Biodiversity guidelines for forest landscape restoration opportunities assessments

Craig R. Beatty, Neil A. Cox and Mirjam E. Kuzee

First edition

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Cover photo: The Soliga are an indigenous tribal people in the Biligiri Rangana Hills of Southern India and may be among the first human settlers of India. A forest dependent people, the Soligo primarily utilise wild plants in their diet, especially a dish made from Kaddisoppu (*Jasminum trichotomum*) a plant endemic to dry deciduous forests (not pictured). Photo courtesy of Oxlaey

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Executive summary

Biodiversity is inherent in forest landscape restoration. As global initiatives like the Bonn Challenge and New York Declaration on Forests inspire nations to pursue sustainable landscapes and economic growth, on the ground, biodiversity binds people and nature to their shared future. Restoring 'forward' to meet current and future landscape challenges requires novel approaches and nature-based solutions. Restoration has the potential to generate billions in economic returns and to mitigate many of the effects of human-induced climate change. But, at its core, restoration should support biodiversity and the species, genes and ecosystems of which it is composed and that provide services directly or indirectly to people.

These *Biodiversity guidelines for forest landscape restoration opportunities assessments* are intended to provide more context, more resources and fresh perspectives to the ongoing global interaction between biodiversity conservation and forest landscape restoration. They do so in the context of the methodology used by dozens of countries and jurisdictions to help practitioners working on identifying and realising their landscape restoration goals—and they should be interpreted as a companion to the *Restoration Opportunities Assessment Methodology (ROAM)*.

Among the Bonn Challenge, The Convention on Biological Diversity, The Sustainable Development Goals and scores of other international, regional and national initiatives, the conservation and restoration of biodiversity remains a constant and clear precursor to long-term social and economic prosperity. Biodiversity and restoration initiatives have, until recently, largely worked in parallel to achieve many of the same objectives and the following guidelines will help those with a mandate or interest in biodiversity or restoration to align their vocabularies and work.

Section one outlines the context and principles of forest landscape restoration and briefly explains the connections between biodiversity conservation and landscape restoration. It then elaborates on the genetic, species and ecosystem components of biodiversity as they relate to forest landscape restoration and includes discussions on starting points for measuring biodiversity and the landscape view that is required for restoration at increasingly large scales. Importantly, it provides a necessary starting point for those who may view forest landscape restoration as an exercise in planting trees and demonstrates that a comprehensive approach that balances the needs of people and nature is well worth the effort.

Section two provides several methods of operationalising biodiversity in the forest landscape restoration assessment process. This includes sources of biodiversity information and data, how to find biodiversity information where it appears there is none, initial ideas on how to map biodiversity, and the importance of considering biodiversity, not just from a biological perspective, but in terms of policies, laws and institutional missions. In this section, readers will find a wealth of resources and contacts to ensure that a lack of available information is not the reason biodiversity is missing from their assessments.

Finally, these guidelines are intended to help practitioners translate and communicate the importance of their work into a biodiversity context, and to help mainstream biodiversity in other sectors. The result should be an assessment process that explicitly identifies options for the choice of and interaction among species in a landscape to produce the biological, social and ecological benefits that form the purpose for restoration. The landscape strategies that result from this explicit inclusion of scientific and traditional biodiversity knowledge will go far in ensuring that the significant investments made in forest landscape restoration can see returns that support the incredible diversity of life and culture.

Part one

Biodiversity and forest landscape restoration

Forest landscape restoration (FLR) is the long-term process of regaining ecological functionality and enhancing human well-being across deforested and degraded landscapes, and it continues to be a key initiative for maintaining or restoring biodiversity. FLR is implemented using a landscape approach, combining natural resource management, restoration opportunities and livelihood considerations across jurisdictional boundaries with an aim to restore a mosaic of land uses, including forests and woodlands, pastures, croplands, and more. At a landscape scale restoration meets societal needs and allows the consideration of multiple benefits from ecosystem services for food, nutrition and water security; promotes local business and social justice; supports rural development and national economies; and builds resilience to disasters and climate change.

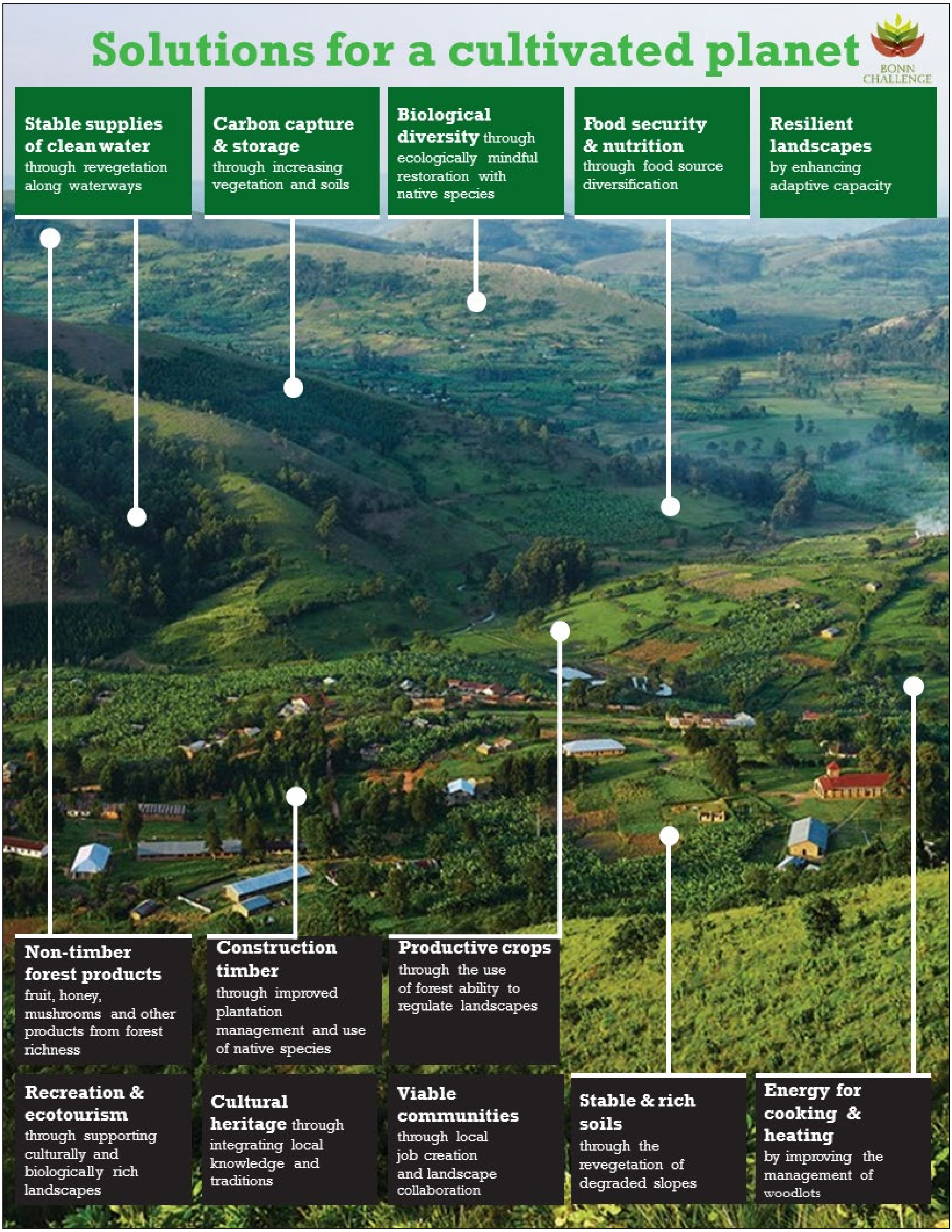
Restoring degraded and deforested landscapes provides key provisioning ecosystem services (such as food, fuelwood and genetic resources); regulating services (climate regulation, nutrient cycling and soil building, water regulation and purification, and pollination); cultural services (spiritual, religious, recreational, educational, and contributing to a sense of place); and can provide needed habitat for threatened species as a large percentage of species on *The IUCN Red List of Threatened Species* are threatened with habitat loss or degradation (Mace, et al., 2005; IUCN, 2018). These important services are typically underpinned by the biological richness of landscapes, with growing evidence that greater biodiversity is directly proportional to both the quantity (functions) and general 'stability'[1] (environmental resilience) of ecosystem services provided to people

Forest landscape restoration (FLR) is the long-term process of regaining ecological functions and enhancing human well-being in deforested and degraded lands. Ultimately, FLR is the process of restoring *"the goods, services and ecological processes that forests can provide at the broader landscape level as opposed to solely promoting increased tree cover at a particular location"* (Maginnis & Jackson, 2002).

Forest landscape restoration is founded upon several guiding principles:

- **Restore functionality** – Restore the functionality of a landscape, making it better able to provide a rich habitat, prevent erosion and flooding, and withstand the impacts of climate change and other disturbances.
- **Focus on landscapes** – Consider and restore entire landscapes as opposed to individual sites. This typically entails balancing a mosaic of inter-dependent land uses, which include but are not limited to: agriculture, protected areas, agroforestry systems, well managed planted forests, ecological corridors, riparian plantings and areas set aside for natural regeneration.
- **Allow for multiple benefits** – Aim to generate a suite of ecosystem goods and services by intelligently and appropriately introducing trees and other woody plants within the landscape. This may involve planting trees on agricultural land to enhance food production, reduce erosion, provide shade and produce firewood, or trees may be planted to create a closed-canopy forest that sequesters large amounts of carbon, protects downstream water supplies and provides rich wildlife habitat.
- **Leverage suite of strategies** – Consider the wide range of eligible technical strategies – from natural regeneration to tree planting – for restoring forest landscapes.
- **Involve stakeholders** – Actively engage local stakeholders in deciding restoration goals, implementation methods and trade-offs. Restoration processes must respect their rights to land and resources, align with their land management practices and provide them with benefits.
- **Tailor strategies to local conditions** – Adapt restoration strategies to local social, economic and ecological contexts; there is no "one size fits all".
- **Avoid further reduction of natural forest cover or other natural ecosystems** – Address ongoing loss and aim to prevent further conversion of primary and secondary natural forest and other ecosystems.
- **Adaptively manage** – Be prepared to adjust a restoration strategy over time as environmental conditions, knowledge and societal values change. Leverage continuous monitoring and learning, and make adjustments as restoration progresses.

1. Ecosystems are well recognised to be dynamic and not static, systems. So, while it is typically incorrect to use the term 'stability' in reference to ecosystems we retain usage here as a general term to guide less technical readers.


Solutions for a cultivated planet
BONN CHALLENGE
Stable supplies of clean water through revegetation along waterways
Carbon capture & storage through increasing vegetation and soils
Biological diversity through ecologically mindful restoration with native species
Food security & nutrition through food source diversification
Resilient landscapes by enhancing adaptive capacity
Non-timber forest products fruit, honey, mushrooms and other products from forest richness
Construction timber through improved plantation management and use of native species
Productive crops through the use of forest ability to regulate landscapes
Recreation & ecotourism through supporting culturally and biologically rich landscapes
Cultural heritage through integrating local knowledge and traditions
Viable communities through local job creation and landscape collaboration
Stable & rich soils through the revegetation of degraded slopes
Energy for cooking & heating by improving the management of woodlots

(Hooper, et al., 2005; Hooper, et al., 2012; Cardinale, et al., 2012; Larsen, et al., 2012; Oliver, et al., 2015a; Oliver, et al., 2015b; Walker, and Salt, 2006).

FLR for biodiversity conservation and restoration can occur in most landscapes. Globally, forests are home to more than 75% of terrestrial biodiversity (FAO, 2016)—and remain a significant source for the discovery of many yet unknown and undescribed species. Numerous animals and plants are specialised forest species and do not occur outside of such habitats. To date *The IUCN Red List of Threatened Species* categorises approximately 29% of assessed forest species as threatened with extinction (IUCN, 2018). Restoration of deforested and degraded landscape can arrest and reverse species extinction in various ways. Furthermore, increasing the number of trees and species on cropland or in silvopastoral systems may build soil and improve water availability for crops in rainfed areas; allowing for diversified livelihoods strategies that aim to bring back and conserve trees on land, while increasing production of crops and livestock at the same time.

While the benefits of restoration to biodiversity may be implicit and are important, landscape restoration that addresses human well-being will also result in explicit and measureable social benefits when the conservation and restoration of biodiversity is an explicit component of the design, planning and assessment of forest landscape restoration potential—its "opportunity assessment".

The objective of this publication is to offer the FLR practitioner, the landscape restoration planner and the decision-maker guidelines for how to better integrate biodiversity knowledge and data into FLR opportunities and assessments and why this approach makes sense. The intent is to provide guidance on how practitioners can operationalise a mandate or interest in explictly including biodiversity knowledge and information in the FLR assessment and planning process. The following document outlines why biodiversity should be included in FLR, some common available sources of biodiversity information and data, the process of communicating biodiversity information within FLR assesments and how project partnerships can be formed to better serve biodiversity conservation and restoration. These guidelines are best used in tandem with the *Restoration Opportunities Assessment Methodology (ROAM)*, published by IUCN in collaboration with WRI (2014), which provides a more comprehensive framework of the FLR assessment process and typical analytical products.

