

# Description of EU-level approach for reporting indicator A.2 of the Global Biodiversity Framework

**Technical note prepared by the European Environment Agency (EEA) in support of the European Union's 7<sup>th</sup> National Report to the CBD on progress in the implementation of the Kunming-Montreal Global Biodiversity Framework**

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## 1. Introduction:

### 1.1 Overview of technical note

The Global Biodiversity Framework (GBF) indicator A.2 'Extent of natural ecosystems' measures the share of a country's or region's territory that is covered by natural and semi-natural ecosystems at a given point in time. In the GBF metadata, "natural ecosystems" are defined broadly to include both natural and semi-natural ecosystems, while "anthropogenic" ecosystems are those that are intensively modified by human activity such that a stable natural ecological state is unattainable without ongoing management. The CBD guidance proposes to develop the indicator based on ecosystem extent accounts, ideally based on the IUCN global ecosystem typology (GET). At its simplest level, the indicator can be expressed as the relative share of anthropogenic versus (semi-)natural ecosystem area in total national territory.

This technical note presents conceptual and methodological aspects related to the implementation of this indicator and describes the initial approach utilised for the calculation of the indicator at EU-27 level (developed in 2025). The note comprises the following chapters:

Chapter 1 gives an overview and introduces the indicator definition and EU-level policy context.

Chapter 2 presents conceptual and methodological aspects for defining the three ecosystem categories mentioned in the CBD guidance for indicator A.2.

Chapter 3 discusses potential methodological criteria for assigning the main European ecosystem types to the three Indicator A.2 categories.

Chapter 4 presents the current approach and initial results of the work undertaken by the EEA for calculating Indicator A2 at EU-27 level.

Chapter 5 presents short initial conclusions and an outlook on future work.

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These chapters are complemented by two annexes that present further technical detail. The overall aim for the note is to help develop a clear methodology for reporting on the share of natural and semi-natural ecosystems in the EU-27 area. It will also support the input by EU experts into a global Task Team on Compilation Guidelines for SEEA-related Biodiversity Indicators in the CBD Global Biodiversity Framework.

## 1.2 Extract of recommendations from CBD guidance document (CBD/SBSTTA/26/INF/14)

This section summarises key components of the CBD guidance document for developing the indicators established within the Kunming-Montreal Global Biodiversity Framework

The GBF indicator “A.2 Extent of natural ecosystems” (hereafter: A.2 indicator) is defined, at national level, as the extent of natural and semi-natural ecosystems as a proportion of total area of the country at a particular point in time, expressed as a percentage. The point in time is the closing date of the accounting period for which the ecosystem accounts were compiled. Trends over time will be evident from changes in the proportion of total area over successive accounting periods. The total surface area of a country includes land, inland water and, if applicable, territorial waters. For countries with marine territory, the indicator should be compiled ideally for the total surface area of the country, including territorial waters. However, it could be compiled only for land and inland water areas if data on the distribution of marine ecosystems are not yet available.

Natural ecosystems are defined as ecosystems “predominantly influenced by natural ecological processes, functions drivers, and composed of native/indigenous species, relative to historic baselines or reference states”. Semi-natural ecosystems are defined as ecosystems “with most of *their* processes and biodiversity intact, though altered by human activity in composition, balance or function relative to the natural state.”

As further discussed in Chapter 2, for the purposes of the indicator A.2 natural ecosystems are defined broadly to include natural and semi-natural ecosystems. On the other hand, intensively modified or anthropogenic ecosystems are defined as predominantly influenced by human activities where a stable natural ecological state is unattainable and future socio-economic interventions are required to maintain a new stable state. It should be emphasized that indicator A.2 is not intended to assess the ecological condition of natural ecosystems. Consequently, ecosystems do not need to be in a good ecological state to be classified as natural or semi-natural within the scope of this indicator.

