Explore sustainable European futures

WP4 – Biodiversity module documentation

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Short Description

This report describes

- *the sources and hypotheses used to build the historical database;*
- *The calculation logic and scope of the module;*
- *The lever choices and ambition levels.*

Quality check

Name of reviewer	Date
Michel Cornet	10/05/2019 (on document structure only)
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Statement of originality:
This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

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List of abbreviations

Aichi Targets – The biodiversity targets set by the CBD members for 2020 at the CBD meeting in Aichi. These are the current global targets for biodiversity conservation; proposed 2030, and potential 2050 targets are now included

CBD – Convention on Biological Diversity

ESA-CCI – European Space Agency Climate Change Initiative

IUCN – International Union for the Conservation of Nature

IPCC – Intergovernmental Panel on Climate Change

WDPA – World Database on Protected Areas

1 Introduction

In any calculator of emissions that include land-use the potential for maintenance of carbon sinks, the development of new carbon sources, and the potential for developing new sinks, and thus negative emissions, is critical. In EuCalc we directly look at the intersection between potential biodiversity conservation and protected areas, following the policy targets of the Convention on Biological Diversity (CBD). Protected areas can play a major role in the preservation of biodiversity, and the proper siting of new protected areas, taking into account natural habitats and potential climate change impacts on biodiversity, can play a major role in either protecting carbon sinks, or the development of new sinks through reforestation/afforestation in restoration efforts. At the same time, proper management of protected areas to minimize disturbances and degradation is crucial to achieve the levels of mitigation expressed in the calculator.

While efforts to decarbonize the other sectors will have multiple benefits to biodiversity, either through creating new habitats (e.g., green roofs), reducing pollution impacts, or reducing levels of warming, these efforts will largely be unquantifiable. The biodiversity part of the overall land-use work package is designed from the point of view of being quantifiable, not only in terms of lands set aside for conservation but also in terms of negative (for the most part) emissions. The need to quantitatively link biodiversity and emissions limits the options as to how this can be approached to those used here. Qualitatively, every module and every lever setting could be assessed for its potential risk to biodiversity and many of the other UN sustainable development goals (SDGs) as well.

2 Trends and evolution of biodiversity in Europe

The long-term decline of global terrestrial biodiversity is well established. Land-use changes are the main driver behind increasing rates of species loss but the situation has been further exacerbated by climate change. Of 1886 species in Central and Western Europe around 13% were classified as threatened in 2015 and 0.2% already considered extinct (IPBES, 2018).

To counteract further biodiversity declines, the EU committed to an ambitious conservation strategy, aiming to halt biodiversity loss by 2020. Part of this strategy was to fulfill Aichi Target 11, which requires member states to cover at least 17% of their terrestrial extent (CBD, 2010). Additionally, member states of the EU are subject to the EU Habitats Directive (European Council Directive 92/43/EEC; The Council of the European Communities, 1992) and the Birds Directive (Directive 2009/147/EC; European Parliament, 2010. These directives require the member states to establish designated areas for biodiversity protection to form the Natura 2000 network - the backbone of the EU's long-term conservation strategy.

Since the EU Habitats Directive was established in 1992 the network of conservation areas has continuously expanded. Covering roughly 10.7% of the terrestrial extent in 1992 it reached 25% coverage in 2015 (Figure 1), suggesting that the EU already reached Aichi Target 11 (IPBES, 2018). However, coverage within member states varies widely and ranges from 6% to 43% (numbers calculated from UNEP-WCMC and IUCN, 2018). There is thus further need for expansion to reach the target on a per member base. Furthermore, many of these protected areas are not being managed for biodiversity. For example, many protected areas still have agriculture, and even villages, embedded within them. Additionally, the areas are not in 'ideal' condition (see below) and this limits their usefulness as carbon sinks and for biodiversity benefits.

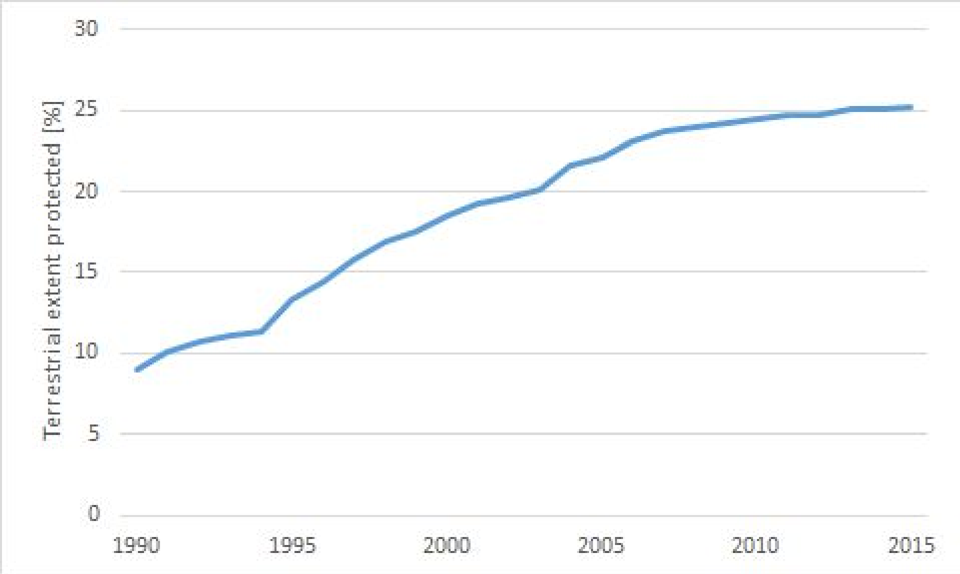

Figure 1. Terrestrial extent of EU28 and Switzerland designated as protected area (Data source: UNEP-WCMC and IUCN, 2018)