An important note about baselines

There are few places remaining in the world where species have not been impacted by human activity. With this in mind, the diversity and abundance of species are typically assessed from a current (Anthropocene) understanding of ecological baselines regarding what is an acceptable level of species abundance and changing community composition, or conservation status of habitats and species.

However, of the roughly 2 million described species, only 87,000 have been assessed for their conservation status by IUCN and significant taxonomic gaps still exist in the global assessment of species' conservation status. Little to nothing is known about the diversity and abundance of most non-vertebrate species and yet many of these form the foundation of all ecosystems. Despite this lack of knowledge, drastic reductions in biodiversity force practitioners to utilise what few details exist to halt biodiversity decline.

The past 250 years has seen species in many wild places disappear, with significant losses to species and habitats in the past 50 years. What today seems abundant, may conceivably be far below historical population levels. What remains are increasingly large numbers of people that rely on an increasingly smaller assemblage of species to provide the services on which human cultures, societies and economies were built, and still very much depend. Establishing baselines is critical and where possible this should be based on trend analysis of species populations or on extent of suitable habitats and ecosystems, especially as these may be impacted due to climate change.

Conservation and restoration

A great deal of literature and science is devoted to the conservation of established species and ecosystems. Far less is devoted to the restoration of biodiversity in places where it has declined or substantially disappeared. The restoration of biodiversity is not simply introducing species and ecosystems, it is also the restoration or conservation of processes that lead to biodiversity. It is ecological processes that create and maintain biodiversity and in order to be successful restoration must consider and support both biodiversity pattern and processes (Pressey et al., 2007). The literature on ecological restoration is growing and generally the focus of this young discipline is to restore degraded ecological systems towards a reference ecosystem or successional trajectory (Young, 2000). This involves support for the reintroduction of species and ecological processes that, over time will interact to create restored ecosystems or will guide species interactions and assemblages to foster desired successional stages. Restoration towards a reference ecosystem may be better suited for some landscapes and restoration objectives, (e.g. species reintroductions or conservation), especially where the motivation is to restore degraded and deforested areas towards their previous condition. For these objectives ecological restoration is a valuable and necessary approach. Within FLR, ecological restoration forms a valuable component of the suite of restoration strategies available to restoration practitioners. FLR utilises many additional restorative actions across landscapes to ensure that FLR focuses on integrating many objectives and sustainable land use types to address the drivers and pressures that led to degradation in the first place.

Forest landscape restoration involves the long-term recovery of ecological productivity that is based on a biodiverse and sustainable ecological trajectory. This trajectory is built on the interactions among the three main components of biodiversity: genes, species and ecosystems across landscapes but in practice is often conceptualised outside of an ecological perspective. As such, genetic diversity, species diversity and ecosystem diversity in forest landscape restoration assessments and planning are often embedded in discussion about agricultural productivity, landscape resilience, or adaptability to climate change. While each of these are noble interpretations, at their most fundamental level each rely on the goods and services provided by species and their webs of interaction within ecosystems. How practitioners can translate among these concepts is the focus of the following sections.

Genetic biodiversity for forest landscape restoration

Genetic diversity of species is one of the most important considerations in landscape restoration. This is true both for agricultural species (as examples: agroforestry species, crop cultivars and livestock breeds) as well as native species utilised in restoration activities. Genetic diversity confers greater protection from disease and helps ensure that the ecosystem services present on the landscape are resilient to environmental change. Genetic diversity is the first line of defense in building resilient landscapes and agricultural economies and is the currency used by species in their ability to adapt and survive against environmental change.

Ensuring that intra-specific genetic diversity of restoration biomass within the degraded landscape to be restored is as varied as possible (within the confines of the resources available) should be an important consideration in the design of restoration strategies. If monocultures of genetically near identical, or cloned, individuals are used for restoration efforts, they are generally more susceptible to damage or loss through stochastic events, such as disease or inbreeding. A more genetically diverse landscape or habitat typically has a much greater likelihood of containing individuals with partial, or total, resistance to a threatening event (e.g. Reusch, et al., 2005).

When sourcing individuals of species for restoration work (especially seeds or seedlings), it is helpful to try to obtain stock with the same, or similar, provenance to the populations that exist (or previously existed) within the landscape to be restored. These individuals are usually genetically better adapted to the environmental conditions (such as local weather patterns) found within the landscape than individuals sourced from external, or more distant, populations. If the restoration practice is an agroforestry intervention, it will be helpful to also consider use or promotion of local crop varieties (including trees) because, as with native plants of local provenance, these local varieties are often better adapted to local environmental conditions and may have greater adaptability to a changing climate.

Species biodiversity and forest landscape restoration

As the fundamental ecological unit, species are the medium through which genetic and ecosystem diversity radiate. The assessment and implementation procedures for landscape restoration are populated with different opportunities to express a choice of species to use in restoration activities. The opportunity to select species for restoration are made when practitioners identify a desired restoration action, refine the assessment of how this action may halt or slow landscape degradation, estimate how restoration might build ecological productivity and determine when restoration plans will be realised as plants in the ground.

In agriculturally dominated landscapes, the choice of different species for use in landscape restoration will depend on many factors including crop types, crop rotations and the specific agricultural issues that can be addressed through FLR. The selection of species can also be used to increase pollinator services, to augment soil biodiversity and fertility, or to increase shade and fodder, each of which are decisions rooted in the practitioner's working knowledge. Additionally, agroforestry species are generally selected based on their availability, stakeholder affinity and economic practicality, but, these species can also have ecological consequences that should be identified, weighed and addressed by the FLR assessment team in consultation with stakeholder groups. Where genetic diversity is lacking or an agroforestry species has the potential to become an invasive alien species, careful assessment, consultation and planning are required to determine an acceptable balance of ecological risk, where such cases present themselves.

Through the process of forest landscape restoration, no matter the political or social objective of such restoration, significant potential exists to make restoration choices that have positive impacts on native biodiversity, in some cases even through the use of exotic species. The diversity of forest landscape restoration approaches within a landscape ensures that no single restoration type dominates degraded landscapes, but that the solutions rely on the use of a diversity of species and methods for restoration. Some of these species may be non-native but are important for human livelihoods and well-being or the restoration of ecosystem services. Despite this reality, each landscape and restoration process should preferentially include the restoration and/or reintroduction of native species at some point in the planned project timeline and landscape.

Apart from the broad reasons for an assessment of which species to utilise in restoration there are some well-defined and practical benefits to ensuring that species conservation or restoration in degraded lands are considered during the overall landscape

Among the largest single-species recovery initiatives in the world, the Canadian government is tasked with implementing the recovery strategy for the woodland caribou (*Rangifer tarandus caribou*). This may involve many assessments of landscape restoration opportunities to support national, provincial, and territorial implementation. Photo courtesy of Bill Bumgarner restoration planning process. Many of these benefits are associated with ensuring that species relationships within restored areas improve the ecological function of the landscape. This includes the re-establishment of a variety of key pollinator species (e.g. native bees and bats) and seed dispersal agents (e.g. squirrels, cassowaries, toucans) that interact with the tree species chosen to grow within the restoration site. Especially in tropical forests, animal pollination and seed dispersal are critical for maintaining and increasing floristic diversity at the landscape scale.

However, habitats are complex and include numerous, less obvious relationships between species within restoration sites and species that need to be considered in the planning process for improving functionality. A review of the ecological community that existed (or presumably existed) at the site prior to degradation should provide some guidance on appropriate species at each trophic level that can be considered for reintroduction/ or population restoration within the project area. It is, however, critical that reference ecosystems not form the entire basis of restoration planning. Not only is FLR intended to support human well-being in addition to increased ecological productivity but these restoration trajectories can be complicated by climate change which is currently shifting species' ranges and altering habitat suitability models (and species ranges themselves). As such, plant and animal communities and populations are currently responding to changing climate conditions and will continue to do so for the conceivable future. What once existed in a landscape can provide guidance on species that could be restored, but a focus on functional traits and climate scenarios may provide more accurate forecasting over the coming decades. When considering or planning species reestablishment, it is always important to consider the impacts, both positive and negative, that these may have on local people within the project site and adjacent areas. It may not, for example, be practical to introduce large predators (such as wolves) into an area where livestock could be regularly killed. IUCN has developed clear guidelines to assist planning species reintroductions and translocations (IUCN/ SSC, 2013).

Finally, the appropriateness of the species to be used or expected in restoration interventions should be the outcome of a participatory process among sectors and stakeholders. Not only can this increase the likelihood that species are delivering the landscape scale functional benefits desired by stakeholders and sectors, but it will also help increase the likelihood that the species used in restoration also meet the livelihood and subsistence needs of the people that ultimately depend on the productivity of the landscape.

Forest landscape restoration and ecosystems

FLR must work across entire landscapes and their associated land uses. These whole landscapes and the interactions among their ecosystems, not just the site specific or ecosystem unit alone, are what drive

Ethiopia has committed to place 15 million hectares of degraded or deforested land under restoration in support of the Bonn Challenge. Much of this commitment will be undertaken in landscapes such as this, in Ahmara Region. Photo courtesy of Adriana Vidal/IUCN the large-scale ambitions of FLR. Species choices and expected interactions among them should be geared towards maximising the multiple benefits from restored landscapes, for both people and landscapes. Ultimately, the choice of species in forest landscape restoration will take a broader view, using species capacities to restore landscapes through contributions to one or multiple services. Additionally, a focus on assessing landscape features (e.g. geomorphological diversity and habitat ecotones) and the other spatial catalysts of biodiversity and the processes that create diversity should be addressed (Pressey et al., 2007; Anderson and Ferree, 2010). These may include improving water retention capacity, preventing the loss or leaching of soil, active soil building, increased seed dispersal and recruitment and so on, while at the same time providing economic and livelihood gains to people through products like fruit and grains, fodder, increased food production, electricity generation and security, and more. The ecological productivity that FLR works to restore can thus be measured in social and economic terms. As landscapes are restored, the increasing taxonomic and functional diversity of the landscape will lead to more resilient landscapes and ecosystems.

From the ground up, increasing soil biodiversity and substrate heterogeneity is an important, yet often under-appreciated consideration in forest landscape restoration. Ideally, the choice of species for FLR interventions should include those that are critical in cycling nutrients, modifying the landscape in ways that support ecological productivity and support the water cycle (such as through increased evapotranspiration)—to name a few.

Rarely does one species independently generate ecosystem services and so a focus on one species in FLR or ecosystem restoration would be short-sighted. It is the biophysical or trophic relationships among species that generate the ecosystem services upon which people rely, therefore, landscape restoration strategies should employ a diverse set of restoration actions and use an ecosystem approach to species choice that will help create the improved ecological conditions for the entire landscape.

Even though it is often no longer appropriate or practical to restore degraded and deforested landscapes towards previous reference levels, restoration practitioners can include components of those former ecosystems and reference levels to guide decision making on suitable forest landscape restoration interventions. In many parts of the world, degradation is severe enough that species are regionally extirpated or extinct and the underlying ecosystem has collapsed or shifted. In these extreme cases, and in less-severe cases as well, the restoration to a new adapted state is a necessary conclusion. Ecosystem restoration at the landscape level through restoring functional species diversity is one of the best opportunities for landscape restoration in these severely degraded areas and can generate the multifunctional benefits desired by people from ecosystems of restored landscapes.

