing ecologically similar control and treatment sites and careful experimental design.

A/R **Reduced Impact** Where **biodiversity conditions are expected to remain the same** without any intervention, the "without-project" scenario is identical to the initial conditions, and the monitoring program must show that conditions after project implementation are better than the original starting conditions.

A/R **Reduced Impact** **REDD** Where **biodiversity conditions are expected to worsen** without any intervention, the monitoring program must show that conditions after project implementation qualify as one of the following:

1. Better than those projected in the "without-project" scenario;
2. Equal to the initial conditions (which, in this context, are by definition better than the "without-project" scenario); or
3. Better than the initial conditions (which, in this context, are by definition better than the "without – project" scenario).

Where the “without-project” scenario is based on quantitative predictive models, it may be simplest to choose option #1 (to demonstrate, for example, that observed “with-project” deforestation is less extensive than projected “without-project” deforestation). Where such models are not available, options 2 and 3 are a more appropriate choice, because they allow one to compare quantitative “with-project” conditions to quantitative initial conditions rather than to qualitative projected conditions.

4. Designing Project Activities and Estimating Their Biodiversity Impacts

4.1 Summarizing the Project's Biodiversity Objectives

Criterion G3.1 of the CCB Standards asks for a summary of the project's biodiversity objectives. While it is understood that the fundamental biodiversity objective of projects seeking CCB approval is to sequester carbon in a way that improves local biodiversity conditions, this section provides an opportunity to list the project's specific goals for conservation in the project zone. And while these biodiversity objectives will to some extent represent project designers' conservation vision for the project area, it is more useful to think of them as a list of the specific propositions that will face rigorous testing under the program's monitoring program.

This means that:

- **Biodiversity objectives should be few in number**, because monitoring the progress towards each objective will require significant costs in time and money.
- **Biodiversity objectives should be easy to assess and quantify using practical indicators**. In some cases, the link between an objective and the biodiversity indicator that will measure progress towards that objective is straightforward. For example, evaluating progress towards the goal of increased forest cover in the project area simply requires tracking the extent of forest cover in the project area over time. By contrast, evaluating progress towards the goal of increased abundance of a rarely sighted mammal species will probably require several proxy indicators of uncertain efficiency (e.g., scat frequency, track frequency, den occupancy, camera trap sighting rates). The simpler the link, the better the biodiversity objective.

Given the two rules of thumb above, it is worth noting that the biodiversity objectives of carbon projects are unlikely to include all of the broader biodiversity objectives of the region where they occur. For example, although protecting the lowland tapir is a top conservation goal throughout the Amazon basin, it need not be a formal biodiversity objective of every carbon project established in Amazonia. Because tapirs are a globally threatened species and thus indicative of HCV 1, designers of projects where tapirs occur are required by the CCB Standards to show that project activities will not affect their habitat negatively (**Criterion B1.2**), to demonstrate that the project includes measures to conserve their habitat (**G3.6**), and to develop a plan to assess the conservation of the project's HCVs in general (**B3.2**).

As the preceding discussion shows, establishing biodiversity objectives is closely linked to selecting biodiversity indicators (which will measure progress towards objectives) and to designing a monitoring program (which will track the indicators). Both are discussed in **Section 5** of this toolbox.

Table 3. Common Biodiversity Goals and Objectives Relevant to Carbon Projects

Examples based on Tucker et al.'s (2005) study of Nepal's Annapurna Conservation Area.

If the biodiversity goal is a...	Then a likely biodiversity objective will be to maintain or increase...	And the specific biodiversity objectives might include...
Key natural habitat for plants and animals (e.g., a specific forest type or aquatic habitat)	Its quantity and quality in the project area	"Increase *Rhododendron* forest cover in the project area" "Reduce densities of invasive plants in *Rhododendron* forests in the project area"
Key plant or animal species (e.g., a species that is nationally or globally threatened, culturally important, economically important, ecologically important, or valued in the region for other reasons)	Its abundance and frequency, or the quantity and quality of its habitat in the project area	"Reduce hunting of snow leopards in the project area" "Maintain current abundance of blue sheep and other natural prey species of snow leopards"
Group of species of special interest (e.g., forest bird communities, threatened species, endemic species, commercially valuable species, or aquatic species)	Its diversity, abundance, and frequency, or the quantity and quality of its habitat in the project area	"Maintain diversity of native tree community" "Increase density of fuelwood species in the intensive forest use zone"

<u>**Main Sources and Further Guidance**</u>

- Several helpful resources to assist in the process of identifying biodiversity objectives are listed in **Sections 3.1.1–3.1.3** of this toolbox.
- Tucker et al.'s (2005) guide to biodiversity monitoring in protected areas includes valuable advice on and examples of establishing biodiversity objectives, available online at www.unep-wcmc.org/collaborations/BCBMAN/PDF/PA_Guidelines_BMA.pdf.
- The CMP Open Standards for the Practice of Conservation (CMP 2007) include advice on identifying major biodiversity objectives (the term used in that document is "conservation targets"). The CMP standards are available online at http://www.conservationmeasures.org/resources.
- Guidance on establishing biodiversity objectives is provided with the Conservation Action Planning tools, which are available online at http://conserveonline.org/workspaces/cbdgateway/cap/index_html.

4.2 Estimating "With-Project" Changes in Biodiversity in the Project Zone

Criterion B1.1 of the CCB Standards asks for a summary of how project activities are expected to affect biodiversity in the project zone. This represents an opportunity for project designers to combine information from other criteria into a narrative (or *theory of change*; see Part 1 of this Manual) that explains how the carbon project is expected to generate biodiversity benefits not provided by the "without-project" scenario. The criteria likely to be incorporated into this narrative include pre-project biodiversity (**G1.7**), pre-project impacts to biodiversity (**G1.7**), pre-project HCVs (**G1.8**), biodiversity conditions under the "without-project" scenario (**G2.5**), major biodiversity objectives (**G3.1**), planned project activities and their expected biodiversity impacts (**G3.2**), risks to biodiversity benefits and measures to mitigate them (**G3.5**), measures to conserve HCVs (**G3.6**), and measures to secure biodiversity benefits beyond the project lifetime (**G3.7**).

The same narrative developed for **Criterion B1.1** will likely also satisfy **Criterion B1.2**, which requires showing that the planned project activities (**G3.2**) will not be detrimental to any HCVs (**G1.8**).