For the purposes of this indicator, natural and anthropogenic ecosystems are meant to be identified based on the IUCN Global Ecosystem Typology (IUCN GET), which is a new global ecosystem classification, recently developed by a team of ecological experts under the guidance of IUCN. The documentation of the IUCN GET (Keith et.al 2020) contains detailed descriptive profiles for each of the 110 Ecosystem Functional Groups (EFGs), which can be found at <https://global-ecosystems.org/>.

98 of the 110 EFGs are considered to be natural or semi-natural and 12 are considered anthropogenic. The distinction between natural and anthropogenic ecosystem types is advised

to be made at level of EFGs rather than biomes, because some biomes include both semi-natural and anthropogenic ecosystem types. The anthropogenic EFGs are listed below.

List of the EFGs in the IUCN GET that are considered intensively modified or anthropogenic and thus excluded from “natural ecosystems” for Indicator A.2:

The biome *T7 Intensive land-use systems* includes the following ecosystem functional groups: T7.1 Annual croplands, T7.2 Sown pastures and fields, T7.3 Plantations, T7.4 Urban and industrial ecosystems

The biome *F3 Artificial fresh waters* includes the following anthropogenic EFGs: F3.1 Large reservoirs, F3.2 Constructed lacustrine wetlands, F3.3 Rice paddies, F3.4 Freshwater aquafarms, F3.5 Canals, ditches and drains

The biome *M4 Anthropogenic marine systems* includes the following EFGs: M4.1 Submerged artificial structures and M4.2 Marine aquafarms.

Lastly, the EFG MT3.1 Artificial shorelines is also considered anthropogenic.

### 1.3 Brief review of EU legal context

Within the EU legal framework, the following environmental directives appear particularly relevant in the context of Indicator A.2: the EU Habitats Directive (92/43/EEC) (hereafter: HD), the Marine Strategy Framework Directive (2008/56/EC) (hereafter: MSFD), and the Water Framework Directive (2000/60/EC) (hereafter: WFD).

The HD defines natural habitats as ‘terrestrial or aquatic areas distinguished by geographic, abiotic and biotic features, whether entirely natural or *semi-natural*.’ (Article 1(b)). The Directive does not establish any distinction between natural and semi-natural habitats, nor is such distinction expressed in other EU legal instruments. In this regard, The European Commission (2015) noted that the interpretation of semi-natural areas varies among EU Member States, reflecting differences in ecological conditions, management practices, and conservation priorities. Generally, the term refers to habitats that have experienced human influences while retaining significant natural features. Competent national authorities typically determine what qualifies as semi-natural, often considering biodiversity value, landscape features, and historical management. The Commission emphasised that such areas should reflect natural conditions and possess intrinsic conservation value that would be compromised by agricultural intensification (European Commission, 2015).

A related legal analysis highlights that terrestrial semi-natural habitats are distinguished for their dependence on human activities (Sobotta, 2018). Conservation strategies for semi-natural habitats must therefore balance protection with continued, sustainable management. For instance, hay meadows are protected precisely because of traditional mowing practices, which prevent succession into scrubland and maintain both habitat and species diversity. In the absence of active management, these habitats would deteriorate, losing their ecological and conservation value (Sobotta, 2018). The European concept of semi-natural habitat types that are kept in an early successional stage via regular human intervention in the form of extensive agricultural practices has been applied to the habitats listed in Annex I of the HD.

An academic review indicates that 61 of these EU priority habitats (about 30% of all listed) depend fully or partially on such practices (Halada et al., 2011). The relationship of traditional and/or extensive farming practices with habitat and species diversity is fully documented in a range of academic publications (e.g. Beaufoy et al., 1994; Maskell et al., 2019; Török et al., 2024; Hempel et al., 2025). A recent study by the European Environment Agency (EEA, 2026, forthcoming) presents a comprehensive analysis of extensive livestock systems in the European Union and their connection with the management of grazing-dependent Annex I habitats.

The terrestrial semi-natural habitats discussed above form, however, only one part of European ecosystems, which also comprises freshwater, marine, forest ecosystem types etc. These do not comprise semi-natural expressions in the sense discussed above. However, EU legislation comprises criteria and definitions that can inform an analysis of the degree of naturalness.