The protection of areas for biodiversity has benefits beyond the pure conservation of species. Managing areas for conservation requires the upkeep of natural habitat and even restoration of degraded land. It provides society with nature for recreation and tourism but also actively contributes to the reduction of GHG emissions (IPBES, 2018). Expanding the network of protected areas nearly tripled the sink in GHG emissions between 1990 and 2015 (Figure 2). The areas thus contribute significantly to the EU's long-term goal to cut GHG emissions by 80-95% of its levels in 1990 by 2050. However, note that there has been a levelling off of this benefit in recent years.

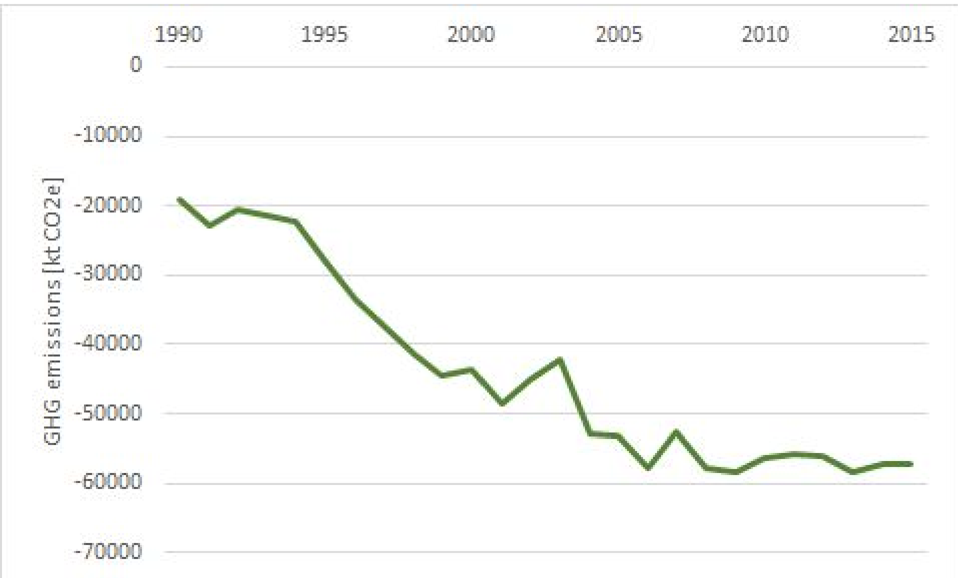

Figure 2. Total GHG emissions from protected areas in EU28 and Switzerland (Calculated based on data from UNEP-WCMC and IUCN, 2018 and UNFCCC, 2019)

The future of European biodiversity depends on the EU's ambitions to halt biodiversity loss and to drastically reduce GHG emissions. Commiting to the CBD's recent potential ambitions for increased biodiversity protection in 2050 would require member states to further invest into the upkeep and expansion of their protected area network but could indeed slow biodiversity loss down (IBPES, 2018). However, only the drastic reduction of GHG emissions will ultimately reduce pressures species are expected to face from climate change in the decades to come.

3 Questions addressed by the module

This module is slightly different from the other modules in that it sets constraints on how much land is available for other uses and directly quantifies biodiversity benefits tied to international policy goals. The question to be addressed is whether increasing biodiversity conservation allows for the development of greater amounts of negative emissions - making it a win-win scenario in the EU.

Table 1. Main questions addressed in the biodiversity module

Theme	Questions		Ambition[1]	Progress
What are the types of impacts we want to take into account in the model?	• Products, materials & resources	• Demand for land for biodiversity conservation	Yes	Done
		• Conflict with competing land uses	Yes	Done
	• Energy	• Limitation of land available for bioenergy; conflicts between biodiversity targets and energy production	Yes	Done
	• Emissions	• Quantifiable net sink saved	Yes	Done
		• Quantifiable net sink increase with restoration	Yes	Done
		• Quantifiable development of carbon source with warming induced changes to vegetation (IPCC Tier 1)	Yes	Ongoing
	• Economy	• Not safely monetizable[2]	No	Not applicable
	• Other	• Natural Capital Risk Register could be developed as a tab	No	Not done
What is the impact of existing solutions to decarbonize the sector?	Sector in EU currently not a carbon source but is a net sink, contributing to negative emissions with increased sink size		-	-
What is the impact of potential breakthrough (technologies or societal) ?	Societal demand to increase preservation of biodiversity ala Paris 1.5 could lead to push for major land set-aside for biodiversity (captured in Ambition Level 4)		Yes	Done
What are the impacts of the sector on the others?	Land sparing for biodiversity could impact land available for food, bioenergy (energy), and timber (buildings).		Yes	Done
What are the impacts of other sectors on this one?	Negative – increased demand for water consumption and land Positive – Efforts to decarbonize other sectors (e.g., green buildings) will have positive but unquantifiable biodiversity effects. Decarbonisation to meet emission targets will benefit biodiversity.		Yes	Done

[1] Does this module ambition to answer that question?