For many projects, **Criteria B1.3–5** will be satisfied by a simple statement that no known invasive species, non-native species, or GMOs will be introduced during the project. Project designers who are unsure of whether the species to be used by a project are considered invasive in the project region or are GMOs should consult the Global Invasive Species Database, the Biosafety Clearing-House, or similar resources (see below).

Projects that do use non-native species should explain why native species are not suitable and why the proposed non-native species will not generate negative biodiversity impacts. Among other things, this discussion will likely address the following questions:

- What geographic regions and ecoregions are the non-native species to be used native to?
- Are they already present in the project zone?
- Have they been used in the region previously?
- Are any of the species known to have adverse impacts on biodiversity in the region?
- Are there any known risks associated with the use of these species in the project region?

Main Sources and Further Guidance

- Part 1 of this Manual provides detailed guidance on constructing a *theory of change*.
- Table 1 of this toolbox provides a list of impacts associated with different types of carbon projects.
- Salafsky et al. (2008) provide a comprehensive list of and classification system for conservation actions; the article is available online at http://www.conservationmeasures.org/resources.
- An updated version of Salafsky et al.'s (2008) list is available online at http://www.iucnredlist.org/technical-documents/classification-schemes/conservation-actions-classification-scheme-ver2.
- The Global Invasive Species Database and associated resources are available online at http://www.issg.org/database/welcome/. See Morse et al. (2004) for a protocol to evaluate the biodiversity impacts of non-native plants.
- The Biosafety Clearing-House distributes information regarding GMOs online at http://bch.cbd.int/.
- **Section 3.1.3** of this toolbox discusses HCVs in detail. Rayden (2008) and other documents available online at http://www.hcvnetwork.org provide additional guidance for identifying and mitigating threats to HCVs.

4.3 Estimating and Justifying Offsite Biodiversity Impacts

Criteria B2.1–3 of the CCB Standards address the possibility that project activities within the project zone may impact biodiversity outside the project zone and ask project designers to:

- Identify negative offsite biodiversity impacts (**B2.1**);
- Document plans to mitigate those impacts (**B2.2**); and
- Show that biodiversity benefits in the project area outweigh negative offsite biodiversity impacts (**B2.3**).

For projects in places with low population density, few anthropogenic pressures on biodiversity, or effective enforcement of environmental laws offsite, these criteria may potentially be satisfied by simply noting that the project does not anticipate any negative offsite biodiversity impacts. Indeed, most carbon project design documents available on the CCBA website at the time this toolbox was prepared foresaw no negative offsite biodiversity impacts.

For many projects, however, biodiversity leakage represents a common (and commonly overlooked) negative offsite biodiversity impact. Under this scenario, anthropogenic pressures that would have degraded biodiversity in the project area are forced to move elsewhere by the project, generating an offsite impact greater than that expected in the 'without project' scenario.

It is important to note that biodiversity leakage may or may not be related to carbon leakage; they should always be considered separately. If carbon leakage is expected (**Criterion CL2**), biodiversity leakage should be expected as well (e.g., logging pressure that is moved offsite will generate leakage of both carbon and biodiversity). If carbon leakage is not expected, the possibility of biodiversity leakage should still be taken into consideration (e.g., hunting pressure that is moved offsite will generate no carbon leakage but may generate significant biodiversity leakage).

By preventing the impending destruction of forests in the project area and thus diverting pressure to forests offsite, REDD projects are especially expected to cause biodiversity leakage. Because REDD-related biodiversity leakage and carbon leakage are both driven by the same offsite deforestation pressure, the same measures taken to mitigate carbon leakage (a requirement of **Criterion CL2**) will typically also mitigate biodiversity leakage (and thus satisfy **Criterion B2.2**).

Other potential negative offsite biodiversity impacts include:

- Displacement of agriculture, mining, or other drivers of deforestation to sites with lower carbon values such as grasslands or wetlands;
- Increased grazing pressure by cattle displaced from reforested or afforested grasslands;
- Increased fuelwood collection pressure by local residents displaced from project areas;
- Increased anthropogenic pressures caused by a migration of families towards the project zone in search of project-related opportunities (e.g., employment, education);
- Removal of seeds, seedlings, topsoil, or other natural resources from offsite forests to restore forests in the project area;
- Use of water from streams, rivers, lakes, or aquifers to restore forests in the project area; and
- Air, soil, or water pollution from chemical inputs (fertilizers, pesticides) used in reforestation, afforestation, or sustainable agriculture projects.

Satisfying **Criterion B2.3** (Show that biodiversity benefits in the project area outweigh negative offsite biodiversity impacts) typically requires a brief qualitative argument of how the "with-project" biodiversity benefits described for **Criterion B1.1** are more numerous or more valuable than the negative offsite biodiversity impacts described for **Criterion B2.1**, especially in light of plans to mitigate those impacts (**B2.2**). While no simple currency exists for weighing negative vs. positive impacts, it makes sense to base this argument on a comparison of the amount of forest or vegetation cover that is expected to be preserved or gained due to positive impacts and the amount that is expected to be lost or degraded due to negative impacts. Another approach could be to assess the types of impacts with respect to nationally or locally defined conservation priorities.

Main Sources and Further Guidance

- The CL2 section of Appendix A of the CCB Standards offers guidance for modeling and mitigating *climate* leakage, including helpful technical reviews by Auckland et al. (2003) and Schwarze et al. (2002).

4.4 Identifying Risks to the Project's Expected Biodiversity Benefits

Criterion G3.5 of the CCB Standards asks for a description of the risks that could potentially derail the "with – project" scenario biodiversity benefits described for **Criterion B1.1**. Some of these risks will have direct links to the threats discussed for **Criteria G1.7** (Describe risks to biodiversity) and **G2.5** (Describe how biodiversity would be affected without the project). Others describe potential rather than existing threats to the region's biodiversity (see a list of some common potential risks in Table 4). Project designers should highlight risks considered most likely by experienced local residents and biologists, rather than aiming for an exhaustive list of contingencies.

Table 4. Potential Risks to Expected Biodiversity Benefits

Note: These risks are mentioned in various carbon project design documents.