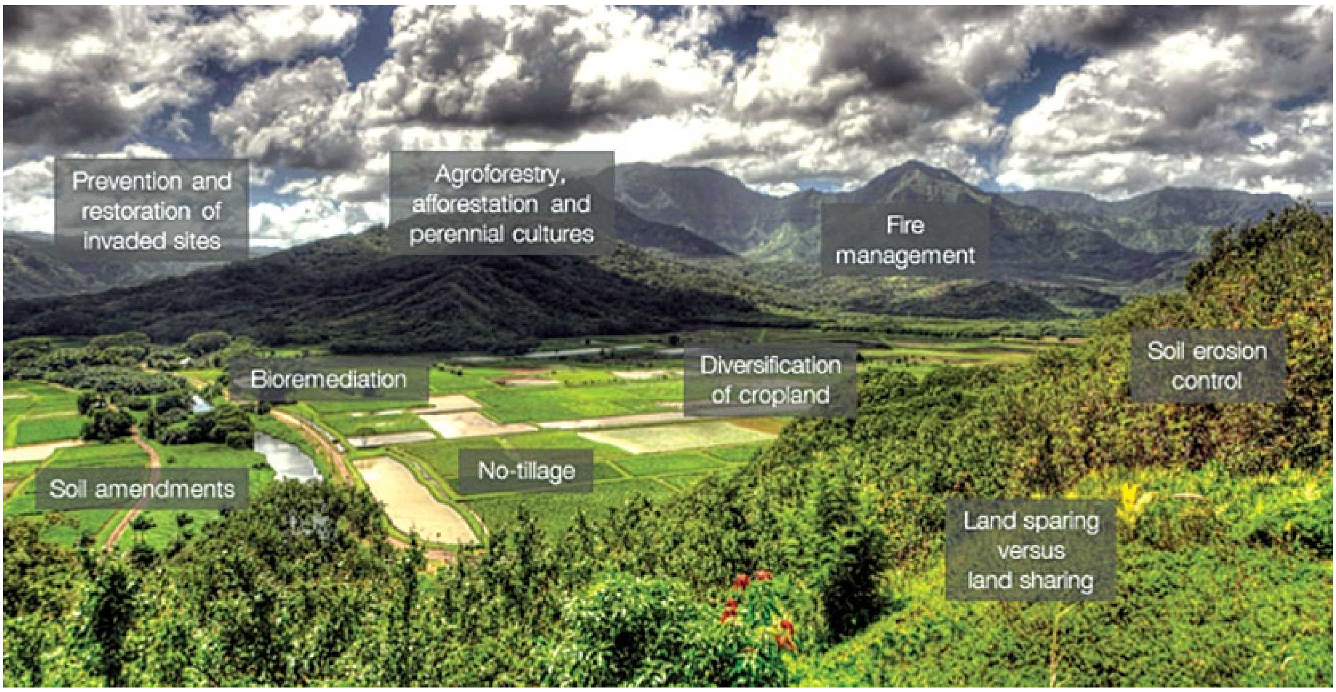


Figure 1. The landscape approach to forest landscape restoration from the *Global Soil Biodiversity Atlas* (Orgiazzi et al., 2016)

Because no global standard definition and classification of ecosystems exists, quantitative assessment of diversity at the ecosystem, habitat or community level remains problematic (World Conservation Monitoring Centre, 1992). However, IUCN and partners are developing a standard ecosystem classification through the ongoing *Red List of Ecosystems* (https://iucnrle.org/).

The ability of landscapes to withstand shocks and recover from disturbance is how resilience in landscapes is measured. All ecosystems are dynamic as are the species that compose them—albeit along different timescales and throughout different geographic ranges. A landscape is often defined based on interactions among ecosystems and how communities and species assemblages within an ecosystem respond to environmental changes will determine the ecosystem's resilience.

Individuals within an ecosystem live and reproduce, and species persistence is the first condition for retaining ecological resilience. As degradation reduces the number of species in a landscape by physical extirpation through land clearing, deforestation, over-harvest, or any other activity that reduces or eliminates species from the landscape—ecosystem resilience and by extension landscape resilience, will suffer. Generally, the fewer species that compose an ecosystem, the less resilient it is. Forest landscape restoration, by definition, occurs in areas where native species and their functions have been lost and regaining the ecological function of a degraded area is predicated on the expansion,

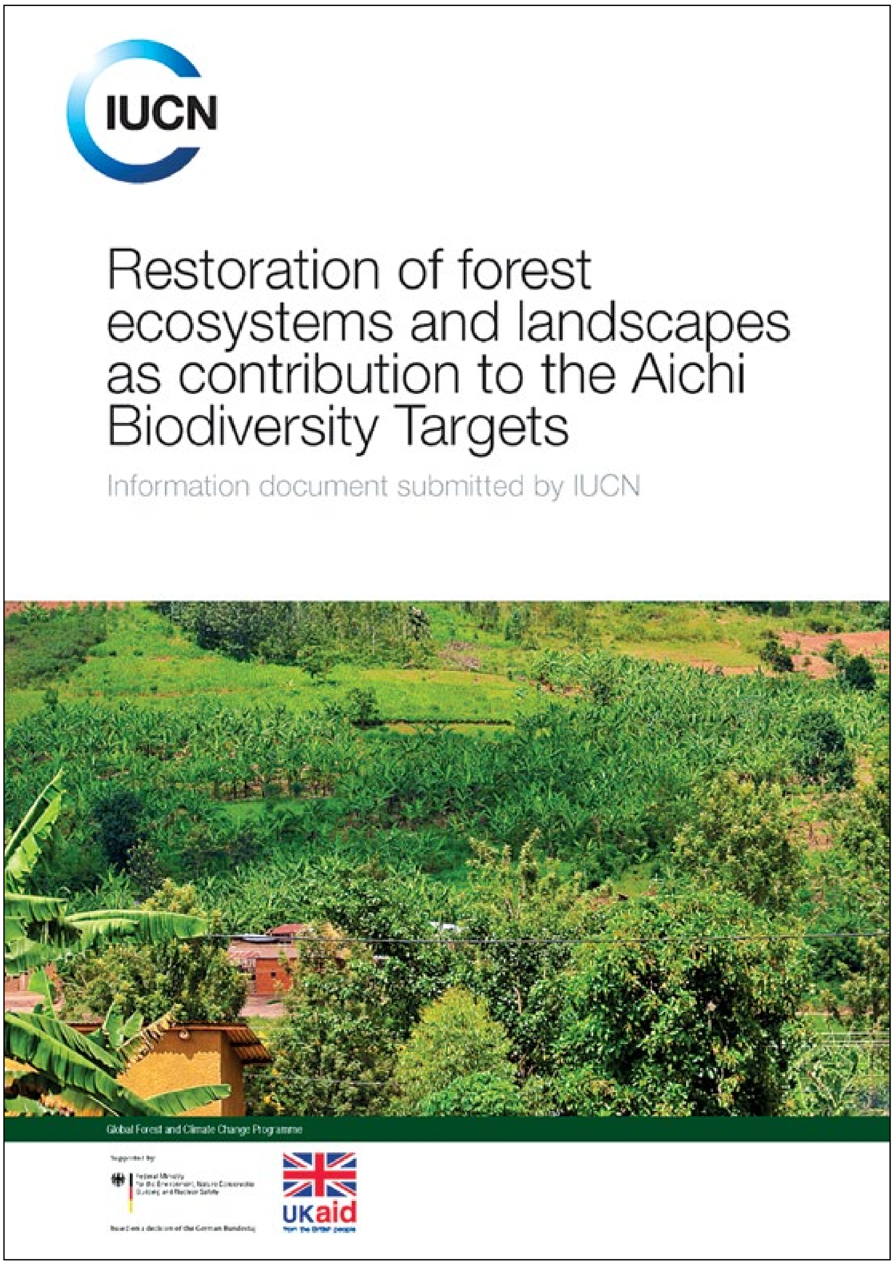


Figure 2 was included as an official information document to the 13th Conference of Parties to the Convention on Biological Diversity in 2016. This publication provides information on how implementing forest landscape restoration (FLR) at the jurisdictional and national level can offer countries a way to recover degraded forests and bring back key ecosystem function in a way that will increase biodiversity levels in a landscape tohelp achieve several Aichi Biodiversity Targets.

establishment, or reintroduction of species that fill functional gaps for degraded landscapes. How these functional gaps are filled depends on many factors, but it is clear that an approach that uses a diversity of species will build more resilient ecosystems and landscapes than an approach that does not. The consideration of ecologically appropriate species is one of the most important steps that can be taken in forest landscape restoration.

An obvious place to begin considering species used in restoration are soil and plant species. Much of the degradation that plagues landscapes begins with declining soil quality or in the erosion of top soil and leaching of soil nutrients. The restoration of soil conditions that support vegetative growth is fundamental, especially the re-establishment of plant species as successional partners, usually in combination with landscape restoration interventions like agroforestry, woodlots and sustainable agricultural systems.

At a minimum, forest landscape restoration should include some component of an integrated ecosystem approach to restoration. This will require that restoration practitioners have a working knowledge of the ecosystem types in their geography as well as the notable or keystone species. A diversified species approach to enhance native biodiversity and increasing connectivity between fragmented landscapes, ecosystems and habitats should be an output of any restoration assessment. Alternatively, where degradation has extirpated many species, this approach can help to build ecosystems with native species based on functional traits that are desirable such as nitrogen fixation, predator or herbivory deterrence, or critical habitat for other species of concern or care.

The ecological and associated socio-economic benefits resulting from the integration of biodiversity restoration and conservation in FLR planning, along with the concepts of genetic, species and ecosystem diversity can be utilised to measure the progress countries can make to meet international commitments such as the Convention on Biological Diversity (CBD) and the UN Sustainable Development Goals (particularly Goals 15 [Life on Land] and 13 [Climate Action]). Article 6 of the CBD deserves special mention as it requests that countries prepare National Biodiversity Strategies and Action Plans (NBSAPs) that are especially important for national implementation of the CBD. Through large-scale FLR planning and action, jurisdictions can support specific targets for national and international biodiversity conservation, while restoring the ecological productivity of the landscapes upon which people rely. Part Two of these guidelines outlines how practitioners can operationalise an interest or mandate in the explicit inclusion of biodiversity in FLR planning. It also suggests some key information sources and methodologies for ensuring that landscape planning for FLR will also include the biodiversity knowledge that can help shepherd restoration planning to long-term restoration success.

While Uganda completed its national assessment of forest landscape restoration opportunities in 2016, implementation and additional assessments at the subnational level are underway. This includes focusing on sustainable land management in agricultural districts, with farming associations and engaging youth groups in working landscapes such as here in Mukono District. Photo courtesy of Craig Beatty/IUCN.

Part two

Biodiversity in forest landscape restoration assessment planning

Within some existing methodologies (e.g. IUCN and WRI, 2014) there are several clear reasons outlined about the value of well-planned FLR activities in maintaining or restoring biodiversity and its benefits. Here, additional guidance for the restoration practitioner is provided on how to more comprehensively and practically approach biodiversity in forest landscape restoration assessments.

In the assessment of restoration opportunities, stakeholders will first identify their goals for forest landscape restoration and this process will lead to different types of restoration actions that, when implemented, should alleviate the underlying drivers of landscape degradation. Each of these solutions will involve actions (i.e. 'restoration interventions') that precipitate physical transitions from degraded to restored and more productive landscapes.

Underpinning each of these transitions are biological processes that support increases in populations or diversity of one or many species. Indeed, without gains in plant, animal, fungal and microbial diversity, there is little hope of long-term restoration success for increased and sustainable productivity. At its most fundamental level, forest landscape restoration is intended to build or support resilient ecologies which are centered on the interconnected relationships among species and functional trophic groups and how these are inherently beneficial for livelihoods and human well-being (e.g. increasing biodiversity in soils leads to increased soil fertility) (Reitbergen-McCracken, et al., 2007, Lamb, 2014).

When considering FLR objectives and associated benefits to biodiversity it is important to recognise that the problem or challenges to be addressed in terms of biodiversity and species should align with

Table 1. Alignments between typical FLR objectives and biodiversity

Example FLR objectives	Biodiversity alignments
Food security	Biodiversity underpins agriculture (including agroforestry), especially through both the resilience to environmental change by locally adapted varieties and species, and through a more diverse provision of goods. It is now widely recognised that healthy ecosystems and especially forests represent an important repository of food and resources that play a key role in contributing towards food security (Sunderland, 2011).
Water security	Forests are well-recognised as good natural upstream protection for water supplies and there are multiple examples of degradation of downstream water courses (including of water quality) where upland deforestation has occurred. Biodiverse landscapes are often regarded as being more effective at providing ecosystems services and are more efficient at protecting water sources (Secretariat of the Convention on Biological Diversity, 2013, Herrera et al., 2018). These ecosystems and forest landscapes are also critical in promoting groundwater recharge and supporting hydrologic connectivity (Pringle, 2001, Hatton and Nulsen, 1999).
Sustainable production	Conservation and restoration of biodiversity across landscapes is globally recognised to be a direct contributor to developing sustainable production systems, especially within forestry, agriculture, fisheries, pharmaceuticals, pulp and paper, cosmetics, horticulture, tourism, construction and biotechnology (SDG Target 12).