[2] Could be dealt with by Natural Captital Risk

4 Calculation logic and scope of module

4.1 Overall logic

The logic of the biodiversity module is based solely on land conservation/restoration as the target for biodiversity conservation. This is one of the approaches being taken in the CBD. It focuses on avoiding carbon release and/or increasing negative emissions as a quantifiable (by GHG negative emissions) measure of potential benefits generated by biodiversity conservation. Thus, it approaches biodiversity conservation solely from a habitat preservation perspective, as this is the only quantifiable way biodiversity as a whole can be linked to emissions (the goal of EUCalc). Impacts to biodiversity, owing to success or failure of different mitigation pathways is shown in The Pathway Explorer (as one of the global impact metrics). Secondarily, risk to carbon sinks caused by warming and land-use induced impacts on vegetation is considered as an offset to gains taken by land sparing. Biodiversity may very well benefit directly from other lever settings in other modules (e.g., green roofs, largely not quantifiable) or indirectly through reduced levels of warming (quantifiable, seen in The Pathway Explorer). Furthermore, the decisions taken in the biodiversity lever potentially limits other modules (e.g., land-use for food production). This will also have GHG emission ramifications as blocking land-use changes from agriculture would reduce those emissions within Europe but could potentially export them to other countries (leakage).

This calculation is based on historical data for land use (sources for historical data are described in D2.1), and on projections of impacts on biodiversity at various levels of warming. For the lever levels of ambition the principle biodiversity measure is plant climate refugia at 2°C. A refugia is defined as area remaining climatically suitable for at least 75% of the species modelled (Warren et al. 2018b) for at least half of the climate models (11 out of 21).

The main outputs of the biodiversity module are:

- The direct negative GHG emissions (in most countries) from land conservation for biodiversity
- Amount of land either needing to be protected and/or restored in order to meet the targets and the negative emissions tied to this.

The calculation logic adopted here requires the following data to estimate land-use and emissions:

1. the percent of each country in different land cover classes between 1992 and 2015, with a focus on 2015 for all future projections; land cover aggregated into natural habitat (including pasture), agriculture, and settlements from the ESA-CCI database;
2. the percent of each country in different protected area classification (IUCN) from the WDPA;

3. the percent of each country identified as a refugia for plants with 2°C warming
4. the percent of land use emissions for each country for agriculture or non-agriculture sectors;
5. the percent of protected areas in each country (by type) that are natural habitats (combining 1 and 2);
6. the percent of refugia area in each country within protected areas containing natural habitats (combine 1,2 and 3)
7. emissions (negative emissions or sink) accruing with preservation / restoration of land for biodiversity

The biodiversity module calculates the percentages of land available for other uses, and the emissions from the land protected for biodiversity (mostly negative).

The land use percentages will be fed to the rest of the land use modules in WP4 and, if applicable, to the timber, transboundary and import modules in other WP.

Estimates of possible sink/source transitions will be calculated for each country and this will feed directly into the emissions from EUCalc and The Pathway Explorer.

4.2 Scope definition

The biodiversity module will enable the user to assess the impact of protecting countries' natural capital, specifically its biodiversity, through land conservation. We do not model the direct extent that biodiversity, in terms of species populations. The model makes the assumption that setting aside more land, emphasizing natural habitats, is beneficial to biodiversity, as followed by the CBD (CBD, 2010). We go further than the numbers in the CBD in terms of percentages by emphasizing preservation of natural habitats (as defined by the ESA CCI satellite data) and, for some levers, by whether areas are thought to be refugia to climate change with 2°C of warming.

Figure 1 presents the scope of the biodiversity module in terms of types and modes of land considered in the module.

Types of land:
- Agricultural
- Natural habitat
- Forest (managed for resource use)

Modes :
- Protected
- Unprotected
- Refugia
- Refugia and protected

Figure 1. Scope definition of the biodiversity module

4.3 Interactions with other modules

The biodiversity module does not receive input from any other module but it provides data to the land-use module, the climate emissions module and the pathway explorer.