Anthropogenic Risks	Natural Risks
Changes in legislation regulating land use or biodiversity conservation	Extreme climate events (e.g., droughts, floods, heat waves)
Changes in local or national governments	Regional climate change over the project lifetime (e.g., increased frequency of severe droughts)
Political or economic instability, or weakening governance (e.g., deteriorating law enforcement)	Extreme natural disturbance events (e.g., landslides, wildfires)
Lower income than expected from carbon credits, leading to a project budget that allows fewer activities than originally planned	Declining plant or animal populations due to natural population cycles
Higher than expected pressure on project zone biodiversity from local communities	
Higher than expected pressure on project zone biodiversity from logging, mining, or other extractive industries	
Higher than expected pressure on project zone biodiversity due to new infrastructure (roads, mines, dams, etc.)	
Anthropogenic fire	

4.5 Describing Measures to Conserve HCVs

Criterion G3.6 of the CCB Standards requests that project designers "demonstrate that the project design includes specific measures to ensure the maintenance or enhancement of the high conservation value attributes identified in **G1** consistent with the precautionary principle."

Rayden (2008) provides specific guidance on designing management measures to maintain or enhance HCVs. He notes that "if the *threats* to the HCVs can be effectively mitigated, it will be possible to proceed with what can be described as precautionary management…: a course of action that makes the best use of the available information about the impacts of your operations and takes steps to implement best practice, while recognizing that ongoing monitoring is necessary fully to understand how to maintain the value."

Readers seeking more detail on the precautionary principle are referred to Cooney (2004), Cooney & Dickson (2005), and PPP (2005).

Main Sources and Further Guidance

- **Section 3.1.3** of this toolbox treats HCVs in detail. Especially helpful in the context of **Criterion G3.6** is the report *Assessment, management and monitoring of High Conservation Value Forest (HCVF): A practical guide for forest managers* (Rayden 2008), available online at http://www.hcvnetwork.org/resources/folder.2006-09-29.6584228415/hcvf%20-%20practical%20guide%20for%20forest%20managers.pdf.

4.6 Describing Measures to Maintain Biodiversity Benefits Beyond the Project Lifetime

Satisfying **Criterion G3.7** of the CCB Standards requires project designers to think about how biodiversity in the project zone will be impacted after their project's activities have ended and to describe project activities specifically intended to increase the chances that post-project impacts are positive and to ensure the permanence of biodiversity benefits generated by the project. Such activities are frequently assumed to have a strong link with the social benefits anticipated in **Criteria CM1** (Net-Positive Community Impacts) and **CM2** (Offsite Stakeholder Impacts).

Common management activities in this context include capacity-building programs for local communities, changes to land titling and other land-use regulations, and conservation activities that will outlast the lifetime of the project (see others in Table 5). Given that the long-term biodiversity impacts of these activities depend on a large number of contingencies and assumptions, project designers are encouraged to give this section more than superficial attention.

For example, one argument commonly presented in this section of carbon project design documents is that a successful carbon sequestration project will act as a catalyst for other such projects in the region. While this may be the case, the opposite proposition is just as valid: that an unsuccessful project will discourage other carbon projects in the region. Likewise, while a successful carbon project may indeed inspire other carbon projects in the region, those projects may not necessarily adhere to strict measures to protect biodiversity.

The point here is not to say that satisfying **Criterion G3.7** requires especially lengthy arguments or modeling exercises—it does not—but rather to encourage project designers to avoid overoptimistic scenarios or assumptions. To this end, Table 5 provides some guidance on what sorts of supporting information can help strengthen arguments concerning some commonly mentioned measures.

Table 5. Selected measures of carbon projects for maintaining and enhancing Biodiversity Benefits beyond the Project Lifetime

If these measures are mentioned…	…then these questions should be considered:
The proposed project will act as a catalyst for other such projects in the region	Are any other carbon projects being prepared in the region? If so, where and by whom? Do they include measures to ensure biodiversity benefits?
	Does the project include specific measures intended to catalyze similar projects in the region (e.g., workshops, public-access project documents)? To what extent do those measures emphasize social and biodiversity aspects of carbon projects?
The proposed project represents one part of a long-term conservation initiative	What other activities are being undertaken as part of the long-term conservation initiative? Where and when are they expected to be undertaken? Which activities are expected to continue after the carbon project's conclusion?
	Who is responsible for the other conservation activities? Are there explicit links (e.g., shared personnel, partnering institutions) between the proposed carbon project and the other conservation activities?
The proposed project includes land-titling or other changes to the long-term legal status of the project area	What are the risks involved in implementing these legal changes? Are such changes likely to be stable over long time scales?
	What mechanisms do local communities possess to address possible conflicts related to these changes (e.g., town meetings, natural resource committees)?
The proposed project includes capacity-building in local communities	What mechanisms do local communities possess to maintain and capitalize on built capacity over the long term (e.g., schools, training institutes, employment opportunities)?
	Which institutions are expected to bear the long-term costs of capacity-building?
The proposed project establishes economic and other long-term incentives for sustainable management of natural resources	What are the risks involved in providing these incentives?
	Which institutions are expected to oversee the sustainable management of natural resources in the long term? Are there explicit links between those institutions and the proposed carbon project?

5. Monitoring Biodiversity Impacts

5.1 Documenting Key Technical Skills for Biodiversity Assessment and Monitoring

Criterion G4.2 of the CCB Standards asks project designers to describe the technical skills required to implement the biodiversity assessment and monitoring program successfully. This typically requires little more than a description of the people and institutions involved; but it is also a good opportunity for designers to resolve potential gaps and biases in the team.

While biodiversity assessment or inventory is a relatively quick and straightforward task, biodiversity monitoring is a long-term venture that requires careful planning, creative fine-tuning, and years of patient data collection. The key to a successful monitoring program is thus a team of talented, well-trained, and communicative people. As Gardner (2010) has noted:

> The monitoring process involves a series of choices, starting from decisions about overarching conservation goals and moving through specific objectives, indicator selection, sampling design and data collection methodologies, description of biodiversity, data analysis and interpretation of findings. All of these choices are at least partly subjective and are influenced by the personal experiences, expertise and underlying agendas of those involved in developing the program.