Example FLR objectives	Biodiversity alignments
Carbon sequestration	Future restoration of degraded landscapes (especially in the tropics) and the associated carbon sequestration potential is now a well-established nature-based solution to the mitigation of ongoing climate change (Griscom, et al., 2017). While fairly little is known about the impacts of biodiversity loss on mitigation by forests and associated habitats, it is often assumed that biodiverse areas are more efficient at storing carbon (Nauman, et al., 2014, Griscom, et al., 2017) and research by Vayreda, et al. (2012) demonstrates the positive impact that forest landscape management as an FLR intervention can have on carbon sequestration in Spanish forests.
Resilience	Genetically biodiverse systems have a greater resilience to environmental change (for instance, resilience to climate change) than degraded landscapes. While this may not be apparent in the short term, variation from within species to across landscapes may be crucially important for long-term resilience of ecosystem function and the services these underpin (Oliver, et al., 2015a; Oliver, et al., 2015b).
Poverty reduction	Biodiversity resources and ecosystems are regularly under-valued as public goods. This is especially important when considering the disproportionate dependence poor people have on biodiversity for their subsistence needs, in terms of both income and insurance against risk and sometimes as a route out of poverty (Secretariat of the Convention on Biological Diversity, 2010). The link between biodiversity and the prospects of poor people indicates that biodiversity conservation (including restoration efforts) should be a priority in international efforts to address poverty reduction (Secretariat of the Convention on Biological Diversity, 2010).
Livelihoods	The importance of forests and other healthy ecosystems as opportunities for sustainable extraction (strongly linked with the biodiversity components of such ecosystems) is clear. It must be noted however, that supplies from ecosystems can be inflexible and low returns commonly limit their role as safety nets and pathways out of poverty (Wunder, 2014). Access by people to these resources along with the diversified sources of non-timber forest products is an important consideration when assessing the value of ecosystems to communities and potentially the sustained conservation of these habitats.

or support the objectives of existing or developing national and international policies associated with forest landscape restoration. Challenges to maintaining or restoring biodiversity at a national scale are often recorded in existing documents such as National Biodiversity Strategies and Action Plans (NBSAPs), the principal instrument for countries to implement their commitments under the Convention on Biological Diversity (CBD). The objectives contained within NBSAPs and other biodiversity-centric documents will commonly focus on restoring individual species populations or on maintaining areas of recognised and prioritised species diversity. While NBSAP's and similar documents are especially helpful for national level objectives, if FLR activities are planned at a sub-national level an additional consideration of more localised challenges may be needed (see following section on National Biodiversity Strategies and Action Plans).

In a few cases, perhaps more regularly at a sub-national level, objectives for restoring or maintaining biodiversity for inclusion in the FLR process may not have been explicitly considered. In these instances, FLR practitioners will need to identify and contact the appropriate local, national and international experts for advice (see following section on Engaging biodiversity professionals).

During the process of considering biodiversity within the restoration assessment timeline, it is always important that positive links between a restored, healthy and biodiverse environment and other sectors of interest (especially those relating to human development) are well articulated to assure decision-makers of the positive social return on investment provided by restoring biodiversity as part of the overall FLR process (see Table 1 for examples of relationships between biodiversity and many of the typical the objectives of FLR).

Key stakeholders to consider and engage with during both the project planning phase, and the data collection activities that are especially important for acquiring relevant biodiversity information will include government decision-makers (including ministerial or departmental environment officials); representatives from appropriate NGOs (e.g. natural history societies or national/local conservation organisations); botanic gardens; academic institutions; local communities and indigenous groups; appropriate technical staff from government, civil society or the private sector (often from forestry and wildlife departments); commercial users of wildlife products or natural resources within the area of interest; and technical support staff, perhaps especially those with environmental and socio-economic modeling skills.

Engaging biodiversity professionals

In addition to a dedicated institution responsible for coordinating the overall restoration assessment and planning process (as described in IUCN and WRI, 2014), certain technical staff are key for ensuring that practitioners take a balanced approach to FLR. A principal need will be access to an ecologist with a substantial working knowledge of native ecosystems and associated fauna and flora that would typically be present in the area under consideration for restoration activities. Having this guidance will contribute to understanding both the various ecological costs and benefits of the planned restoration, and the timeline or schedule for accomplishing the project objectives.

Equally important is engaging the participation of a naturalist or someone who is familiar with the traditional knowledge and cultural values of biodiversity in the area(s) of interest. The cooperation of a classical ecologist and a stakeholder familiar with the traditional and cultural aspects of biodiversity will help ensure that each of these perspectives is included and validated during the assessment process.

These key advisory roles will help guarantee that the investment in restoration work is effectively addressing landscape challenges and objectives. The ecologist and naturalist will also be able to advise on how best to track restoration progress (including reporting on established biodiversity indicators; See Monitoring the impact of FLR on biodiversity and communities). In some cases, it may be difficult to identify an ecologist with the necessary skills to provide advice on the native fauna and flora of a landscape. In these instances a botanist or wildlife biologist can be enlisted in the ecologist's place, however this biologist will need to have a good working knowledge of ecological principles, and access to a network of supporting expert zoologists and botanists (such as the IUCN Species Survival Commission, https://www.iucn.org/ssc-groups).

Another key consideration in engaging with partners on biodiversity and FLR is the alignment of perspectives and expectations. While there are significant potential gains from the explicit inclusion of biodiversity information in forest landscape restoration assessments, the inclusion of stakeholders focused solely on biodiversity or forestry can sometimes create tension, yet, their inclusion is necessary. Managing expectations in the results of FLR can be a delicate process, ultimately the objective of forest landscape restoration is to restore ecosystem functionality for the benefit of both people and planet.

Some examples of possible biodiversity meditations within FLR assessments:

1. Include and communicate with people who care about and support biodiversity, including national focal points for the Convention on Biological Diversity, academic institutions and naturalist societies.
2. Utilise relevant knowledge and information on species and ecology in data collection and analysis of FLR opportunities
3. Provide adequate outputs and recommendations that can be communicated across sectors (from conservation NGOs to Ministries of Agriculture/Finance/etc.)

If biodiversity conservation and restoration is not the main entry point for a forest landscape restoration opportunities assessment, we can safely assume that some biodiversity gains will be made, and it is important to quantify them. If the entry point for an FLR opportunities assessment is to achieve more substantial biodiversity conservation and/or the restoration of areas of high biodiversity value, then the biodiversity gains are the explicit objective of forest landscape restoration. In both cases there will be biodiversity gains that are worth pursuing in the assessment process, outcomes and the monitoring of FLR. Stakeholders primarily interested in biodiversity conservation should recognise the potential for such biodiversity gains even though the landscape may not necessarily be restored to its reference state, original ecosystem or vegetation. Stakeholders interested in the multiple objectives that FLR can bring should always consider the benefits of conservation and restoration for biodiversity.

Of clear importance throughout the planning and preparation phase is ensuring that stakeholders in the FLR process are aware of any potential impacts (positive or negative) resulting from expanding consideration of biodiversity both within the delineated restoration area and in adjacent or associated areas. Feedback during the planning and preparation phase from civil society stakeholders including representatives of governments, non-governmental agencies and local/indigenous communities will greatly inform the project, especially on any controversial subjects or initiatives.

Monitoring the impact of forest landscape restoration

Monitoring progress towards meeting the FLR objectives will typically be tailored to the availability of local resources or opportunities and will characteristically take place once restoration actions are underway. Monitoring takes place during and after the physical process of restoration and is also an important consideration in the data collection and assessment timeframe. However, it is imperative that monitoring frameworks and indicators are discussed and agreed upon by stakeholders during the assessment process. This will set up the conditions that will make monitoring possible, whether or not it is actually completed. Much of the input data for the assessment will also serve as potential indicators of FLR progress and importantly, baselines will be measured and set during the assessment stage.

While some biodiversity indicators will be common (e.g. habitat cover, species diversity, area under protection), the precise methods used will vary among habitats and ecosystems. For example, monitoring species populations or communities may require different approaches in savanna woodlands compared to lowland tropical rainforests or high desert and will also depend on stakeholder engagement and continuity. However, a range of standardised tools and monitoring protocols exist which can be used or adapted as necessary for most major plant and animal taxa. Technological advances have made a range of tools more easily accessible and affordable, such as drone- or satellite-based remote sensing, in situ sensors such as camera traps or acoustic recording devices, and environmental DNA monitoring, all of which will have a role to play in some landscapes undergoing restoration. Wherever possible, data collected should feed not only into landscape-scale and national-level reporting schemes, but also into research, monitoring and evaluation processes that support global databases such as *The IUCN Red List of Threatened Species, Protected Planet* and the *Living Planet Index*. This is particularly important since data from these databases is used to measure progress towards delivery of global environmental goals (such as the Aichi Targets as well as the Sustainable Development Goals). IUCN welcomes more input to the *Red List of Threatened Species* on species' distributions, natural history, threats and conservation status. To submit new information to IUCN, please use the following email contact address: redlist@iucn.org. Additionally, the IUCN Species Survival Commission's Monitoring Specialist Group is a key resource when designing or implementing FLR strategies or implementation.

IUCN has also developed biodiversity indicators under *The Red List of Ecosystems* which will continue to develop over the coming years. Engagement with *The Red List of Ecosystems* and IUCN Commission on Ecosystem Management professionals will ensure that biodiversity and ecosystem monitoring in FLR assessments also supports these international criteria on ecosystem conservation status.

Engaging with local communities and other stakeholders within the FLR landscape for monitoring restoration progress is a practical way of both facilitating local ownership of the FLR process and establishing an efficient and regular means of tracking changes in biodiversity. Efforts should be made to identify a key restoration ecologist (national or international) who can work with local experts on the ecosystems to be restored. This expert can provide guidance to local stakeholders (for instance, local university students or wildlife enthusiast groups) in the monitoring process for how to determine if restoration efforts are working or if additional attention is required to reach landscape objectives. Examples of tracking opportunities might be recording sightings of a threatened target species in areas under restoration; counts for the number of individuals of a native tree species regenerating from the existing seedbank; or improvements to an ecosystem service in surrounding farmlands (e.g. fruit-setting increases linked to native pollinator population abundance). Such citizen science opportunities may enhance data collection, increase the sustainability of monitoring programmes and improve the engagement among FLR proponents and local communities for restoration actions. Without local input and engagement, it will be difficult to monitor the variety of ways that FLR has affected the provision of ecosystem services and the social benefits or costs that have resulted from restoration activities.

Lichen *Sticta angstroemii* (Lobariaceae, Ascomycota) photographed in a fragmented cloud forest in Campos do Jordão, São Paulo, Brazil. Lobariaceae lichens may be used as bioindicators for conservation purposes as they are used to detect remaining forest fragments, in this case the Atlantic Forest. Photo Courtesy of Manuela Dal Forno.

Biodiversity information for the assessment process

Following the engagement of key stakeholders in the biodiversity sector and the establishment of a forest landscape restoration assessment process like the Restoration Opportunities Assessment Methodology (ROAM), attention will pivot towards the collection and analysis of data and information regarding FLR. This task will often be split among working groups on topics like stakeholder mapping, spatial data analysis, ecosystem service modeling, gender analysis, cost-benefit analysis, enterprise identification, policy analysis and assessments of institutional readiness. While most biodiversity data tends to be geographic and taxonomic, biodiversity information should be a welcome component of any working group and is typically already included in some form or another.

Biodiversity information sources

Once the broad FLR outputs and scope have been considered and agreed on, attention will be turned to the available existing resources and data that can help to inform the assessment. Typically, the outputs and scope of FLR are agreed upon during the inception phase of national or subnational interest in FLR as a nature-based solution to any number of social and ecological challenges. Often these are codified in a restoration planning and/or scoping document produced collaboratively by the people with the rights to manage land in the identified assessment area. This process should ensure that the best available biodiversity knowledge can be integrated into the entire assessment using a combination of the best biodiversity science and information and the most relevant regional, national and local biodiversity knowledge.

Existing national biodiversity data and contacts

Most countries have a valuable history of gathering and maintaining information about their natural environment. In addition to more general information about the fauna and flora of the country, there will also be data sets associated with historical land use change (including conversion of forested land) and land use practices undertaken within the country. Additionally, there may be data available on the commercial use of species which can be used to guide the restoration process on plants and animals (including agricultural varieties and crop wild relatives) now extirpated or rare within the assessment area.

The first step in the collection of data resources to support the substantial inclusion of biodiversity information in the FLR assessment process should be for the FLR assessment management structure (e.g. FLR technical committee, FLR executive committee, institutional lead organisation, etc.) to work with the biodiversity professional to identify local or national wildlife and forestry experts who are willing to assist in restoration assessment and planning. This will include developing an initial contact list of the governmental departments, civil society organisations, academic institutions and local communities that are likely to have the appropriate expertise. When contacting these key actors, it is helpful to ask about additional expert contacts to ensure none have been overlooked in the initial search. Establishing a network from the start will be very important to developing local to national ownership of the overall restoration process.

Some key national biodiversity data sets

National Red Data List or Book Information—many countries have published national Red Data lists or books that identify and document species that are national priorities for conservation. The content of these publications varies substantially between countries, some are general publications while others are extremely detailed in the information presented. Many focus on vertebrates alone (often large mammals), but information on multiple taxonomic groups, including invertebrates and plants (such as threatened tree species) is becoming more common. The project team should look to review these documents to see if the species listed can be integrated into the restoration assessment and planning process and what value their inclusion would bring. If not publically available, these data can often be acquired by contacting the national focal point for the Convention on Biological Diversity or in reviewing National Biodiversity Strategies and Action Plans (NBSAPs).