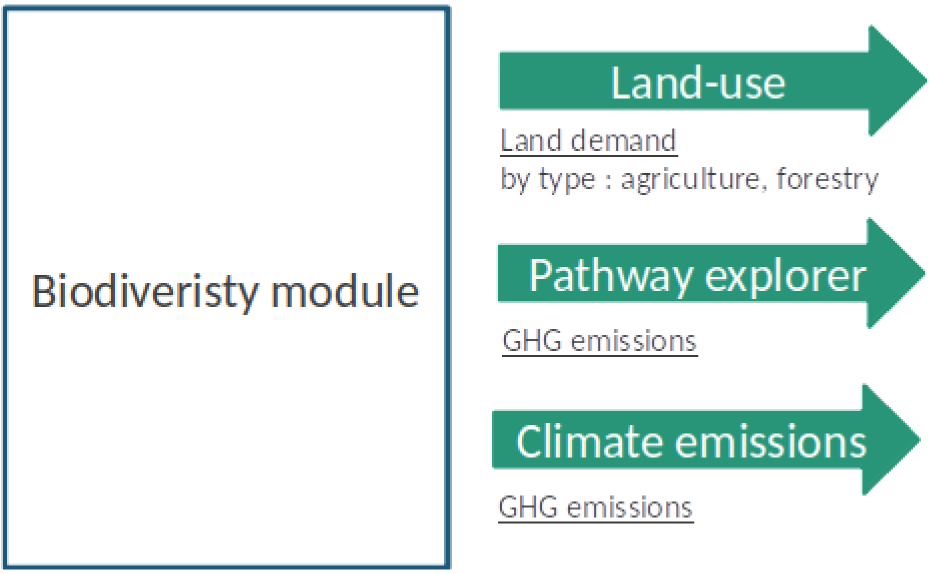

Figure 2. General calculation logic for biodiversity module

4.3.1 Inputs for the biodiversity module

No other module provides inputs into the biodiversity module. Starting levels come from direct data input (see 7 Historical database).

4.3.2 Outputs from the biodiversity module

The following section details the outputs created by the biodiversity module.

4.3.2.1 Land-use (WP4)

The biodiversity module generates a demand for the restoration of agricultural lands and forest lands to 'natural' states, expressed in hectares.

Table 2. Interface between biodiversity and agriculture

Land type	Short description	Status
Agriculture lands	Restoration of lands associated with crop production for human or livestock consumption, grassland areas and feedstock production for bioenergy.	Done
Forest lands	Restoration of lands associated with supply of wood products for bioenergy and biomaterial	Done

Principle interaction with other modules is through the overarching land use module and agriculture (e.g. timber). Other interactions and positive biodiversity benefits of other lever settings could potentially be captured via a proposed/potential dashboard light system tied to natural capital benefit/risk. For example, green roofs benefit biodiversity but not in ways that are easily measurable or tied back to emissions.

If the climate module lever is set at 1 or 2 (3-4°C warming) then some of the areas within the EU may shift from net sinks to net sources and this needs to be captured either in the biodiversity or land use module. Discussions are ongoing.

4.3.2.2 Climate Emissions (WP1)

To reflect the net sink capacity of protected areas, the biodiversity module provides GHG emissions associated with the protected natural habitat. Values are provided for CO_2, CH_4 and N_2O.

4.3.2.3 Pathway Explorer

The biodiversity module provides GHG emissions associated with the protection of natural habitat. Values are provided for CO_2, CH_4 and N_2O.

Table 3. List of inputs from and outputs to other modules

LEVERS	OUTPUT		
Naming convention	0.2 Pathway explorer	1.4 Climate Emissions	4.1 Land-use
lever_land-prioritisation	Years	Years	Years
lever_biodiversity	bdy_emissions-CH4[Mt]	bdy_emissions-CO2[Mt]	bdy_frozen-land_agriculture[ha]
	bdy_emissions-CH4[MtCO2e]	bdy_emissions-CH4[Mt]	bdy_frozen-land_forest[ha]
	bdy_emissions-CO2[Mt]	bdy_emissions-N2O[Mt]	Country
	bdy_emissions-N2O[Mt]	Country	
	bdy_emissions-N2O[MtCO2e]		
	bdy_emissions-CO2e[Mt]		
	Country		

4.4 Detailed calculation tree

The extension and restoration of protected land on an inter-year scale results in a technical bottleneck hampering the development of a fully integrated biodiversity module. At the current stage, the land requirements for each lever setting are thus pre-calculated outside of the KNIME module, stored in the general database and accessed on runtime. For completeness, this section provides details about all the calculations performed.

4.4.1 Land demand

Land demand depends on the protection target chosen. For each country we determine what percentage is 'protected' as specified by the WDPA (which includes Natura 2000 sites, SSIs, and Birds and Habitats Directive areas). Within each of these areas we determine what percentage is natural and what percentage is agriculture and urban. For our analyses we only consider natural habitats as being of high biodiversity value. For some levers we also consider whether areas are refugia (i.e., remain climatically suitable for >75% of the plant species modelled (out of 80,000 potential species) for more than half of the climate models used (Warren et al 2018a,b). A simplified overview over this procedure is presented in Figure 3.