The Marine Strategy Framework Directive (MSFD) is a useful reference for marine ecosystem types. Analysis of the MSFD text helps to identify the following ecosystem features as particularly relevant for assessing degree of naturalness:

- Species & habitat integrity: characteristic species present
- Functional ecological processes maintained: food web interactions, recruitment / regeneration, nutrient cycles, substrate processes.
- Structural features: habitat complexity, physical structure (seabed, hydrodynamics)
- Thresholds of disturbance due to human activities as under MSFD, such as seabed integrity descriptor, noise etc.

The Water Framework Directive (WFD) is the main legal EU instrument governing freshwater habitats, including inland surface waters, transitional waters, coastal waters and groundwater. Its overarching objective is to ensure the enhanced protection and improvement of the aquatic environment, *inter alia*, through measures aimed at the progressive reduction of pollution, including discharges and emissions from human activities.

The Directive contains provisions relevant to assessing the degree of naturalness. Specifically, it establishes criteria for designating surface water bodies as artificial or heavily modified, linking these classifications to the objective of achieving good ecological status. Within the WFD framework, the designation of Artificial Water Bodies (AWB) and Heavily Modified Water Bodies (HMWB) could provide a useful extent-based proxy for identifying anthropogenic freshwater ecosystems. However, the biological and physico-chemical quality elements defined under the WFD primarily reflect ecological condition and pressures, rather than ecosystem naturalness as currently described in the CBD guidance for Indicator A.2.

As discussed in the next sections, it could be useful to add ecosystem condition parameters as an element in identifying (semi-)naturalness of at least selected ecosystem types. The WFD criteria for classifying ecological status, which may serve as indicators for the (semi-) naturalness of freshwater bodies. For rivers, these elements include:

- Biological elements: composition and abundance of aquatic flora, benthic invertebrate, and fish fauna (including age structure);

- Hydromorphological elements supporting biological elements: hydrological regime and river continuity;
- Chemical and physico-chemical elements: thermal and oxygenation conditions, salinity, acidification status, nutrient conditions, and specific pollutants.

For lakes, the quality elements comprise:

- Biological elements: phytoplankton composition, abundance and biomass, other aquatic flora, and benthic invertebrate fauna;
- Hydromorphological elements: depth variation, bed structure and substrate, and intertidal zone structure;
- Chemical and physico-chemical elements, as above, and specific pollutants.

For coastal waters, the elements include:

- Biological elements: phytoplankton composition, abundance and biomass, other aquatic flora, and benthic invertebrate fauna;
- Hydromorphological elements: morphological conditions and tidal regime;
- Chemical and physico-chemical elements, and specific pollutants.

In the case of heavily modified or artificial water bodies, ecological potential is determined by the lower of the values for biological and physico-chemical monitoring results for the relevant quality elements. Member States are required to provide maps for each river basin district illustrating the classification of ecological potential for each water body.

In addition to the previous Directives, the EU has adopted an amendment to the Environmental Accounts Regulation (EU) No 691/2011 which includes an ecosystem accounting module. The implementation of the ecosystem accounting module within the EU statistical system is coordinated by Eurostat and has led to the development of EU guidance notes and an accompanying [EU ecosystem typology](#) (for use in accounting and beyond).

The amended Regulation 691/2011 requires EU Member States to report the area and changes in area for each ecosystem type within their national territory. These ecosystem extent accounts cover both terrestrial ecosystems (including freshwater) and marine ecosystems. The EU ecosystem typology has three different levels of increasing ecological detail. The document describing this typology also contains an initial crosswalk of the EU ecosystem typology at Level 1 and Level 2 to IUCN GET functional ecosystem groups. Such crosswalks can help in developing an approach to connect EU ecosystem extent accounts to corresponding IUCN GET classes.

However, it should be noted that the relationship between classes in both typologies is generally not one-to-one but often one-to-many (or vice versa). This creates a substantial challenge for using a crosswalk approach in this case, which is confounded by the fact that the geo-spatial data underpinning the EU ecosystem extent accounts (Corine Land Cover – CLC) cannot be easily related to IUCN GET functional ecosystem groups.