In most cases, designing a biodiversity monitoring program and evaluating the data it produces will require the assistance of a professional biologist. While non-specialists may be a good choice to actually collect monitoring data (see why in **Section 5.4**), a professional with formal training in experimental design should help ensure that the monitoring program will produce viable information. Likewise, it is wise to have at least one trained scientist oversee the monitoring (e.g., to clean and organize data as they are collected, to ensure that data are being collected correctly and on schedule, to meet regularly with data collectors to solve problems and take advantage of opportunities).

As Gardner cautions, however, professional biologists often bring their own biases to monitoring projects. Butterfly experts will want to monitor butterflies; ornithologists will favor birds. Likewise, in many regions of the world, biodiversity experts are scarce, which means that a monitoring program with a narrow focus (e.g., only butterfly communities) may be too dependent on the expertise of a small number of people. It is important for project designers and experts to be open about the costs and benefits of these biases, and to seek a balance between experts' interests and the project's needs.

In most cases, nearby universities are the best sources of professionals capable of designing biodiversity monitoring protocols. An increasing number of environmental consulting firms will also design and carry out monitoring programs for a fee.

5.2 Selecting Biodiversity Indicators

Biodiversity variables or biodiversity indicators[6] are ecosystem or community attributes that can serve as proxies for the health of natural systems. Their increasing use in natural resource management has spawned a large body of research that is intended to help users understand what makes a good biodiversity variable, how

[6] While the CCB Project Design Standards use the term 'biodiversity variables,' it is worth noting that the term 'biodiversity indicators' is much more commonly used in the technical and scientific literature. The two terms are treated here as synonyms.

to select appropriate variables, and how to place variables within the context of a larger conceptual framework of threats and objectives.

While these articles provide useful guidance to thinking about indicators, the array of different approaches taken by different authors (and the even broader array of potential indicators) can be overwhelming. Since a consensus regarding the use of biodiversity indicators has yet to emerge, our goal here is to provide broad guidelines for using biodiversity indicators in the context of carbon projects.

5.2.1 Attributes of Good and Bad Indicators

The traits that make some types of indicators helpful and others less so are reviewed in SBIA Stage 5 of Part 1 of this Manual (Richards and Panfil 2011a). In the specific context of biodiversity indicators for carbon projects, some additional recommendations for selecting indicators include:

- **Choose indicators that have clear links to the biodiversity objectives described for Criterion G3.1.** This is the most important attribute of a biodiversity indicator in a carbon project: that its links to the conservation targets are clear, direct, easy to understand, and well established. Ideally, the relationship between indicators and conservation targets is documented in the scientific literature. For a discussion of some indicators that are often linked to the biodiversity objectives of carbon projects, see the section below. See Box 5 for an example of a biodiversity indicator that failed because of unclear links to the conservation target.

Box 5. When Biodiversity Indicators Fail

Reindeer and moose are among the largest and most charismatic components of northern Scandinavian forests. They are also culturally and economically important to indigenous peoples and a source of food for local populations. In the twentieth century they were used as indicators to track the health of the region's managed forests. But while reindeer and moose populations remained constant over time, the old-growth forests whose health they were intended to reflect were significantly reduced in size, with the result that several hundred other species that depended on old-growth forests became threatened.

Why did reindeer and moose fail as biodiversity indicators? For the simple reason that they are ecologically flexible species that prosper in degraded forests as well as undisturbed ones. More thought in the planning stages of monitoring—specifically a clearer focus on managers' primary conservation target (old-growth forests and their associated biodiversity) and better data on the relationship of reindeer and moose to those targets—could have avoided this costly error.

For other examples of poorly chosen biodiversity indicators, see Failing and Gregory's 2003 article "Ten common mistakes in designing biodiversity indicators for forest policy."

Sources: Fridman and Walheim 2000;, Failing & Gregory 2003.

- **Choose indicators that have clear links to management interventions described for Criterion G3.2**. Indicators should ideally have a clear relationship with management activities, such that an increase or decrease in a given indicator can be attributed to specific interventions. See Box 6 for an example of biodiversity indicators of an A/R and REDD project in Mexico that are linked to specific management interventions.

Box 6. Example of Biodiversity Indicators that Are Clearly Linked to Project Management Interventions

A reforestation and carbon sequestration project underway in the Sierra Gorda Biosphere Reserve of Mexico—a protected area with high biological diversity—consists of hundreds of small-scale plantings dispersed over land that had been previously deforested and degraded. The reforested land belongs to farmers who planted native pine and other tree species, and who since 2006 have sold carbon offsets to buyers on the voluntary market. Additionally, these small-scale forest restoration areas are being complemented with avoided deforestation and degradation (REDD) activities, and the project was successfully validated (June 2011) under both the VCS and CCB Standards.

Biodiversity is usually positively correlated with the size of the forest area and the degree to which smaller forest areas are connected to one another. Generally, forests of larger area and with greater structural complexity harbor more species than smaller forested areas with a longer perimeter ("edge effect") versus interior forested area. Connectivity facilitates key ecological processes such as pollination and seed dispersal that increase biodiversity. To monitor biodiversity in compliance with CCB Standards, the Sierra Gorda carbon project proponents selected indicators of (a) forest area, (b) forest perimeter and (c) shared forest and reforestation perimeter as proxies for the biodiversity value of the reforested areas. These are standard landscape conservation measures that have clear links to the specific management interventions of the project. Additionally, species monitoring is carried out by creating a list of species observed by the project proponent and the land owner that will be analyzed over time to see if they change towards forest interior species and away from edge and disturbed area species.