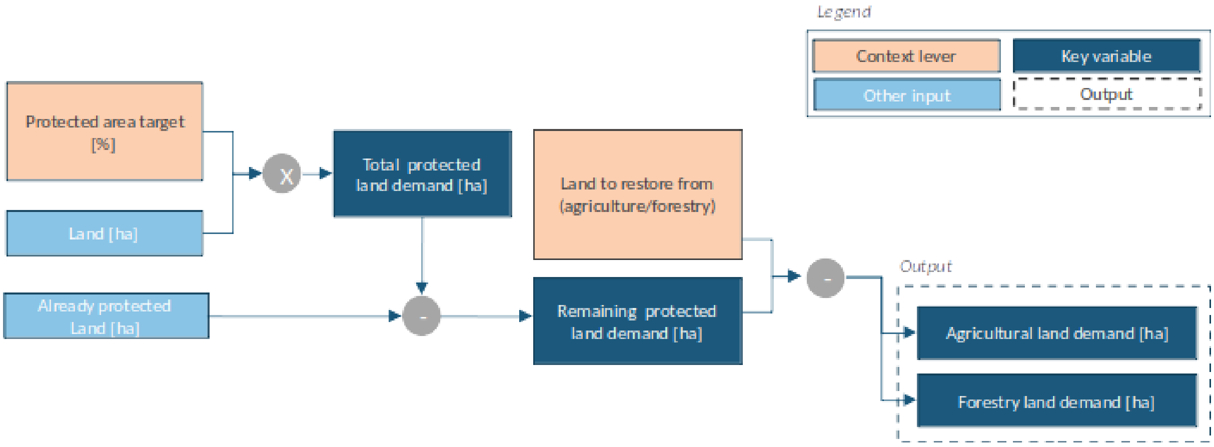

Figure 3. Simplified calculation tree for land demand within the biodiversity module

For the lever ambitions if the land required to meet the protection expansion target exceeds the amount of natural land within the boundaries of existing protected areas the previous year, then we first target restoration of agriculture lands within the existing protected area boundaries. If the appropriate amount of land is not available, the lands from outside these boundaries has to be reallocated and restored. Depending on user settings, the restoration occurs firstly either within agricultural land or within previously unprotected natural land. In cases where the first level of restoration is inadequate to reach the protection target, restoration will occur within any unprotected area until the demand is met or no additional land is available (see Figure 4 for a schematic overview).

While theoretically possible, we do not consider the case in which protected areas are released (i.e., degazetted) or downgraded. The reason for this choice is that this practice is at odds with existing policies and previous behaviour, which favour the creation of a static network of protected areas. Instead, we keep the focus on the improvement of habitat and reduction of human pressure within protected areas, aided by further expansion of the existing network.