A second option for establishing a link between EU classifications and IUCN GET would be to develop a crosswalk between the EUNIS habitat classification and IUCN GET. Initial work to develop this solution is ongoing, supported by the EEA. Both options need to be further explored considering the recently published guidance on translating national ecosystem classifications into IUCN GET categories (IUCN, 2025).

## 2. Conceptual aspects for defining the A2 ecosystem categories

### 2.1 Conceptual reflections on the A.2 ecosystem categories

The relative influence of human land use and other activities on ecosystem naturalness and species richness is reflected in the main categories of natural, semi-natural and anthropogenic ecosystem types that underpin the Global Biodiversity Framework indicator A.2 ‘Extent of natural ecosystems’. This section summarises a discussion document developed for a UN Task Team to further define indicators A.2 and B.1 of the GBF.

This discussion documents posits that the CBD metadata guidelines make a clear case for a broad definition of natural ecosystems, including semi-natural ecosystems, and states that:

- “Semi-natural ecosystems often retain substantial biodiversity and are thus important from a biodiversity perspective, along with natural ecosystems. This contrasts with anthropogenic (intensively modified) ecosystems, which are of far less importance from a biodiversity perspective. Thus, the key distinction from a biodiversity perspective is between natural or semi-natural ecosystems on the one hand and anthropogenic ecosystems on the other.
- If semi-natural ecosystems were excluded from the indicator, this may have the unintended consequence of reducing attention to their management, conservation and in some cases restoration.
- In practice there are virtually no ecosystems that are completely natural and there is no agreed scientific basis for making firm distinctions between natural, near-natural and semi-natural ecosystems, which exist on a continuum, so a narrow definition of natural ecosystems would make the indicator difficult to operationalise.”

The task team document points out that since the development of the CBD metadata guidance for indicator A.2, further work has taken place on defining natural and anthropogenic ecosystems. This included the development of *Guidelines for classifying agricultural and plantation forestry ecosystems in the IUCN Global Ecosystem Typology*.<sup>1</sup> Several of the borderline cases between natural and anthropogenic ecosystems relate to ecosystems in which there are agricultural or forestry activities. The new guidelines document was thus considered useful in elaborating the task team proposals summarised below.

#### 1. Definition of natural ecosystems proposed in the UNSD task team draft document:

- Natural ecosystems are a broad category of ecosystems, contrasted with anthropogenic ecosystems. The term ‘natural’ does not imply unimpacted by humans, and the composition, structure and functioning of most natural ecosystems have been modified to varying degrees through human activity. If the characteristic functional and structural properties of the ecosystem type are still recognisable and at least some of the key

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<sup>1</sup> The work to develop these guidelines was initiated and led by the IUCN and undertaken over the period January 2024 to March 2025. A reference group guided the work, consisting of experts from the IUCN Commission on Ecosystem Management’s network of scientists and experts of the Technical Committee on SEEA Ecosystem Accounting.

native biota are still present, the ecosystem is considered part of the broad category of natural ecosystems rather than an anthropogenic ecosystem.

- Note that this is a broader definition than the definition used in the metadata, which says: “The term ‘natural ecosystem’ broadly refers to ecosystems where the impact of humans on ecosystem composition, structure and function are low compared to natural factors.” However, the metadata goes on to say in the next sentence that the term natural “is used in the indicator in a broad sense, including natural and semi-natural ecosystems”, which is not actually consistent with the definition provided. The broader definition above is consistent with the purpose and rationale of the indicator.

## **2. Definition of anthropogenic ecosystems proposed in the UNSD task team draft document:**

- Anthropogenic ecosystems are those created and maintained through human activities, i.e. human activities are the primary determinant of the composition, structure and functioning of the ecosystem. Anthropogenic ecosystems have typically replaced an antecedent natural ecosystem, which is no longer recognisably present.
- There are thus two clear criteria for identifying anthropogenic ecosystem types:
  - The ecosystem type is *created and maintained* by human activity, i.e. the human activity is the *primary determinant* of the ecosystem’s composition, structure and function. Human activity does much more than influence or impact on the ecosystem, even substantially – it *creates* the ecosystem.
  - The antecedent natural ecosystem type is no longer recognisably present.