National biodiversity strategies and action plans

NBSAPs have been created for 189 countries party to the Convention on Biological Diversity. This means that nearly every country has completed a recent assessment of its national biodiversity and formulated a strategy and action plan for biodiversity conservation. Not surprisingly, the depth and breadth of these NBSAPs vary according to the capacity of countries to undertake and implement these activities. However, despite variations in NBSAPs, all of them provide information on national biodiversity status, threats, trends, priorities and strategic actions.

Several NBSAPs acknowledge the role of restoration in supporting national and international biodiversity targets and for countries or regions undertaking forest landscape restoration assessments, NBSAPs can be both a wealth of species-specific information as well as a starting point for generating interest in FLR for stakeholders involved in the NBSAP process (see Biodiversity data sources).

Extracting relevant biodiversity information from NBSAPs

As an internationally mandated process, the development of NBSAPs and their content is relatively standardised and typically includes general Biodiversity Information Sources. Similar to forest landscape restoration assessments, NBSAPs identify stakeholders, geographies and actions many of which are the same as in FLR assessments. The results from the NBSAP policy and institutional analysis will often align with the same process in an FLR assessment, and may actually include a number of the same key

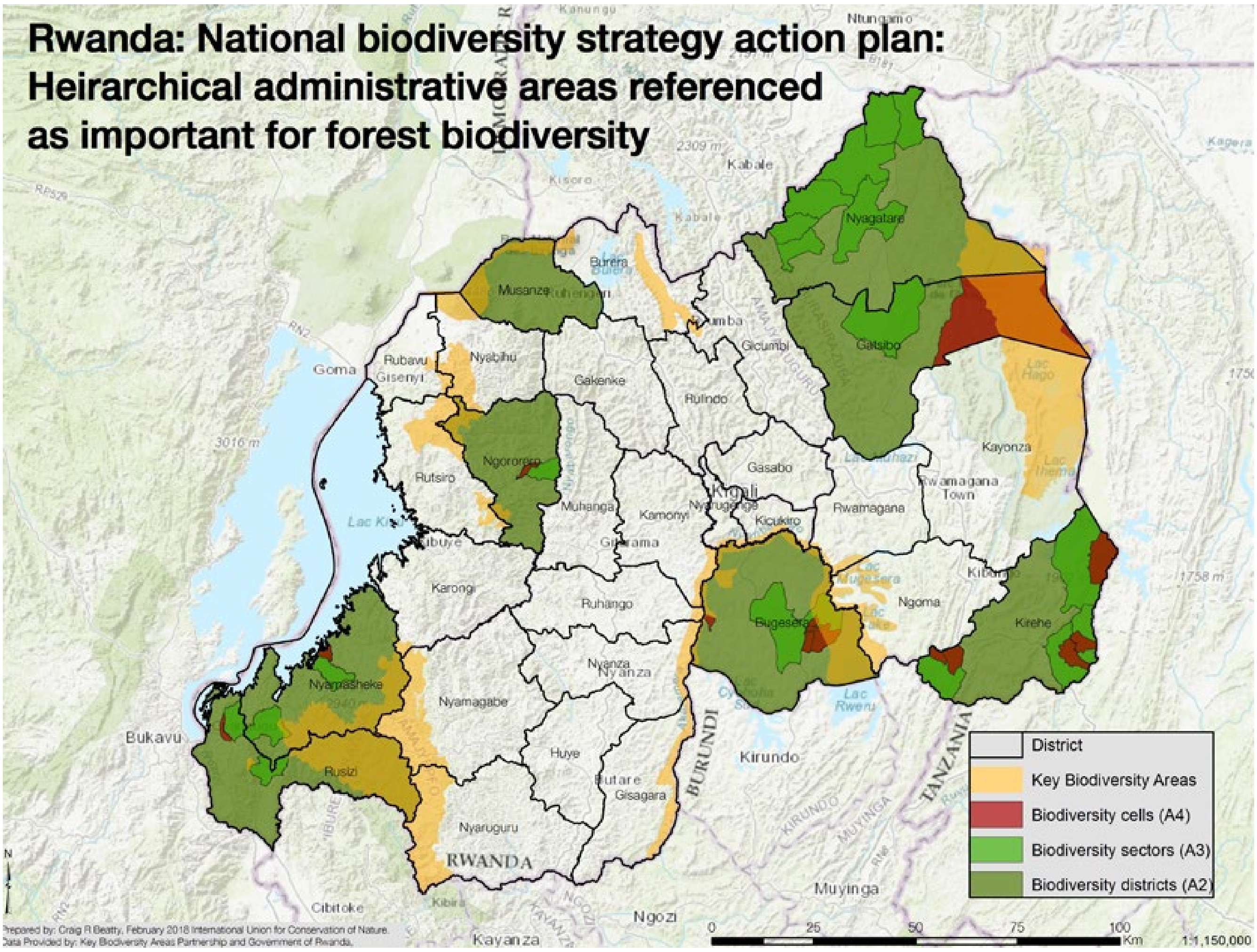


Figure 3. shows the data that was extracted from Rwanda's NBSAP, which contained no maps. Rwanda's administrative divisions are districts, sectors and cells. Within the NBSAP, several districts are mentioned as priority areas for biodiversity and within each district critical habitats are identified that explicitly refer to sub-districts (sectors) and/or the cells within them (three administrative levels). There were also situations where specific forests were mentioned without naming the administrative division where these features were located. A simple internet search provided the necessary information to confirm these administrative areas. From this textual information and administrative area spatial data, a GIS analyst can create national maps of priority areas for biodiversity based on administrative hierarchies and these data can be used during the spatial analysis of FLR opportunities and priorities. Additionally, this analytical process could also be completed using watersheds, which may more accurately depict ecosystem boundaries.

stakeholders within a jurisdiction. Therefore, it would be wise to begin the FLR assessment with an audit of the policies and laws mentioned in the NBSAP and how they may relate to FLR. Sectoral policies that have bearing on biodiversity conservation are usually well-linked with, or the same, policies that address forests and landscapes, though they are often addressed in different sections of these policies.

NBSAPs are also replete with geographic information on the status and trends of biodiversity. Often this information is contextual and refers to geographic areas or features where biodiversity conservation is especially important. While most NBSAPs do not contain accompanying geospatial data, extracting this information from the text of an NBSAP is relatively simple and provides additional guidance in identifying and integrating areas important for biodiversity into FLR assessments. The national CBD focal point for the area under assessment may also be able to assist in obtaining this information.

Finally, as an internationally recognised process undertaken by almost every nation, NBSAPs received a significant amount of support for their creation. In each country, workshops helped gather experts and the information necessary to formulate the strategies and actions indicated in the plans. In many cases, this was recent enough that the institutional platforms and staff are still relatively intact. Working group rosters and lists of stakeholders are readily available for follow-up by FLR practitioners and are usually available as annexes to NBSAP documents. Government staff currently working on FLR assessments often have colleagues within their own departments or ministries that worked on the development of their national NBSAP. Identifying and communicating with these individuals on the ongoing FLR assessment will provide the opportunity to mainstream both biodiversity and forest landscape restoration.

Biodiversity data sources

Historical data sets

For some countries and regions, land cover/land use (including forest and associated habitat extent) and species distribution have been recorded or tracked for decades. In many cases, records have focused primarily on living natural resources with clear commercial value. These records may be helpful for determining the previous extent of native ecosystems, including the former distribution of important species (e.g. timber trees) that may form a portion of future restoration interventions. Historical records of the distribution of animal species may be of value to the planning process, especially if one of the targets of the FLR process is to re-establish landscapes that support these species. Natural return of extirpated species to a restored landscape might be used as a general indication of successful restoration.

Culturally important species and sites

As part of an overall strategy for landscape restoration and its biodiversity component, it is helpful for both the technical restoration process and interactions with local communities to consider culturally important species and sites within the planning process. These may be species or sites that are important for religious or spiritual purposes, that have some local economic use (such as for subsistence food or medicine), or may be areas or species of enjoyment because of their beauty, intrinsic value or other type of significance to local communities. Information about species and sites of importance (such as sacred groves) is often available at a local scale only, and is most appropriately gathered through early interaction with naturalists and communities within proposed project areas.

International data

In addition to the many valuable national biodiversity data and information resources, there is a substantial range of standardised biodiversity data produced by international conservation organisations; much of this is useful during FLR assessments. The following is a partial list of some of the leading data available that FLR practitioners may wish to consider using:

The IUCN Red List of Threatened Species – The IUCN 'Red List' is the world's primary source for data on both threatened and non-threatened species (over 87,000 species are documented). Detailed information is often provided within the Red List on the global distribution of a species (including spatial data on a species' range), population trends, habitat and ecological requirements, threats to the species, use and trade, and conservation needs. Red List information is then used to determine the global conservation status for each species—this status can range from 'Critically Endangered' (global conservation priorities) to 'Least Concern' (of less immediate conservation concern). Data are publicly available for non-commercial use, and can be accessed at the following: http://www.iucnredlist.org

Key Biodiversity Areas (KBAs) – KBAs are nationally identified sites that are recognised to contribute to the persistence of biodiversity. Globally standardised criteria and thresholds (divided into five categories: threatened biodiversity; geographically restricted biodiversity; ecological integrity; biological processes; and, irreplaceability) have been developed to guide the identification of priority conservation sites with defined boundaries. KBA's are increasingly being used to support conservation planning and sustainable development at national and regional levels. Now included within KBAs are the Important Bird and Biodiversity Areas (IBAs) and Alliance for Zero Extinction sites (AZE) more fully detailed below. The World Database of Key Biodiversity Areas can be accessed at the following: http://www.keybiodiversityareas.org/home

Kruger National Park, South Africa. Photo courtesy of Craig Beatty/IUCN

Important Bird and Biodiversity Areas (IBAs) – Developed by BirdLife International, these are sites that have been identified as significant for the persistence of bird species. They have been catalogued through internationally standardised criteria, with over 12,000 IBAs in over 200 countries and territories. These sites are also recognised as KBAs for birds. More details about IBAs and their value can be accessed at: http://www.birdlife.org/worldwide/programme-additional-info/important-bird-and-biodiversity-areas-ibas

Alliance for Zero Extinction sites (AZEs) – The AZE is a partnership of non-governmental biodiversity conservation organisations working to prevent species extinctions by identifying and safeguarding the places where Endangered or Critically Endangered species are restricted to a single remaining site. Terrestrial species groups evaluated against the AZE criteria include mammals, birds, amphibians, conifers and some reptiles, with progress being made on other species. Additional information on AZE sites can be located at the following (including a global map): http://www.zeroextinction.org

The IUCN Red List of Ecosystems (RLE) – The IUCN RLE is of interest to restoration practitioners, most especially in that it hopes to provide a global assessment of the conservation status of the ecosystems of the world by 2025, based on the application of a series of recently developed standardised categories and criteria. This central goal has been established to support conservation in resource use and management decisions by identifying ecosystems most at risk of collapse. Further information about the IUCN RLE and its current geographic coverage can be obtained at: https://iucnrle.org

Global Invasive Species Database (GISD) – This database is maintained by the IUCN/Species Survival Commission Invasive Species Specialist Group. It contains searchable details about alien and invasive species that have a negative impact on native biodiversity and natural areas, including a list of the '100 of the World's Worst Invasive Alien Species'. While understandably not yet comprehensive in covering the vast array of potential invasive species, the GISD represents an extremely helpful tool when planning a FLR project, especially for initial screening of non-native species associated with the project landscape. It is also important to note that not all introduced exotic species are invasive. The Convention on Biological Diversity defines "invasive alien species" as "plants, animals, pathogens and other organisms that are non-native to an ecosystem, and which may cause economic or environmental

Avoiding lasting damage from invasive species during FLR planning

While the use of native species is strongly recommended wherever possible, there will be many instances where a specific FLR intervention requires the utilisation of non-native species—for instance, in situations where quick-growing trees are needed and no native alternatives exist, or where agroforestry has emerged as a nature-based solution to landscape degradation. In cases where non-native species use is planned, great care must be taken to identify species that will not damage local ecology by becoming or harbouring alien invasive species.

Invasive species have emerged as one of the most common threats to native biodiversity. In addition to the problems caused to native species (for instance through predation, competition or changes to soil or substrate structure) invasive species can impact local communities, by invading and damaging farmland and other economically viable sites. The cost of removing invasive species can be extremely high, and in many cases, it may be impossible to totally eradicate alien invasive species, leaving ongoing costly population control as the only feasible management option.