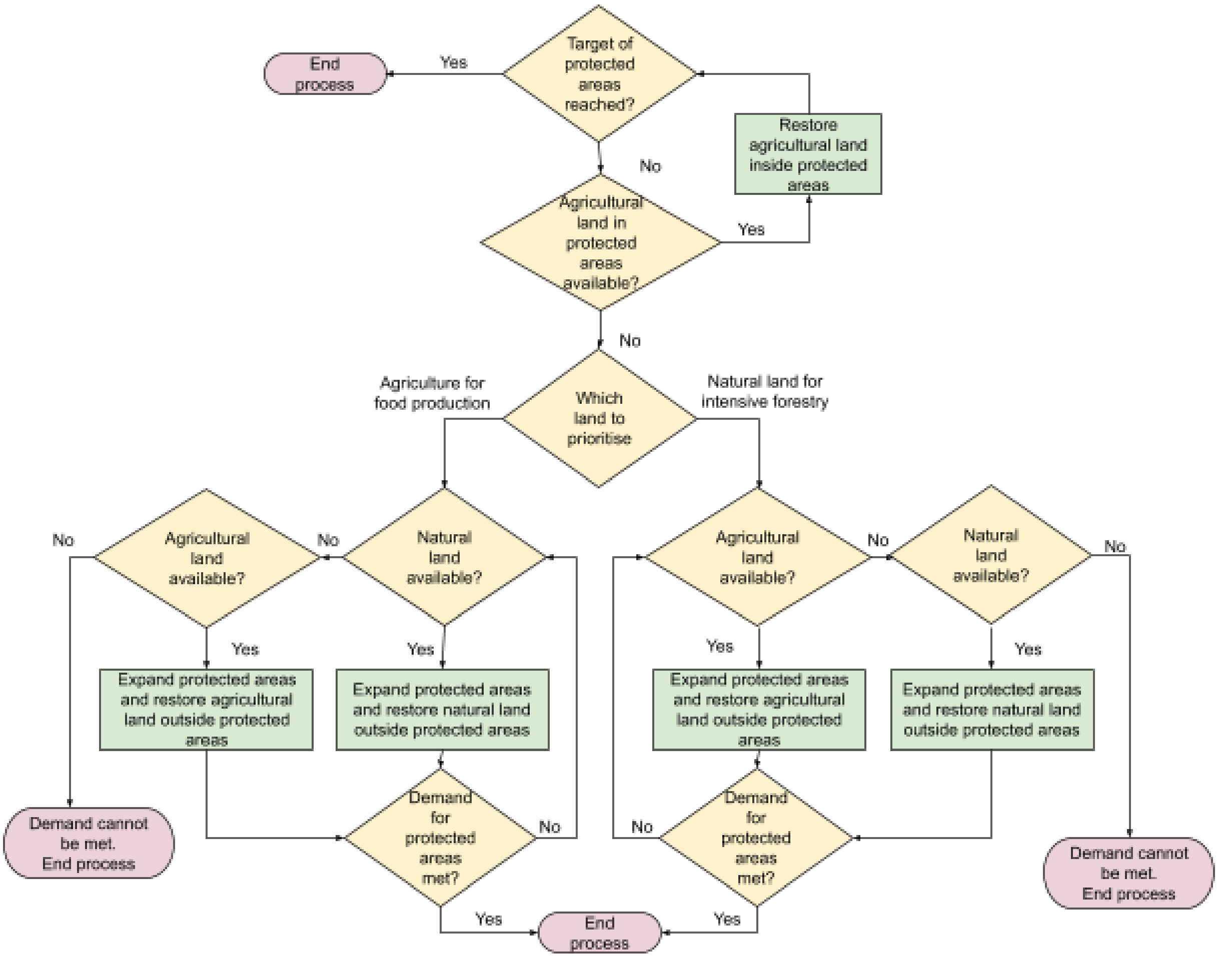

Figure 4. Flow of restoration and protected areas expansion within the biodiversity module

4.5 Calibration

The calibration process is introduced in the cross sectoral model documentation. However, the design of the biodiversity module, and the data sources taking into account future climate impacts, does not allow for calibration. The individual biodiversity models have all been calibrated (see Warren et al. 2018a, b) as part of their development process, but the models for the past/present are not time series but 'current'. Refugia is based on changes from this 'current'. The land use emissions come from the EU emission reports to the UNFCCC, and the land cover is based on a time series from satellite data (also internally calibrated). In this regard the biodiversity module differs from some of the other modules.

5 Description of levers and ambition levels

5.1 Lever list and description

The levers have been chosen to align with the current international targets set by the CBD, to which the EU is a signatory. The initial targets follow the targets for 2020 while the higher ambition levels follow proposals for targets for 2030 and 2050. The levers were discussed as part of the stakeholder process and constrained by those that could be quantified, especially via emissions. The second lever allows the user to specify what types of lands are set-aside or restored in order to meet biodiversity goals. This is a prioritization setting exercise as some individuals may be willing to risk food security for greater biodiversity protection (as other natural habitats, while not protected, would also provide a biodiversity benefit).

Table 4. Lever list of the biodiversity module.

#	Levers	Description	Level	Status
1	Protected area size [%]	Set the ambition in terms of protected area size. For example, the lever sets the ambition to reach a land-coverage of 30% by 2030.	1-4	Implemented
2	Land prioritisation	The land prioritisation levers prioritises the restoration of natural habitat from agricultural land (food production) or forestry (bio material)	A-B	Implemented

5.2 Lever hierarchy

The first lever to be applied is the overall protected area size to be achieved. This determines by how much the existing network of protected areas in each country has to be extended. The second lever for land prioritisation then determines which type of land (agricultural or forestry) is used for the expansion.

While there are no levers in other modules that have a direct impact on the land-demand for biodiversity, there is a clear impact of this lever on the land management within the land-use model. By sending land-demand for biodiversity protection to the land-use module we reduce land-availability for food and biomaterial production, thus imposing a hierarchy which prioritises biodiversity protection over production.

5.3 Definition of ambition levels

5.3.1 GHG focused levels: 1, 2, 3 and 4

The ambition levels 1-4 are expressing the range between a minimal (1) and maximum (4) ambition levels in terms of GHG emissions.

Table 5. General definition of ambitions levels

Level	Definition
1	**Past trends of changes** This level contains projections that are aligned and coherent with the historical trends in natural habitats and percent of land protected
2	**Ambitious change** This level is an intermediate scenario, more ambitious than level 1 but it is not reaching the full potential of the available solutions.
3	**Very ambitious change** This level is considered very ambitious but still realistic given the current technology evolutions and the best practices observed in some geographical areas.
4	**Transformational changes:** This level is considered as transformational and requires large additional efforts such as strong changes in the way society is organized, a very fast market uptake of deep measures, an extended deployment of infrastructures, major technological advances and breakthroughs (but without relying on new fundamental research), etc.

5.3.2 Disaggregation methodology per Member State

The ambition levels for protected area size are predefined by the CBD and the absolute ambitions are the same for each country (e.g. 17% of a country's area be protected by 2020). This results in some countries having to put more effort in extending their network of protected areas than other countries.

5.3.3 Curve shapes

According to values extracted from the WDPA (Protected Planet, 2017), the expansion of protected areas within each country often happens in stepwise increases. On average, however, the expansion appears to be relatively linear

(Figure 5). We thus decided to implement linear curves for the ambition levels. If the ambition target needs to be prior to 2050, the linear increase stops in the target year and is then held constant until 2050.