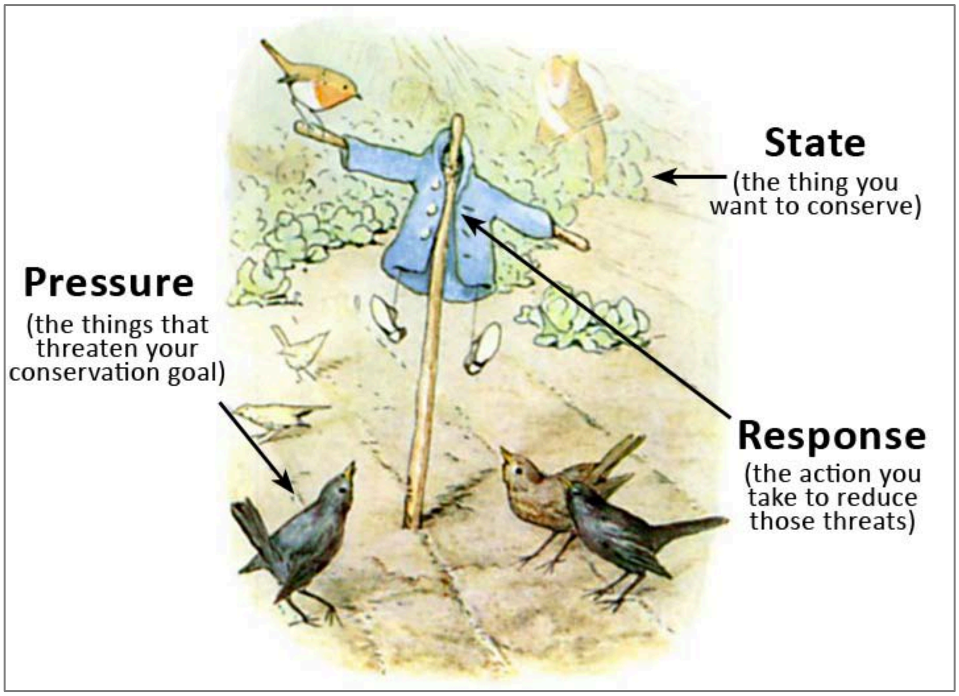
Sources: Rainforest Alliance 2011; Bosque Sustentable 2011.

- **Choose multiple indicators.** Natural systems are extremely complex, and even variables that are carefully chosen to reflect the health of a system will sometimes fluctuate for reasons unrelated to the project. For example, the local abundance of a bird species that only nests in forests might be one appropriate indicator of forest recovery in a reforestation project. It should be kept in mind, however, that even if forest cover increases during the project, the bird species' population may fluctuate unpredictably due to disease, predator-prey cycles, extreme climatic events, and other natural factors. Thus, monitoring the abundance of the entire guild of forest-specialist bird species might be a better choice than monitoring the abundance of one species. While there is no single ideal number of indicators, it is necessary to strike a balance between choosing too few indicators (and thereby running the risk of failing to document actual biodiversity improvements) and choosing too many indicators (and thereby necessitating an expensive and complicated monitoring program).
- **Choose Pressure, State, and Response (PSR) indicators.** The most commonly used conceptual framework for biodiversity indicators classifies them into pressure, state, and response indicators (see Figure 3). The simple message of the PSR framework is that monitoring programs should never monitor conservation targets in isolation, but rather together with the positive and negative influences on those targets. Thus, while a reforestation project might be wise to track over time the abundance of forest-specialist bird species (a state indicator), it would also do well to simultaneously monitor the frequency of forest fires (a pressure indicator), and the number of trees planted over time (a response indicator).

- **Use indicators that can be monitored with relative ease.** Many monitoring programs produce substandard data or are abandoned early because the indicators selected require monitoring activities that are expensive, difficult, dependent on outside experts or equipment, or impractical for other reasons (Danielsen et al. 2005). For more details, see the section below on **Criterion B3.3**.
- **Use indicators that reflect local conditions**. Indicators will be more effective when they are sensitive to local processes within the project area. For example, migratory animals make poor biodiversity indicators for carbon projects because their population trends depend to a large extent on conditions outside the project zone. Except for carbon projects that cover extremely large areas or are set in a large matrix of relatively undisturbed forest, the same caveat applies to non-migratory animals that range over very large areas.

Figure 3. An Illustration of the Commonly used Pressure-State-Response Framework for Biodiversity Indicators

Artwork by B. Potter.



5.3 Four Common Indicator Types for Carbon Projects

While there are no fixed requirements for how biodiversity benefits of carbon projects must be demonstrated to satisfy the CCB Standards, it is likely that the validators who evaluate the biodiversity impacts of carbon projects will be especially interested in the following types of indicators:

- The quantity and quality of forest, native forest, and/or natural vegetation in the project area (a State variable);
- The status of any species identified in HCV 1 (see **Criterion G1.8**), and the status of other plant and animal species that are of special economic, ecological, or cultural interest in the project area (a State variable);
- The frequency or intensity of anthropogenic impacts that are directly harmful to biodiversity in the project zone (e.g., hunting, fishing, fires; a Pressure Variable); and

- The frequency or intensity of project interventions relevant to biodiversity (e.g., the number of trees planted per hectare each year, the number of park guard patrols carried out each month; a Response variable).

It is worth noting that these indicator types span all three categories of the PSR framework (see Figure 3). The first two indicators are State variables that track the status of the biodiversity being managed. The third is a Pressure variable that tracks the status of threats to that biodiversity. The last is a Response variable that tracks the status of interventions undertaken to address those threats.

In theory, this means that a project whose monitoring program can demonstrate that natural vegetation in the project area is more extensive, more structurally complex, or less disturbed; that no HCVs have been degraded; that some of the anthropogenic impacts to biodiversity identified at the start of the project have become less frequent; and that project activities in favor of biodiversity have been carried out concurrently with these improvements is likely to be considered a success. Of course, the importance of these four indicators will vary from site to site and from project to project, such that monitoring programs that show positive results in fewer indicator types might under certain conditions be considered successful.

All of these indicator types have direct links to common conservation targets of carbon projects (Table 6). Likewise, all four types are applicable to the three main types of carbon projects mentioned at the start of this document (A/R, reduced-impact forestry and agriculture, and REDD). They are discussed in more detail below.

Table 6. Types of Common Biodiversity Indicators and Conservation Targets of Carbon Projects

Type of Biodiversity Indicator	Related Conservation Targets
The quantity and quality of natural vegetation in the project area	Natural vegetation types and the plant and animal species associated with them
	HCV 2 (large, landscape-level forests)
	HCV 3 (rare, threatened, or endangered ecosystems)
The status of High Conservation Value species identified in **Criterion G1.8** and the status of other species of interest	HCV 1 (species values); this includes suites of threatened or endemic species, or habitat used by such species
	Species not threatened or endemic at the national or global level but harvested at unsustainable levels in the project zone (e.g., hunted species, timber taxa)
	Species especially representative of the region or notable for other reasons
The frequency or intensity of anthropogenic impacts that are directly harmful to biodiversity in the project zone (e.g., hunting, fishing, invasive species)	In this case, the specific conservation target will depend on what is being harmed by the impact (e.g., if the impact is hunting, then the conservation target may be healthy populations of game species).
The frequency and intensity of biodiversity-relevant project activities	In this case, the specific conservation target will depend on the type and intent of the intervention (e.g., if the project activity is anti-poaching patrols, then the conservation target may be healthy populations of game species).