While there is a need to be careful about vegetation choices (such as exotic trees that have the potential to become invasive species), it is also important to make wise choices when intentionally introducing animal species. All the detailed information gathered by the project's ecologist should be considered before any options for introduction are considered. As with vegetation, the introduction of invasive animal species can be difficult to reverse and can result in ongoing damage to not just the project area, but to the landscape including surrounding areas and ecosystems.

harm or adversely affect human health." The GISD database can be searched at: http://www.iucngisd.org/gisd

World Database of Protected Areas (WDPA) – Access to this publicly available database, a joint project between United Nations Environment (UNEP), The World Conservation Monitoring Centre (WCMC) and IUCN, is provided through the 'Protected Planet' online platform. Spatial data, which includes important RAMSAR wetland sites, can be downloaded, including the most globally comprehensive information on terrestrial and marine protected areas coverage. Related statistics and further details about both the WDPA and Protected Planet can be accessed at the following: https://protectedplanet.net

Integrated Biodiversity Assessment Tool – While this is not a primary biodiversity data resource, it is a valuable tool that brings together a range of global and national data layers useful for FLR planning, such as protected area boundaries (from the WDPA), biological information about habitat and species diversity indices (provided through the IUCN Red List), and Key Biodiversity Areas for biodiversity (including previously discussed IBAs and AZE sites), which is useful for both research and conservation planning purposes and for guiding sustainable development (especially when managing business risk and opportunity). These data are available at two sites—IBAT for Research and Conservation Planning (https://www.ibat-alliance.org/ibat-conservation) that provides access to freely available information, and IBAT for Business (https://www.ibatforbusiness.org) where a fee is required for the commercial use of the extensive biodiversity data.

Policy and institutional biodiversity information

During an FLR assessment, one of the key activities is an analysis of the extent to which existing policies, laws, codes and institutions enable or discourage forest landscape restoration. The national policies and laws that are specifically related to biodiversity have often been well-summarised in the national biodiversity strategy and action plan (NBSAP). As a result, the types of laws and policies that are outlined in NBSAPs may more commonly reflect policies as they specifically relate to threatened species, trade and protected areas for conservation without taking a broader view of the social implications or reliance on biodiversity. Other policies, plans and strategies

Beehives produce honey that can be a valuable non-timber and non-agrigultural commodity, while also supporting increases in pollination. Communities and bees both depend on the biodiversity of the landscape here on the slopes of Mount Elgon in Bukwo District, Uganda. Photo courtesy of Craig Beatty/IUCN identified during the assessment process that are relevant for FLR relate to natural resource use, land tenure regimes and conflict, and jurisdictional and tenure issues. Since many of these policies may inherently or specifically deal with access to natural resources, there is an inherent biodiversity component to each and most provide additional information on the social reliance on natural resources and capital.

Forest landscape restoration takes a view of biodiversity conservation that includes species and ecosystems that may not currently be threatened, but that provide the critical conditions for restoration of multifunctional landscapes. As biodiversity declines species and ecosystems are increasingly at risk, resulting in wide-scale landscape degradation. To better understand the enabling environment for FLR that may also maximise biodiversity outcomes, it is necessary to better understand the policies and plans impacting the wider landscape.

Analysis of FLR strategies, laws, policies and plans affecting the assessment area in question will provide critical guidance to overcoming the bottlenecks for the successful implementation of FLR. This may include identifying conflicting policies or policies that may disproportionately impact one sector at the expense of another. This is a process that is typically carried out by a 'policy and institutions' working group within the FLR assessment structure, but a biodiversity professional who is comfortable translating such policies (e.g. agricultural or trade policy) for their impact on biodiversity will drastically improve the recognition and mainstreaming of biodiversity in FLR. An analysis of the enabling environment for FLR can give a clear picture of the (dis)incentives to restore and conserve that exist for stakeholders within the landscape, and this analysis can assist in providing recommendations for a holistic and cohesive approach to biodiversity and FLR.

One of the difficulties for the practitioner may be differences in legal boundaries and jurisdictions among the various laws and policies relating to FLR and in the NBSAPs, for example. NBSAPs are overwhelmingly based on protected areas, whereas many of the other legal instruments surrounding FLR consider jurisdictions such as provinces, districts or communities. Extracting and interpreting this necessary information at the correct administrative or political level for the FLR assessment remains a challenge. This difficulty can be further compounded by the lack of mainstream biodiversity consideration in existing land use, economic, development, or FLR policies and plans. As a result, biodiversity that may not be a priority for conservation (NBSAP), and is also not catalogued in the other policies and plans including in terms of specific natural resource export value, may be overlooked. Since biodiversity and ecosystem services are regularly under-valued as public goods, policies and laws supporting the role of biodiversity in restoring functional landscapes, have

The presence of bird species can be an important indication of restoration success. Many species have strict habitat requirements, but the continued presence of generalist species is also an indication that landscapes may not be degrading further. Additionally, birds calls and sightings are a relatively simple was to monitor at least one component of biodiversity. Green-backed tit (*Parus monticolus*) Sikkim, India. Photo courtesy of Akshay Vishwanath.

generally lagged behind policy objectives designed to catalyse economic growth (Arrow et al. 1995, Kumar et al. 2013). The undervaluing of biodiversity and ecosystem services has in turn lead to low investments in landscape restoration, despite its numerous and diverse benefits.

Moreover, each of the typical goals for FLR have a broad base of laws and institutions that support them, especially as these goals support objectives that are more directly tied to social welfare. The political will and movement for topics like public health and poverty alleviation are relatively well established and funded, and it is clear that both of these goals are intimately linked to healthy landscapes (Herrera et al., 2018). The restoration, maintenance and conservation of landscape biodiversity—irrespective of, but also acknowledging conservation value—is key to achieving significant and sustainable progress on these goals.

One especially helpful aspect of NBSAP development is the identification, development and refinement of public policies to support biodiversity conservation. By extension, many policies developed for the conservation of biodiversity also have bearing on the restoration of degraded landscapes. In some cases, restoration actions may be mandated to include a threshold of native plant species used in the restoration process. In other cases, the types of restoration that can be implemented may be defined by the laws that have been passed to support the conservation of biodiversity or to limit the spread of invasive species. The analysis of public policies and laws that were developed under the NBSAP process and how they might connect with similar policies and laws for FLR can lead to efficient alignments of both existing policies and policy gaps.

FLR practitioners should seek to modify public policies that undermine forest landscape restoration initiatives to ensure that any restorative actions taken on degraded lands are supported politically and institutionally. While often a substantial task, the modification of national or subnational legislation to support landscape restoration and/or biodiversity conservation has occurred in many countries and has led to positive outcomes for people and nature. Addressing and modifying public policy helps ensure that the solutions brokered through the stakeholder-driven FLR assessment process and resulting strategies find a foothold for implementation that may withstand political cycles and benefit from the long-term vision for sustainable and effective landscape restoration.

Biodiversity data in mapping and spatial analysis

Key in the alignment between biodiversity information and FLR assessments to support conservation and landscape restoration initiatives like REDD+ and the Bonn Challenge is the analytical assessment of where and how information on restoration and biodiversity interact. Assessments for biodiversity conservation, typically through NBSAPs but also through other conservation programmes and initiatives, contain a wealth of geographic data on biodiversity, habitat and landscapes. Similarly, FLR assessments also collect and analyse spatial data to identify drivers of landscape degradation and opportunity areas for landscape scale restoration across many different land uses. One of the primary objectives of this guidance document is to facilitate cooperation and data/knowledge sharing among these complimentary processes.

Between national, regional and global sources of biodiversity information there are many well-documented and respected spatial information sources on species, habitats and ecosystems. Globally, *The IUCN Red List of Threatened Species* requires that all published threatened species accounts contain distribution ranges and most species accounts contain this information. Additionally, there have been several global assessments of ecosystems and ecoregions including by the US Geological Survey[2] and WWF/TNC.[3] The global focus on monitoring forest loss and changes in land use and land cover have also led to the use of remotely-sensed satellite data which can provide useful and real-time information on forest loss and land cover change, which should not be conflated with monitoring biodiversity *per se,* but still provides useful and actionable landscape information. Measuring and assessing biodiversity within an FLR context should take advantage of these global data sets as well as national or finer-scale biodiversity data discovered during the inception of the assessment.

A result of the FLR assessment process should be maps of where land is degraded (often including

2. https://rmgsc.cr.usgs.gov/ecosystems
3. https://www.worldwildlife.org/biome-categories/terrestrial-ecoregions

analyses of the intensity of this degradation), where restoration is possible, and what opportunities for restoration might exist. In each of these products biodiversity information can be used to help define, prioritise or refine areas that show high potential for implementing forest landscape restoration activities. Places where biodiversity is under threat can be included in the spatial analysis as a type of prioritisation filter giving higher weight to places receiving greater degradation pressures. The FLR practitioner should locate degraded areas where FLR implementation would benefit the landscape and its people and where these areas overlap with areas that are a high priority for biodiversity as well.

Alternatively, since most biodiversity data will relate to the presence or absence of species or other biodiversity criteria, integrating these data into the spatial assessments of degraded land, priority areas and FLR opportunities is relatively straight forward exercise. Biodiversity data are typically geographic presence data and it is rare to find spatial data that covers an entire FLR assessment area that also includes biodiversity attributes like species richness or diversity indices (e.g. Shannon's index or Simpson's Index). Despite this, conservation planning and habitat suitability modelling is possible using tools familiar to conservation biologists or ecologists (e.g. NatureServe Vista, Maxent, Marxan, Zonation, VORTEX, RAMAS, BIOMOD, etc.). When provided with appropriate species context, these types of models can be helpful in illustrating how species may respond to restoration.

To effectively map biodiversity priority using the data resources mentioned above, the spatial analyst should contact the data providers using the contacts listed in Biodiversity Data Sources. Once data are acquired, they can be analysed separately as a biodiversity analyses or they can be integrated into the broader data analysis portion of the FLR assessment. The choice will depend on the objectives and expectation of the FLR assessment working group and stakeholders. If biodiversity is a key consideration included as a goal for FLR, it might make sense to complete a free-standing biodiversity analysis and then use the results of this analysis to help inform or prioritise other analyses (e.g. degradation, food security, resilience, etc.). However, if biodiversity restoration is not an explicit goal of the FLR assessment, it might make sense to include these data as components of the underlying FLR assessment. This means including biodiversity data as one of many criteria in a multi-criteria analysis, or using biodiversity data as a proxy for other biophysical or social processes that are of interest to the FLR assessment.

Multi-criteria analysis for biodiversity in FLR assessments

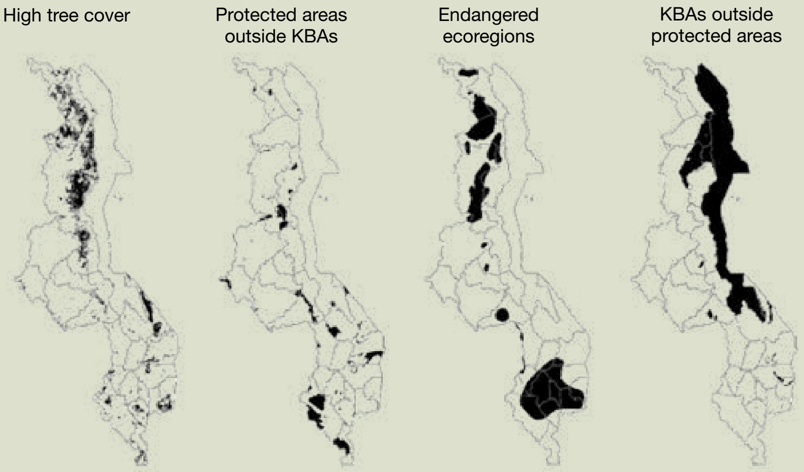
The spatial analysis of biodiversity data within a multi-criteria analysis framework is relatively simple. The spatial data analyst should acquire each of the relevant data layer types, ensure they are in raster format and work with stakeholders to parameterise them to include data that would be interesting in the analysis. The parameterisation of the spatial biodiversity data could include removing species ranges for species that are considered 'least concern' or selecting a particular taxon that is of interest to stakeholders or restoration practitioners. Additionally, it could include extracting areas that have a minimum specific canopy cover percent or ecoregions that have demonstrated conservation priority or value.

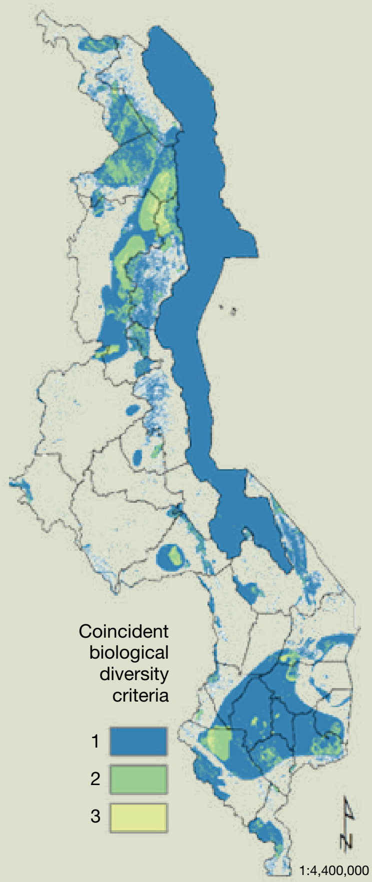
The analyst then reclassifies these data into binary rasters where "1" equals the parameter of biodiversity that the analyst finds interesting and "0" includes all other areas within the raster extent. It is possible to assign different weights to input layers during reclassification, but the discussion of appropriate weights can become protracted among project partners and stakeholders. It is simpler instead to discuss the appropriate parameters for each layer with stakeholders.