## **The task team document acknowledges that the term semi-natural can be used in two ways in relation to ecosystems:**

- It is widely used to describe a *condition state* of a natural ecosystem, in which composition and structure have been modified (by human activity or its direct consequences) but the characteristic functional and structural properties of the natural ecosystem type are still recognisable and at least some of the key native biota are still present. It is also sometimes used (especially in Europe) to describe natural ecosystems that have been transformed through human management into pastures or meadows that retain local indigenous species but from which woody components have been largely removed. Without ongoing human management these ecosystems would revert to tree-dominated ecosystem types. In this second sense, semi-natural is a descriptor of an *ecosystem type* rather than an ecosystem condition state. This leads to two different options for interpreting the term ‘semi-natural’:
  - Semi-natural ecosystems in the sense of a condition state of natural ecosystems fall clearly within the broad category natural ecosystems.
  - Semi-natural ecosystems in the sense of a specific habitat types which retains a natural species composition but is dependent on regular but limited human intervention to retain its characteristics. An example are pastures or meadows from which woody components have been removed but which share many of the characteristics of natural ecosystems and also group logically together with natural ecosystems.

**A brief discussion of use of the term ‘semi-natural’ in a marine and freshwater context:**

The term ‘semi-natural’ can have further interpretations in the context of other academic traditions; some of these are discussed below.

in the context of marine ecosystems, it is important to note that scholars refer to *semi-natural habitats* as systems used for experimental and behavioural studies. For instance, cage systems that expose species to natural environmental conditions are frequently described as semi-natural habitats (Denic, 2018). Similar approaches are applied in semi-natural incubation systems for *Chelonia mydas* (Iswanto & Agam, 2024). In the same way, in freshwater environments, Brouwer et al. (2014) employed so-called semi-natural systems to study *Oncorhynchus kisutch* (coho salmon).

These examples highlight the variability in the use of the term semi-natural within the marine and freshwater domains. Unlike terrestrial systems, where the term often refers to landscapes shaped by anthropic management, in marine and freshwater science it may denote experimental conditions simulating natural processes.

There are also important cases that relate to in situ activities that maintain or support marine species diversity while being connected to human use of the sea. Native mussel beds established for fishery purposes or nature-based pollution filtering come to mind. Coral reefs that are restored, re-established or even newly created for nature restoration purposes also seem an example which fits this category.

Restored coastal sites are often regarded as semi-natural environments - ecosystems that have been substantially influenced by human intervention but retain the capacity to perform essential ecological functions (Gregg et al., 2021).

The creation of artificial reefs (or at least hard structures) for conservation purposes or associated with wind energy platforms are other potential examples. Would these potentially qualify as being ‘semi-natural’ in the sense that they support species diversity but are clearly anthropogenically disturbed habitats?

## 2.2. Conceptual definitions adopted by the EEA

Work by the European Environment Agency (EEA, 2023, EEA, 2026 forthcoming) proposes to characterise the categories natural, semi-natural and anthropogenic for the European continent as follows:

- Natural ecosystems (and the habitats they contain) are purely the result of natural processes and evolutionary developments over tens of thousands of years without human influence (except of limited use of plant and animal biomass via hunting, fishing and gathering).
- Semi-natural ecosystems retain environmental conditions (i.e. soil characteristics and water cycles) and a species pool that are similar to those of natural ecosystem types. However, they are dominated by vegetation types which are the result of regular human

activity (e.g. mowing or livestock grazing), which suppresses the climax vegetation typical for natural ecosystem types.

- Anthropogenic ecosystem types are characterised by environmental conditions that have been actively changed by human activities (e.g. via large-scale drainage, soil improvement, infrastructure and building development, marine port and energy infrastructure, irrigation, use of chemical fertilisers and pesticides etc.). This means their species pool is actively altered by planting, sowing and/or the active introduction of non-native species and species richness is rather limited compared to natural or semi-natural ecosystems.