5.3.1 The Quantity and Quality of Natural Vegetation

Given that the primary threat to biodiversity worldwide is the destruction of plant and animal habitat, the maintenance or restoration of habitat will be a leading biodiversity objective of carbon projects. In turn, indicators that track the quantity and quality of natural vegetation in the project zone will rank among the most common variables for monitoring biodiversity impacts. Table 7 lists a sampling of such indicators.

In the case of REDD and A/R projects in which the protection or restoration of natural habitat is the primary carbon sequestration activity, indicators of carbon sequestration (e.g., time series of satellite images confirming no deforestation or increased forest cover in the project area) can also serve as the leading indicators of biodiversity preservation. Other indicators may also be needed to show evidence of biodiversity benefits, since animal communities beneath an intact forest canopy may be seriously degraded by hunting or other human impacts. Where such impacts are present, it is advisable to also demonstrate benefits for animal communities within the project area (see **Section 5.3.3** and Box 6 above).

Table 7. Some Typical Indicators of the Quantity and Quality of Natural Vegetation

Quantity of Natural Vegetation	Quality of Natural Vegetation
Extent of natural vegetation as measured in aerial photographs or satellite images	Field measurements of vegetation structure variables (e.g., stem density, basal area, height, stand diameter distribution, size and frequency of canopy gaps, leaf litter depth) in permanent plots or transects
Extent of natural vegetation as measured in ground-level photographs taken at fixed sites	Field measurements of vegetation growth form variables (e.g., the abundance and frequency of trees, shrubs, woody vines, grasses) in permanent plots or transects
Extent of specific vegetation types as measured and/or mapped in the field	Field measurements of vegetation composition variables (e.g., the abundance and frequency of species, genera, and families) in permanent plots or transects
Field measurements of indirect attributes of natural vegetation coverage (e.g., light levels, soil moisture, leaf litter depth) at fixed sites	Field measurements of vegetation guild variables (e.g., the frequency and abundance of non-native vegetation, or late-successional species) in permanent plots or transects
	Field measurements of vegetation dynamics variables (e.g., natural recruitment of native tree saplings)
	Condition of natural vegetation as measured in ground-level photographs taken at fixed sites

5.3.2 Status of Species of Interest

The conservation targets of carbon projects often include individual species, and these can potentially serve as biodiversity indicators. They may be species mentioned in HCV 1 (species that are globally threatened, nationally threatened, or endemic) or species that are of interest for other reasons (e.g., they are typical of a certain forest type, harvested at unsustainable rates in the project zone, economically important, or considered to be ecologically important keystone species). Monitoring programs that succeed in showing increasing trends in the frequency or abundance of species mentioned in HCV 1 have an especially strong claim to having demonstrated biodiversity improvements (see Box 6). Such species-level monitoring, however, is also the most difficult of the four types discussed here.

As noted above, monitoring multiple species can reduce the noise of natural population fluctuations. Animal species should ideally be small-ranged taxa that reproduce within the project area, since population trends of these will tend to be better indicators of local conditions than population trends of wide-ranging or migratory animals that reproduce elsewhere. Plant species should ideally be herbaceous (e.g., understory herbs) or fast-growing species, since population trends of slow-growing trees are unlikely to be detectable in the five-year verification cycle of most carbon projects. In some cases, it may make more sense to monitor indicators of population health rather than indicators of population size. For example, the seed set or seedling density of a threatened shrub might be compared from year to year. Species should also be common or frequent enough for monitoring to be feasible (e.g., it is unlikely that anything rigorous can be said about population changes over a five-year period of an animal species that is spotted twice a year).

5.3.3 Frequency of Biodiversity Threats

Quantitative evidence showing that the intensity of important threats to biodiversity has declined over time during a carbon project adds additional weight to arguments that biodiversity has improved over the same period. Managers are thus advised to include in the monitoring program as many of the threats to biodiversity identified in **Criterion G1.7** as can be tracked over time in a cost-effective manner.

Although project staff may assume that threats are much more easily tracked than biological indicators, threat monitoring is not simple and should be designed just as rigorously as other types of monitoring. Perhaps the most important consideration in this respect is that the effort made to detect threats should be standardized if threat intensities are to be compared over time. For example, the observation that more hunters were encountered in the project zone during the first year than during the second year is hard to assess if the number of park guards patrolling, the number of patrols carried out, the location of those patrols, or other measures of effort differed between those two years.

It is also useful for managers to remember that high-quality data on threat intensity can in some cases be collected in cooperation with the stakeholders who are linked to or even directly responsible for the threats. For example, communities, government agencies, and conservation programs routinely rely on fishermen and hunters to track the intensity of fish and game harvests. In cases where the goal is not to end natural resource harvests but rather to reduce their intensity to sustainable levels, this may be an appropriate option.

Finally, as with biological monitoring, it is extremely important to design threat monitoring protocols in a way that ensures that non-events (e.g., park guard patrols that do not encounter any poachers) are documented just as faithfully as events (e.g., park guard patrols that do).

5.3.4 Frequency of Biodiversity-Relevant Project Activities

Careful records of which interventions were carried out where, when, and with what frequency can themselves represent a valuable biodiversity indicator. The goal of collecting such data is not typically to demonstrate a statistical relationship between management activities, threat intensities, and biodiversity conditions over time; doing so is extremely difficult and beyond the scope of most monitoring programs. Likewise, response indicators cannot by themselves demonstrate biodiversity improvements over time.

Instead, data on the scope and frequency of interventions provide valuable context for evaluating the success or failure of other biodiversity indicators. For example, data showing reduced levels of illegal livestock grazing in the project area are more satisfying when considered in the light of information describing when and where fences were built, or how many times project staff visited neighboring ranches to discuss solutions to the illegal grazing problem.

Records of project interventions also are necessary to apply adaptive management to the project. When there is no logical connection between interventions and improved biodiversity conditions, then the project proponent should reconsider the value of those interventions.