The analyst then directs the GIS to perform additive map algebra using the input binary raster layers that have just been parameterised and reclassified. The resulting raster will show where biodiversity criteria overlap and to what degree. Care should be taken here to reduce the potential for data overlaps that are artifacts of the analysis. A frequent example of this in biodiversity analysis is the overlap between KBAs and protected areas. Utilisation both of these layers in a biodiversity multi-criteria analysis without recognising their autocorrelation will lead to double-counting these areas.

In the figure below, four broad biodiversity criteria were used to assess biodiversity for inclusion in *Malawi's National Forest Landscape Restoration Assessment and Strategy*. "High" tree cover was determined using 40% minimum canopy cover as the threshold. Stakeholders also wanted to identify gazetted protected areas outside of currently identified Key Biodiversity Areas and Key Biodiversity Areas outside of current protected areas. Due to the nature of the assessment, protected areas were not included in this analysis as explained in the National Assessment document. Finally, ecoregions designated as "endangered" or "critically endangered" were included as inputs. When overlaid with each other they produce the colour map which shows where input criteria are coincident.

Within Malawi's national FLR assessment it was determined that if less than 10% of Malawi's national commitment to FLR under the Bonn Challenge was implemented using approaches that prioritised restoration using native species and supporting natural ecosystems, Malawi could restore all of its degraded land within its Key Biodiversity Areas. This would potentially lead to tremendous national gains in Malawi for its commitments under the Convention on Biological Diversity.





Accounting for ecological dynamics and flow in the assessment of biodiversity data for FLR is the final consideration in spatial analysis. While spatial data are static, ecosystems, species and genes are dynamic and the proximity of areas important for biodiversity to each other confers an additional level of consideration when mapping biodiversity priorities for FLR; the configuration of remaining habitat fragments, water courses, or populations may increase the priority of these areas for biodiversity restoration. If data are available, it is recommended that biodiversity professionals analyse species trends and population dynamics over several species' generations for their inclusion in the spatial data analysis of FLR assessments. This will also provide more robust information for baseline data and reference values for monitoring the impact of FLR on biodiversity.

It may also be relevant to consider how species ranges may shift due to changes in climate or the derivative effects of climate change. There is at least one confirmed modern case of a mammal extinction due to climate change (Waller et al., 2017) and the influence of changing climates including the impacts of rising sea levels on species are real and are evolving (Thomas et al. 2004, Wetzel et al. 2013). These can include range contractions or reductions in population, in addition to broader ecosystem changes due to shifts in species relationships, the impacts of alien invasive species, or undetermined trophic cascades. It is clear that when considering FLR in the context of climate change, the inclusion of biodiversity should not only account for the current ecological conditions, but also predicted future ecological conditions when possible. This allows for the selection of restoration species that may be more resilient to shifts in weather and climate patterns. The utilization of a diversity of species in restoration also helps to insulate large investments in design, planning and implementation from attrition due to unpredicted environmental changes. Several tools, including the Climate Change Vulnerability Index[4], developed by NatureServe can be instrumental in modeling how climate change may impact species. Additionally, IUCN Species Survival Commission's Climate Change Specialist Group (https://iucn-ccsg.org/) may be able to provide additional resources and information regarding the susceptibility of species to climate change and recommendations for enhancing species conservation under changing climate conditions.

Identifying biodiversity gaps

Despite the increasing wealth of trustworthy biodiversity information from national and international data sources, it is probable that for many locations there will be substantial gaps in the knowledge about which species and ecological communities existed at the site prior to its degradation. In many cases there will be few records about the species composition of the former landscapes (especially for invertebrates, fungi and some plant groups), however a lack of available information cannot deter restoration efforts. If additional information emerges about the former presence of a species at the site during landscape restoration, an evaluation can be undertaken to determine whether populations of this species should be included within the ongoing work or including in the future—this is perhaps especially true for tree species or 'keystone' animal species that perform substantial ecological benefits that support the persistence of many additional species within the landscape (such as tree seed dispersal).

One of the most glaring gaps that follows from the assessment of biodiversity in FLR assessments is the relative scarcity of native seed and seedling stock for restoration activities (Jalonen et al, 2017). Throughout the world, FLR initiatives often recommend that native species be planted and used in restoration activities and this generally receives broad support. However, in most places native species are not widely cultivated and there is a dramatic gap in the ambitions of native biodiversity restoration and the physical and genetic stock to achieve these ambitions (Haase and Davis, 2017). During an FLR assessment it will be necessary to enlist an audit of potential seed and seedling sources within the assessment area, often with the help of nurseries and botanic gardens should they exist. In some cases, the lack of native seed and seedlings may present a barrier to effective FLR interventions using native species. Though, in other cases this could present a valuable business opportunity for rural areas to collect and supply native seed and seedlings for pending restoration interventions, as has happened in several countries (Urzedo, et al., 2017, De Vitis, et al., 2017).

Considering biodiversity in FLR assessments and planning

As hundreds of millions of hectares of degraded land are committed to landscape restoration it becomes increasingly important that FLR practitioners are informed and understand the many perspectives of the landscapes in which they are working. Plans for restoration interventions should be modified and implemented within the landscape context such that restoration supports increased human well-being and the overall biodiversity value does not decline due to restoration activity.

In FLR implementation the practitioner employs a suite of restorative strategies, including traditional ecological restoration. Importantly, FLR does not advocate for large-scale shifts in prevailing land use, but rather in restoring degraded and deforested landscapes and aligning current land use with FLR principles. At the same time, trade-offs need to be considered that may lead to changes in land use. For instance, while agroforestry can be an important FLR intervention, it may not be an appropriate intervention strategy in areas with an existing high biodiversity value. Additionally, ecological restoration in areas with extremely low biodiversity value is typically prohibitive in cost and effort.

An estimate of how restoration may affect native biodiversity should be a key outcome of any landscape restoration opportunities assessment. Through

4. http://www.natureserve.org/conservation-tools/climate-change-vulnerability-index

the analysis of spatial and non-spatial biodiversity information within an assessment area, the FLR practitioner should acquire a good understanding of the biodiversity priorities of a landscape along with the assessments of degradation and its drivers. The objective in safeguarding biodiversity is to "do no harm" when implementing restoration actions, but the vision is to use restoration to improve biodiversity outcomes. In terms of biodiversity this can be accomplished through restoration in one of two ways:

First, restoration of landscapes to increase productivity and support human livelihoods has the potential to decrease pressure on biodiversity. Restoration that improves landscape conditions, agricultural productivity and provides other social benefits can lead to fewer pressures on areas of high biodiversity and reduce or prevent over-exploitation of natural resources. In many places, healthy ecosystems provide the necessary ecosystem services and social safety net for survival for the rural poor. Furthermore, FLR can make landscapes more biodiverse overall, as species of trees, plants and crops in the assessment area are increased when implementing restoration strategies.

Second, appropriate restoration interventions in degraded areas that are specifically important for biodiversity have the potential to help species recover and increase biodiversity outcomes at the landscape scale. This is especially the case for areas in the analysis that are classified as degraded but exist within protected areas or Key Biodiversity Areas (KBAs). Restoration of these areas, especially with ecological restoration in mind or as a component, helps improve and maintain the integrity and connectivity of these landscapes. This also extends to the effect of landscape restoration on the quality of water and waterways, which often represent areas where FLR interventions are not physically possible, but that may see drastic improvements as a result of restorative actions.

Some additional resources for ensuring that restoration activities support biodiversity include *The World Bank's Environmental and Social Safeguards (Chapter 6), IFC Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living. Natural Resources (PSS 6), The Society for Ecological Restoration's International Standards for the Practice of Ecological Restoration.* Bioversity's *Resource Box for Resilient Seed Systems, and Guidelines on Business and KBAs* developed by The Key Biodiversity Areas Partners.

A file-eared tree frog (*Polypedates otophilus*) from the island of Borneo. Photo courtesy of Philip Bowles

Key questions

Where, or how, is biodiversity distributed within the assessment area? Are biodiversity data available or accessible?

Initial screening of biodiversity distributions can be undertaken using the biodiversity data sets outlined earlier (for both threatened and non-threatened species). These data include publicly available spatial information for an increasingly wide range of species. Overlaying the range maps for these species (or areas of conservation priority) can provide a general guide to how species are potentially distributed within the assessment area. It is important that local data sets are included within the review process if available. Not only will these contain information about additional species included in regional or global data sets to date, but in many cases, they will have more specific data on the sites where priority species have been recorded. Also, it is important to note that wherever possible any historical data on land-use change (especially where biodiversity distribution is discussed) will be important for planning restoration work.

An Abyssinian Slaty-flycatcher (*Melaenornis chocolatinus*) perches with some lichen in the Suba Forest in Oromia, Ethiopia. Photo courtesy of Craig Beatty/IUCN.

Are there geographic areas that should be prioritised for restoration because this activity will be of clear local benefit to both people and nature?

While reviewing the potential areas in a landscape for restoration activities, there will be a range of options for initiating FLR work. Areas of former native vegetation that are now heavily degraded and under little current use, are clearly sites that would generally benefit from FLR interventions for both people and nature. Identifying degraded land close to existing areas of native vegetation is a good first step towards more specific planning of FLR activities that benefit biodiversity or allow for natural regeneration strategies of adjacent degraded land. The restoration of these lands in principle should allow for range expansion of desirable species that are currently confined to the remnant areas of habitat (though recolonisation of restoration sites for some taxa can be a slow process), while also providing the wider ecosystem services for people dependent on the landscape under restoration.

The transition zone between agricultural land, buffer forest plantations and native juniper forest in Oromia, Ethiopia. Photo courtesy of Craig Beatty/IUCN

How can species native to the landscape, especially plants, be included within the restoration process and what is the current availability of native plants? Are plant nurseries available or is there an opportunity to develop native plant nurseries as part of the restoration process?

In many, but not all FLR interventions, it may be best to focus restoration efforts on native plant species that are adapted to the local environment for greatest return on both biodiversity conservation and expansion of ecosystem service benefits to people. Local forestry officials, extension workers and the lead project ecologist may provide support on plant species selection which may focus on mixed areas of native species, rather than native monoculture plantations and intercropping with native tree species in agroforestry systems or windbreaks, for example. Sourcing native species for restoration may present its own challenges, as access to native saplings and seedlings may not be immediately possible from local nurseries. This issue needs to be considered early in the overall project planning process, especially as there may be opportunities for local community employment through the development of plant nurseries to grow the native species required for FLR (a long-term commitment in many cases). If more immediate planting of an area is needed, exotic species may be used to stabilise degraded land while native plants are being grown, It may then be possible to either replace the exotic vegetation with native species as soon as possible in a relay approach or to integrate them into a successional plan (Tanveer, et al., 2017).

A Siamese Rosewood (*Dalbergia cochinchinensis*) nursery in Siem Reap, Cambodia. This state-run nursery provides seedlings to landowners and schools at no cost, and commercial purchase is available for those wishing to start a rosewood plantation. A high-value species, Siamese rosewood can provide a lucrative long-term forest landscape restoration investment.

How will the restoration of an area, biome or ecosystem impact the biodiversity value of areas, biomes and ecosystems (including freshwater and marine?) adjacent to, or linked/associated with, the landscape to be restored?

The restoration of habitat within a large project site will almost certainly have some ecological or environmental impacts on the biodiversity richness (or value) of surrounding areas, biomes or ecosystems. Within terrestrial systems, an immediate impact will be the reestablishment or expansion of a habitat type that was either formerly lost to the area, or much reduced, often resulting from earlier pressure by people for land or resources. While this may be desirable from the view of restoring biodiversity (as summarised throughout these guidelines) it is important that care is taken to survey habitats at the project location before any restoration work begins. Without good, well-planned surveys of the landscape, there is the possibility that important local habitats, such as natural grasslands or wetlands could be damaged through inappropriate measures. Before a project begins, it is good practice to map out these areas and think carefully about the impacts that extensive planting or restoration work might have on these (such as changes to hydrological systems). In addition to the largely terrestrial impacts of restoration, there will be additional changes to local freshwater and marine systems, usually within the watershed of the restoration project. As noted, sometimes complicated changes to hydrological systems can result from changes to the surrounding vegetation—reduction of the run-off of water from land into freshwater lakes, streams and ultimately into marine systems are likely, as is a reduction in the sediment eroded from terrestrial habitats. In many cases this may provide a positive overall environmental impact for the associated hydrological system (e.g. reduced turbidity), but consideration of these prospective changes must be made during the planning stage.