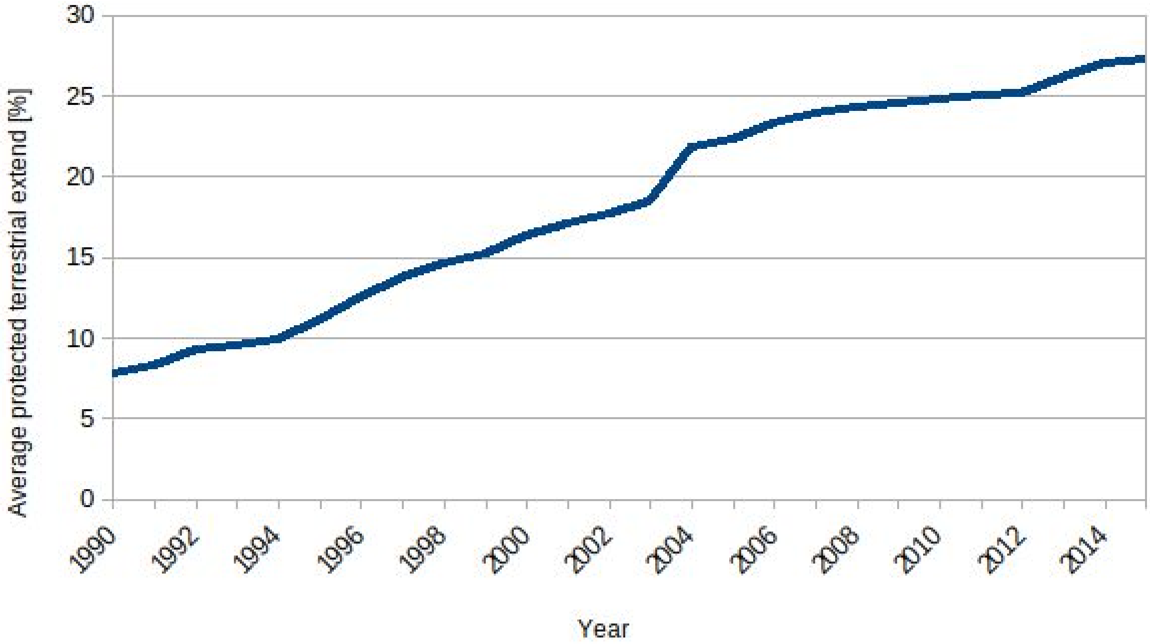

Figure 5. Average proportion of terrestrial extend protected per country in EU28 and Switzerland (based on WDPA

5.4 Policy description

The policies that drive the lever are those set by the CBD as representing the member states (and which the EU is a part of). Protected areas could follow either EU wide programs such as Natura 2000, SSIs, and lands set aside by the Birds and Habitats Directive or those of individual countries (state forests and parks) and even of civil society (private reserves, refuges such as those protected by Land Trusts, etc.)

5.5 Lever specification

5.5.1 Protected area size

5.5.1.1 Lever description

With this lever we want to quantify the emissions that might reasonably be expected to be tied to the conservation of biodiversity through habitat maintenance and restoration (primarily as a carbon sink). The lever assumes biodiversity refugia for plants with 2°C of warming (levels 2 and 3) and eventually will take into account how loss of plant species richness could lead to the development of carbon sources through climate-mediated habitat conversion. It is expressed as the percentage of a country protected for biodiversity and classified as being a natural habitat. These percentages are then converted to emissions/negative emissions. While the component of each lever relating to human pressure is not factored directly into the emission calculations the reduction/elimination of such pressures would be required in order to reach the mitigation benefits expressed for this sector in EuCALC.

5.5.1.2 Rationale for lever and level choices

Table 6. Ambitions levels for protected area

Level	Definition
1	Each country meets their CBD Aichi 2020 target 11 by 2020, with the definition of protected being restricted to those areas primarily focused on biodiversity conservation in areas with natural habitat. Human pressures on these protected areas reduced. For example, some National Parks contain settlements, and allow uses not entirely consistent with biodiversity conservation (the amount of non- 'natural' habitats in current protected areas can exceed 10% of the area). This means that for 2020, and continuing to 2050/2100, the biodiversity protection threshold is set at 17% of natural habitats using the European Space Agency Climate Change Initiative Land Cover Database (ESA-CCI) for 2015 for land cover definition. Maintain existing protected areas in good status and well managed. Reduce the level of human pressure on existing protected areas, which is substantial in many parts of the EU (see Figure 6).
2	Each country meets their Aichi targets in areas classified both as natural and also as a climate refugia for biodiversity (plants) at 2°C. This means that some countries will require substantially more protected areas than 17%, including restoration of habitats. Reduce human pressures on protected areas by 50%. Values for climate refugia based on data from Warren et al. (2018 a,b).
3	Each country meets the proposed 2030 targets (Plan for Nature) for countries protecting 30% of their land surface for biodiversity. As the goal of the target is biodiversity conservation, then this is further modified by the 30% of areas identified as in being in natural condition (including pastures) in 2015, and that they also be plant refugia under 2°C warming (where possible). In many EU countries this will require restoration of some percentage of agricultural habitat. This will potentially reduce crop yields but will increase negative emissions. This potentially increases the likelihood of leakage in cases where the rest of the world does not follow the EU in mitigation efforts
4	Highest biodiversity protection ambition following the guidelines of half for nature and the ambitious proposed potential CBD 2050 targets. In this level, 50% of each country is set aside for nature, drawing first from natural habitats, then looking at level of restoration necessary in agricultural habitats (helping meet CBD Aichi target 15). Priority for restoration given to plant refugia at 2°C. Human pressure on existing protected areas reduced by 75%. This may lead to 'leakage' in the food and timber production sectors by requiring greater imports of food or timber to offset lands lost within the EU for these sectors. Many countries will not have 50% of their land identified as potential plant refugia at 2°C, and this is the reason it is identified only as a possible goal for prioritization of restoration.