Main Sources and Further Guidance

- The CMP Open Standards for the Practice of Conservation (CMP 2007), available online at http://www.conservationmeasures.org/resources, include advice on selecting appropriate biodiversity indicators.
- The Center for International Forestry Research (CIFOR) has published several toolboxes regarding indicators for reduced-impact forestry projects at http://www.cifor.org/acm/pub/toolbox.html. The Ecology section of Toolbox 2 includes a list of biodiversity indicators that are potentially useful in other types of forest-related carbon projects. Other valuable resources for reduced-impact forestry include Noss (1999), Lindenmayer et al. (2000), Duinker (2001), Franc et al. (2001), Whitman and Hagan (2003), NCASI (2003), Dudley et al. (2005), and Hagan and Whitman (2006).
- Many of the oldest and best-developed sets of biodiversity indicators focus on streams and rivers, and several stream monitoring protocols have been developed for non-scientists. See one example at http://water.epa.gov/type/rsl/monitoring/.
- Reed et al. (2008) discuss the importance of involving local communities in the process of selecting biodiversity indicators.
- It is worth noting that the indicators established by the Biodiversity Indicators Partnership (http://www.bipindicators.net) are not typically applicable to individual carbon projects. Rather, those indicators measure individual countries' progress towards biodiversity targets established by international agreements.

5.4 Designing a Biodiversity Monitoring Program

The monitoring plan mentioned in **Criterion B3.3** of the CCB Standards is a series of protocols designed to track biodiversity variables over time. Successful biodiversity monitoring is contingent on the careful selection of biodiversity indicators, which is discussed at length in **Section 5.3**.

As is the case with biodiversity variables, a large body of research exists regarding the many different techniques available to monitor biological communities. Some articles recommend specific protocols for monitoring specific taxonomic groups, while others provide a broader array of techniques for monitoring the plants and animals of a given biome (see resources section below). In the specific case of carbon projects, the most valuable monitoring articles may be those that emphasize how difficult monitoring is, how frequently monitoring programs fail to meet their objectives, and how important careful planning is to increase the probability of success (e.g., Gardner 2010).

Such critiques note that traditional monitoring protocols often require significant inputs of time, money, and scientific expertise, which are hard to sustain over long periods, while providing few benefits to local communities. These obstacles have led several researchers to experiment with monitoring programs that are explicitly designed to be simple, inexpensive, and run by teams that include both outside scientists and local residents (Danielsen et al. 2000, 2005, 2007, 2009; Ekstrom 2008; Holck 2008; Gardner 2010).

So-called "community-based monitoring" would appear to be a good fit for many carbon projects. In addition to its focus on practical issues of sustainability, such monitoring also has the potential to interact in a positive way with the social component of carbon projects. For example, the involvement of local residents in monitoring programs can improve methods and results by incorporating their knowledge of the region's biodiversity into protocols and can improve data quality by allowing programs to collect data year-round rather than during occasional expert visits. Likewise, local involvement in monitoring can empower communities by helping instill a greater sense of ownership of and responsibility for the biodiversity objectives of a project.

Local-based monitoring also carries risks, however (Table 8). For some projects, the proper mix of local and expert participation in monitoring programs will be easily determined by local conditions. In most cases, however, careful consideration will be required to balance the sometimes conflicting goals of high-quality data, low costs, regular measurements, and community participation.

Table 8. Advantages and Disadvantages of Monitoring Programs with Different Levels of Outside Expert Involvement and Technical Complexity

		Complexity of monitoring techniques and equipment	
		Low **(e.g., animal sightings, simple threat monitoring)**	**High** **(e.g., camera traps, aerial surveys)**
Amount of monitoring carried out by outside experts	**High**	**Advantages:** High-quality data collection and analysis; equipment inexpensive and locally available **Disadvantages:** Higher total cost; data collected periodically over shorter time spans; results dependent on availability of experts; new or intensified threats identified less quickly; less community ownership of monitoring data	**Advantages:** High-quality technical data and analysis **Disadvantages:** Highest cost; equipment may not be locally available; results dependent on properly functioning equipment and availability of experts; data collected over shorter time spans; less community ownership of monitoring data
	Low	**Advantages**: Lowest cost; equipment inexpensive and locally available; data collected continuously over longer time spans; new or intensified threats identified more quickly; more community ownership of data **Disadvantages**: More problems with data quality and consistency; significant training required; cost of monitoring borne disproportionately by local communities	**Advantages:** Data collected over longer and/or more continuous time spans by local people; more community ownership of data **Disadvantages:** Higher cost; more problems with data quality and consistency; equipment may not be locally available; significant training required; results dependent on properly functioning equipment; cost of monitoring borne disproportionately by local communities

In the context of carbon projects, recommendations for establishing biodiversity monitoring protocols can be divided into scientific recommendations (measures to improve the quality of the data) and practical recommendations (measures to improve the sustainability of the monitoring plan):

Scientific Recommendations

- **Ensure that professional scientists are involved in the initial stages of monitoring.** While the degree to which outside experts participate in monitoring programs over the long term may vary, it is extremely important that they be involved in the initial design (i.e., through participation in project design workshops, and/or review of the monitoring plan) and set up of protocols, and in the training of monitoring staff. In the ideal scenario, the same scientists involved in the assessment of the initial biodiversity conditions will also take part in later stages of biodiversity monitoring.
- **Ensure that professional scientists or statisticians are involved in the analysis of monitoring data.** Monitoring data tend to be complex, and answering even simple questions about trends over time can require significant experience with statistics.
- **Monitor indicators at fixed geographic sites within the project zone.** Fixed transects, plots, points are preferable to floating surveys, as they minimize variation caused by geographic variation within the project zone.
- **Do not restrict monitoring to a small number of species.** This is especially important where biological communities in the project zone are diverse and intact (e.g., REDD projects), and where five years' worth of species-level monitoring may reflect natural fluctuations in plant and animal populations more than the consequences of conservation interventions.
- **Ensure that zeroes are recorded.** As noted above, it is extremely important that non-events are documented just as faithfully as events.