Marabou stork (*Leptoptilos crumenifer*) and pied crows (Corvus albus) in Jinja, Uganda. Photo courtesy of Craig Beatty/IUCN.

Are there individual species (perhaps threatened or endemic species), species assemblages, or other conservation units that need special consideration and potential accommodation within the planning process?

The benefits of directly including biodiversity conservation information and stakeholders in the planning process far outweigh the costs if it is clear from the start that FLR is not primarily intended to be a mechanism for full ecological restoration. While FLR might not achieve all the goals of complete ecological restoration, those involved with biodiversity conservation and FLR have a significant opportunity for cooperation in increasing ecological productivity and supporting livelihoods. For biodiversity professionals, FLR provides an opportunity to broadly improve the conditions of species and ecosystems and to reduce the threats and pressures to biodiversity at a scale of hundreds of millions of hectares worldwide. FLR practitioners can gain valuable knowledge about species and ecosystems in the target landscapes such that restoration actions can be assessed and planned within an ecosystem context—increasing the chances of landscape restoration success.

Both conservation and restoration have the potential to monitor and communicate the benefits of a biodiversity-integrated approach to FLR assessments. These can include reporting against international and national development targets and goals, but more importantly can realise the benefits that a biodiversity-informed approach to FLR can have for human well-being and livelihoods in the short and long term.

The Vietnamese Giant Snail (*Bertia cambojiensis*) is restricted to only a small area in southern Vietnam. Due to its large shell and rarity, it is under pressure from collection and declines in habitat extent and quality. Photo courtesy of Paul Pearce-Kelly.

Effectively communicating biodiversity

The identification and assessment of forest landscape restoration opportunities, interaction with relevant stakeholders, analysis of policies, and the analysis of spatial data and economic benefits of biodiversity in the previous section and in the ROAM handbook have hopefully led to a network of national and international biodiversity contacts and pertinent information on FLR and biodiversity. Additionally, spatial data and economic analysis should have created empirical data on the location and priority of biodiversity sites within the assessment area. When under restoration, these areas may help to alleviate the pressures and threats to biodiversity, increase overall biodiversity of the landscape to be restored, and help restore high value biodiversity areas that are currently degraded.

Although this work is complete for the time being, the results need to be clearly articulated and communicated both within the assessment team and to external audiences. Communication within the team ensures that the benefits to FLR through biodiversity considerations are explicitly included in the forest landscape restoration opportunities assessment and strategy. Communication outside the immediate assessment team ensures that the information collected or synthesised from the assessment process will be taken up in relevant policies and plans and mainstreamed in FLR implementation.

The assessment of biodiversity for forest landscape restoration assessments is one component of a much larger process. While biodiversity is considered at each stage, there are important milestones within the assessment process where biodiversity information can be most effectively communicated and/or integrated.

The identification of biodiversity benefits as a key component of any FLR assessment should be communicated at the beginning of each process. It may be that biodiversity conservation is not a primary objective of forest landscape restoration, and this may be for understandable and practical reasons. However, whether or not biodiversity and the support of productive ecosystems is a stated goal of forest landscape restoration, the underlying processes that make FLR successful are all rooted in the restoration of the biological and ecological processes that are carried out by the interaction among species in a landscape. Biodiversity is a component of any landscape restoration action and as much as the inclusion of specific biodiversity knowledge is important in the assessment process, the recognition of all actors of the primal dependence of FLR on biodiversity is a concept that must be communicated. The restoration of landscapes takes many paths for many different and often competing reasons —some of which would be impaired by an over-reliance on the integration of biodiversity specifics. For instance, the selection of agroforestry species may be severely restricted by what markets and growing conditions will tolerate and as such, the practicality of a biodiversity perspective to agroforestry species may be restricted.

When integrating biodiversity knowledge into the assessment process, the FLR practitioner should recognise when a discussion of biodiversity helps facilitate the process and when it detracts from the goals of FLR. In the case of agroforestry, while biodiversity may not always form a significant portion of agroforestry species choice, the implementation pathway for agroforestry restoration presents an appropriate entry point for a discussion of biodiversity. As a diverse strategy implemented at the landscape scale, the restoration of landscape biodiversity can help to support the success of agroforestry interventions and rather than focusing on species choice within the intervention, the restoration practitioner can additionally focus on where agroforestry interventions could interact with and/or support landscape biodiversity. Conversely, it may also be possible to assess how the restoration of ecological function in one area may support the delivery of ecosystem services in other areas.

During the process itself, biodiversity information and knowledge can be collected and communicated during the project's inception by including stakeholders that are interested in and concerned with biodiversity conservation and restoration. During the analysis portion of the landscape assessment, biodiversity information and data can be a starting point for policy and institutional analysis through a review of NBSAPs, international and national biodiversity data sources, and through the assessment of ecosystem services and connections between species and economic markets. The analysis phase of the assessment process is an opportune time to ensure the role biodiversity plays in achieving FLR objectives is clear and supported by existing data, science and policy. Once biodiversity is explicitly included in the analysis, it becomes much easier to communicate the results of an FLR assessment in terms of biodiversity gains and benefits.

The digestible communication of biodiversity knowledge generated from the landscape assessment process is paramount. This means that the information on the importance of biodiversity is not presented as a factor that can be considered or not—it is the ultimate condition upon which restoration will either succeed or fail. Restoration interventions, especially those in species poor productive landscapes that fail to support biodiversity and genetic diversity in the restoration of ecosystem productivity, risk failure because interventions may not be well-suited to prevailing ecologies and landscape processes (Lindenmayer et al. 2002, Reynolds et al. 2012).

This is not to say that maps and analysis of where biodiversity is especially important to consider are not valuable components of the FLR assessment process in and of themselves. Data products, knowledge generated and institutional connections between biodiversity and FLR processes help to mainstream both biodiversity and forest landscape restoration. The result from the communication of this biodiversity information within the assessment team and to broader audiences will be an acknowledgement of the primal role biodiversity plays in the long-term success of forest landscape restoration and the deeper integration of biodiversity knowledge, tools and capacities into an already impactful and meaningful process.

A thick-billed raven (*Corvus crassirostris*) in the Simien Mountains, Ethiopia. Photo courtesy of Rod Waddington

Conclusion

In practice, FLR is largely concerned with interventions that occur in human-dominated landscapes under cultivation. This means that FLR leans heavily on restoration activities like agroforestry, conservation agriculture and other agriculturally-based restoration methods to increase soil fertility and food production. However, the integration of native and novel biodiversity into these interventions is a unique and important entry point for a more substantial consideration of ecological processes in in FLR.

Forest Landscape Restoration continues to emerge as a key tool for improving local to global environmental conditions for both people and nature. It is expected that in many instances, an expanded consideration and careful use of biodiversity data in the FLR process will lead to the desired socio-economic and environmental 'win-win' objectives of modern landscape restoration and conservation activities.

Successful forest landscape restoration that integrates biodiversity considerations and benefits will be critical for restoring the ecological productivity of a landscape. These increases in ecological productivity are the product of healthy and sustainable landscape practices that support resilience and food productivity and sustain biodiversity. That forest landscape restoration is not outwardly focused on the conservation and restoration of biodiversity is, perhaps, one of its strengths; issues of species and biodiversity can often fail to find traction in the decision-making processes surrounding landscape planning, design and financing especially when conservation may be at odds with economic or industrial pursuits.

Biodiversity is inherent in the FLR approach—increases in ecological productivity cannot be sustainably achieved without gains in species diversity and the landscape benefits that are provided by this diversity. However, the majority of FLR interventions, since they occur in degraded and deforested land, are focused on arresting and reversing degradation in the landscape that are currently under cultivation or use by people. The land area throughout the world available for restoration on deforested or degraded agricultural land is enormous and is without any doubt an area larger than the practical land area available for traditional ecological restoration.

This guidance document has outlined the importance of considering genes, species and ecosystems in FLR assessments and in the resulting implementation strategies. It has also provided a wealth of resources for connecting to biodiversity information and biodiversity professionals and outlined some of the foresight that is critical for surveying and monitoring the effect of FLR on biodiversity and ecosystem services. Also key is the detailed description of biodiversity information sources that are both explicit in their connection to biodiversity (e.g. *The IUCN Red List of Threatened Species* and the *IUCN Red List of Threatened Ecosystems*) and the implicit connections in economic development policies. Suggested procedures for mapping biodiversity priorities within an assessment process are articulated here along with sources of spatial and non-spatial biodiversity data to support this mapping process. Finally, these guidelines provide suggestions and resources for FLR practitioners on how the FLR assessment process can include biodiversity safeguard procedures to help ensure that FLR does not inadvertently drive reductions in biodiversity through interventions that may be beneficial for biodiversity and ecosystem services in some situations, but detrimental to biodiversity in others.

These guidelines are intended to facilitate a broader integration of biodiversity knowledge and consideration in the FLR assessment process. Increases in landscape biodiversity remain a critical outcome of successful forest landscape restoration, but large gains in biodiversity and species conservation are not the *raison d'être* of forest landscape restoration. Gains to biodiversity should be incremental and supportive of people within landscapes. This is not to negate the incredible opportunities for large biodiversity and ecosystem restoration gains that may result from FLR activities, but these objectives should be tempered by an inter-sectoral approach that iteratively restores functioning ecosystems for functional landscapes.

As one of the largest and most widely-respected authorities on biodiversity and ecosystems, IUCN recognises the potential impacts of large-scale landscape changes on biodiversity and ecosystems. Forest landscape restoration has enormous potential to support human livelihoods in tandem with increasing biodiversity, ecosystem services and ecological productivity in degraded landscapes. Forest landscape restoration should not occur in areas that are not degraded and this should preclude areas of conservation priority or concern. Where there is ambiguity in the definitions or extent of degradation the onus lies on restoration practitioners to utilise these guidelines to ensure that native ecosystems are not improperly classified as 'degraded' and to not only support FLR approaches that cause no harm to native biodiversity, but to use diversified restoration approaches to augment biodiversity, especially in areas important for threatened species and ecosystems.

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Annex 1 Elements of an NBSAP

National Biodiversity strategies and action plans are replete with useful information for forest landscape restoration opportunities assessments and contain much of the information required to ensure that FLR is aligned well with national commitments under the Convention on Biological Diversity. Importantly, NBSAPs have a consistent structure that allows this information to be found relatively easily and most countries have used this structure to define representative national targets that help achieve the biodiversity objectives set out by the CBD.

Within these NBSAPs there are typically audits of the status and trend of national biodiversity. These are generally geared towards the conservation status of species of concern (as defined by the IUCN Red List of Threatened Species or National Red Lists) and trends in the geographic coverage of protected areas. Descriptions of these biodiversity metrics form the baselines against which biodiversity conservation strategies are measured and inform much of the reporting countries submit to the CBD.

Additionally, NBSAPs contain a significant amount of reporting on national legislation for biodiversity. In many cases this legislation pertains to the establishment and maintenance of protected areas and wildlife conservation activities, but increasingly includes broader legislative applications of biodiversity into sectors where biodiversity may not be a primary objective, but that depend upon biodiversity (e.g. agriculture).

Combined with information on strategies to fund the implementation of these action plans, NBSAPs provide the information that is intended to translate assessments of biodiversity at a national scale into measurable and actionable strategies for the conservation of biodiversity in support of the mission of the CBD.

Biodiversity Indicators Partnership
https://www.bipindicators.net/

CBD NBSAPs
https://www.cbd.int/nbsap/

Status and trends of national biodiversity	NBSAP issues, gaps and revisions	Establishing and monitoring measurable national goals and targets
Legislative measures	NBSAP management	Action plans
Funding strategies	Communication, education and public awareness	Public policy development

Adapted from: *The Biodiversity Planning Process: How to Prepare and Update a National Biodiversity Strategy and Action Plan* (CBD 2007)

Indicative outline of an NBSAP

I. INTRODUCTION

1. Values of biodiversity and ecosystem services in the country and their contribution to human well-being
2. Causes and consequences of biodiversity loss
3. Constitutional, legal and institutional framework
4. Lessons learnt from the earlier NBSAP(s) and the process of developing the updated NBSAP

II. NATIONAL BIODIVERSITY STRATEGY: PRINCIPLES, PRIORITIES AND TARGETS

5. Long-term vision
6. Principles governing the strategy
7. Main goals or priority areas
8. National targets

III. NATIONAL ACTION PLAN

9. National actions to achieve the strategy, with milestones
10. Application of the NBSAP to sub-national entities
11. Sectoral action

IV. IMPLEMENTATION PLANS

12. Plan for capacity development for NBSAP implementation, including a technology needs assessment
13. Communication and outreach strategy for the NBSAP
14. Plan for resource mobilisation for NBSAP implementation
15. Institutional, monitoring and reporting
16. National coordination structures
17. Clearing house mechanism

V. MONITORING and EVALUATION

*adapted from CBD *NBSAP* Training package Version 2.1

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