5.5.2 Land prioritisation

5.5.2.1 Lever description

In some instances, meeting the habitat conservation goals of the levers will require additional, currently 'unprotected' land. In these cases, a sub-lever gives the user the choice of what type of land they want to use for habitat conservation.

5.5.2.2 Rationale for lever and level choices

Setting A gives the priority to protecting natural areas not currently part of the WDPA. In many cases, these would likely be forested areas and this would mean they would no longer be available for intensive forestry, but potentially could be used for sustainable forestry with a biodiversity priority. Setting B prioritizes restoring land currently used for food production (identified in remote sensing images as agriculture). In all cases the initial priority for meeting goals comes from the restoration of agricultural lands currently WITHIN protected area boundaries.

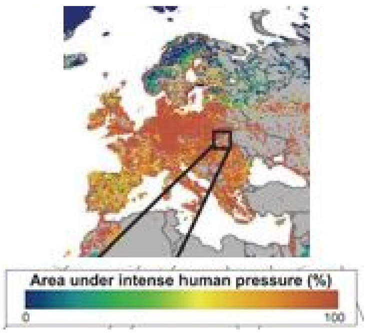

Figure 6. Proportion of protected areas within a country under human pressure in Europe (modified from Fig 1 in Jones et al. (2018)). Most of the protected areas in the EU fall within this category. Only by reducing these pressures could the full mitigation and biodiversity benefits be met.

A and B were chosen as ambitions for the sub-lever as they do not follow the 1-4 ambition level prioritization of EUCalc, they are an arbitrary choice. There are emission ramifications in the choice as selecting setting B, restoration of agricultural lands, would lead to creating of more sinks, so more negative emissions. On the flip side, it might require agriculture intensification elsewhere thus offsetting emission gains.

6 Description of constant or static parameters

6.1 Constants list

Constants refer to parameters that are independent of year and country. There are no parameters within the biodiversity module that fall into this category.

6.2 Static parameters

Static parameters are parameters which vary by year but are not linked to a lever. There are no parameters within the biodiversity module that fall into this category.

7 Historical database

Table 7. Database for biodiversity module

Dataset	Description	Main sources	Hypotheses to fill gaps	Data quality check
Protected area [%]	Proportion of terrestrial extend of a country protected	World database of protected areas (UNEP-WCMC and IUCN, 2018)	not applicable	Official data source; considered reliable.
Land cover [%]	Type of land (e.g. agricultural, urban)	ESA CCI-LC[3] (ESA, 2017)	not applicable	Official data source based on satellite images; considered reliable.
Protected area under human pressure [%]	Human footprint in protected areas	Jones et al. (2018)	not applicable	Peer reviewed article; considered reliable

[3] http://maps.elie.ucl.ac.be/CCI/viewer/download.php

8 References

CBD. 2010. Decision Adopted by the Conference of the Parties to the Convention on Biological Diversity at its Tenth Meeting. X/2. The Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets. Secretariat of the Convention on Biological Diversity.

Jones, Kendall R., Oscar Venter, Richard A. Fuller, James R. Allan, Sean L. Maxwell, Pablo Jose Negret, and James E. M. Watson. 2018. One-Third of Global Protected Land Is under Intense Human Pressure. Science 360 (6390): 788.

ESA. 2017. European Space Agency Land Cover CCI Product User Guide Version 2.0. Technical Report.

European Parliament. 2010. Directive 2009/147/EC of the European Parliament and of the Council of November 2009 on the conservation of wild birds.

IPBES. 2018. The IPBES regional assessment report on biodiversity and ecosystem services for Europe and Central Asia (M. Rounsevell, M. Fischer, A. Torre-Marin Rando, & A. Mader, Eds.). Bonn, Germany: Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

The Council of the European Communities. 1992. Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.

UNEP-WCMC and IUCN. 2018. Protected Planet: The World Database on Protected Areas (WDPA) (version August 2018). Cambridge, UK: UNEP-WCMC and IUCN. www.protectedplanet.net

UNFCCC. 2019. United Nations Framework Convention on Climate Change GHG Data. https://unfccc.int/process-and-meetings/transparency-and-reporting/greenhouse-gas-data/ghg-data-unfccc/ghg-data-from-unfccc

Warren, R., J. Price, E. Graham, N. Forstenhaeusler, and J. VanDerWal. 2018a. The Projected Effect on Insects, Vertebrates, and Plants of Limiting Global Warming to 1.5°C Rather than 2°C. Science 360 (6390): 791.

Warren, R., J. Price, J. VanDerWal, S. Cornelius, and H. Sohl. 2018b. The Implications of the United Nations Paris Agreement on Climate Change for Globally Significant Biodiversity Areas. Climatic Change 147 (3): 395–409.