Practical Recommendations

- **Involve local residents or project staff in monitoring as much as feasible.** As noted above, important benefits accrue from involving local residents in monitoring programs. Local-based monitoring can also help strengthen projects' social components. Projects must recognize that the participation of locals may carry a cost for them and should fairly compensate for this cost in monetary or non-monetary ways.
- **Incorporate monitoring within other project activities wherever feasible.** Monitoring activities are often spatially and temporally separate from the other activities of carbon projects, but managers should think creatively about opportunities to combine the two. For example, staff may frequently pass along specific stretches of road, trail, or river on their way to and from work; this represents an interesting opportunity to collect data on wildlife and other indicators in those places. Olupot and Sheil (2011), for example, analyzed wildlife sightings compiled by researchers who routinely traveled along a 12.4-km section of road in an African national park. Similar work has been done along rivers in the Amazon (see Box 7). In such cases, data collection costs very little in time and money, since it takes advantage of existing activities and otherwise unproductive staff time.
- Include a budget in the design of the biodiversity monitoring program. This is important because monitoring data can be expensive to collect and analyze, and because there are important trade-offs between data quality, program viability, and cost (Table 8).

Box 7. Opportunistic Biodiversity Monitoring on an Amazonian River

The Los Amigos Conservation Concession is a large, privately managed protected area in the diverse lowland rainforest of southeastern Peru. Forest degradation is ongoing in the region and carbon stocks have been measured at a regional scale (Asner et al. 2009), making Los Amigos one of several protected areas in the region that are candidates for REDD. As with most REDD projects, the primary biodiversity indicators at Los Amigos are the rate and location of deforestation.

However, because there are other threats to the concession's biodiversity (especially hunting), the monitoring program at Los Amigos also tracks sighting rates of 31 species of reptiles, birds, and mammals along fixed transects inside the concession. Sixteen of these species are threatened at the global or national level and thus represent HCV 1 species. To minimize the cost of this monitoring in time and money, transects are located along river banks and surveyed by park guards during their regular boat patrols of the Los Amigos River, using time that was previously spent in unproductive travel. The first four years of data collected by the park guards appear to show significant biodiversity benefits, as most species were spotted more frequently over time.

Figure 4. The Los Amigos River in Amazonian Peru

Note: Park guards monitor hunting pressure by tracking how many birds, mammals, turtles, and caimans are spotted during boat travel.

Source: Pitman et al. (2011).

Main Sources and Further Guidance

- One of the most helpful step-by-step texts for establishing a biodiversity monitoring program in general is Tucker et al.'s (2005) guide to monitoring in protected areas, available at www.unep-wcmc.org/collaborations/BCBMAN/PDF/PA_Guidelines_BMA.pdf.
- The Monitoring Matters Network maintains a helpful website with a variety of monitoring tools and case studies at http://www.monitoringmatters.org/.
- Chapter 14 of Gardner (2010) provides a detailed discussion of the steps required to ensure efficient sampling design and data collection in biodiversity monitoring programs; Chapter 15 explores strategies to optimize the analysis and interpretation of data from such programs.
- General texts on biodiversity monitoring include Sutherland (1996), Feinsinger (2001), Hill et al. (2005), Spellerberg (2005), Newton (2007) and Lindenmayer and Likens (2010).
- Helpful texts on monitoring specific taxonomic groups are available for a broad range of taxa, including amphibians (Heyer et al. 1994), ants (Agosti et al. 2000), birds (Sutherland et al. 2004), fungi (Mueller et al. 2004), invertebrates (New 1998), mammals (Wilson et al. 1996), and soil fauna (Moreira et al. 2008).
- Carbon projects in areas with significant wetlands should explore the Ramsar Convention Handbooks, several of which discuss wetland monitoring in detail (e.g., Handbook 13). They are available online at http://www.ramsar.org/cda/en/ramsar-pubs-handbooks-handbooks4-e/main/ramsar/1-30-33^21323_4000_0__.

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Appendix 1

Biodiversity-related requirements of the CCB Standards (Second Edition; CCBA 2008) and the section where each is discussed in this toolbox.

Criterion Category	Criterion Summary (Criterion Number)	Section
G1. General Description	Describe the types and condition of vegetation within the project area (G1.2)	3.1.1
	Describe current biodiversity and threats to biodiversity in the project zone (G1.7)	3.1.2
	Describe High Conservation Values if present (G1.8)	3.1.3
G2. Baseline Projections	Describe how biodiversity would be affected without the project (G2.5)	3.2
G3. Project Design and Goals	Summarize project's major biodiversity objectives (G3.1)	4.1
	Describe project activities and their impacts on biodiversity (G3.2)	2.1–2.4
	Identify likely risks to expected biodiversity benefits during the projectand outline measures to mitigate these risks (G3.5)	4.4
	Show that project design includes measures to conserve High Conservation Values (G3.6)	4.5
	Describe measures to secure biodiversity benefits beyond the project lifetime (G3.7)	4.6
G4. Management Capacity and Best Practices	Document technical skills required to implement the biodiversity assessment and monitoring program of the project successfully (G4.2)	5.1
B1. Net Positive Biodiversity Impacts	Use appropriate methodologies to estimate changes in biodiversity in the project lifetime (B1.1)	4.2
	Demonstrate that no High Conservation Values will be negatively affected by the project (B1.2)	4.2
	Identify all species to be used and show no negative impacts of invasive species (B1.3)	4.2
	Describe possible impacts of non-native species on the region's biodiversity (B1.4)	4.2
	Guarantee that no GMOs will be used (B1.5)	4.2
B2. Offsite Biodiversity Impacts	Identify negative offsite biodiversity impacts (B2.1)	4.3
	Document plans to mitigate offsite impacts (B2.2)	4.3
	Show that biodiversity benefits in project area outweigh offsite impacts (B2.3)	4.3
B3. Biodiversity Impact Monitoring	Develop a plan to select biodiversity indicators and monitoring methods (B3.1)	5.2-5.4
	Develop a plan to assess conservation of High Conservation Values (B3.2)	5.2-5.4
	Commit to developing a full biodiversity monitoring plan (B3.3)	5.4
GL3. Exceptional Biodiversity Benefits	Demonstrate that the project zone includes a site of high biodiversity conservation priority	3.1.4
Within 6 mo. of project start or 12 mo. of validation	Develop monitoring plan and carry out monitoring	(See B3.1–3)
Periodically during implementation and prior to verification audits	Analyze monitoring program data and compare to original starting data	(See B3.3)