While anthropogenic ecosystem types are the most simplified, the species richness per area can vary substantially in each main category, depending on habitat type, geographic location and other factors. However, the diversity of species that live in grazed semi-natural habitats is generally at the top end of species richness per habitat type (Dengler et al., 2014). Annex 1 summarises the outcome of a web search for definitions of the terms ‘natural’ and ‘semi-natural’, which was part of the fact-finding for the definitions proposed above. The following chapter discusses how the general definitions above can be applied in practice for assigning European ecosystem types to the three Indicator A.2 categories.

### 3. Methodological considerations in assigning the main European ecosystem types to the Indicator A.2 categories

#### 3.1. Introduction

The previous chapters have discussed the global and European legal context for implementing Indicator A.2 as well as principal conceptual and methodological choices in developing the indicator. There are often transitions between the three main Indicator A.2 categories (natural/semi-natural and anthropogenic) which require an effort to develop clear definitions and associated criteria and thresholds. Furthermore, there are two options for identifying semi-natural ecosystem area: one that relates to ecosystem condition and one that defines semi-natural as a specific sub-category which occurs only under specific circumstances (see section 2.1).

The EEA has contributed to developing the European concept of semi-natural habitat types that are kept in an early successional stage via regular human intervention in the form of extensive agricultural practices (Halada et al., 2011). This requires combining parameters that represent important management practices with ecological criteria that relate to species diversity and continuity of key structural factors. This approach is applicable for open land habitat types many of which are listed in Annex I of the EU Habitats Directive.

The approach of defining semi-natural habitats as linked to traditional agricultural land use is not applicable to many other European ecosystem types, however. These include very important ecosystem domains, such as forest, freshwater or marine ecosystem types. This means that for these ecosystem types the assignment to any of the three main A.2 categories must rely on criteria that relate to ecosystem condition. Which implies that ecosystem extent data alone are not sufficient in developing data sets to underpin indicator A.2 and need to be

complemented with geo-spatial data on ecosystem condition. The sections below propose concrete methodological criteria for the main European ecosystem types.

### 3.2. Proposal for criteria to identify semi-natural terrestrial habitat types of the open landscape

The characterisation of semi-natural habitat types as a specific category dependent on extensive and/or traditional farming practices needs to be made operational by identifying criteria to identify this expression of semi-natural ecosystem types. Building on the conceptual discussion in chapter 2 the following criteria are proposed for identifying non-forest terrestrial semi-natural habitats:

- The original soil profile (e.g. in terms of stratification or compaction) and soil characteristics (e.g. pH value, nutrients) have not been altered in a substantial way.
- The site hydrology has been left largely untouched thus maintaining a water regime that corresponds to natural water cycles (incl. temporary flooding); however, limited drainage via surface ditches that correspond to traditional use practices and allow a seasonally high groundwater table is acceptable.
- The production of biomass that is harvested via grazing and/or mowing relies mainly on natural productivity.
- This means that use of external bought-in mineral or organic fertilisers (nitrogen above all) is very limited (a threshold of maximum 30 kg N per ha/yr is proposed (Stevens, 2004)).
- The use of pesticides or modern irrigation systems is not compatible with maintaining semi-natural ecosystem condition (whereas small-scale traditional water meadow practices are acceptable).
- Agricultural intensification via ploughing, (re-)seeding or other practices to change the native species composition (e.g. by introducing more productive grasses) is not acceptable.

The criteria listed above are considered relevant for the following habitat types: semi-natural grassland, heathlands, certain shrubland and wetland types plus a limited number of sparsely vegetated habitat types (cf EEA, 2026 forthcoming).

### 3.3 Proposal for criteria to identify the semi-natural category in other ecosystem types

This section discusses methodological options for identifying the semi-natural proportion of ecosystem types that do not fall in semi-natural category presented in section 3.2. This concerns the majority of European ecosystem types; however, the review below is not yet fully complete and further development is needed.

#### **a) *Draft criteria for forest ecosystem types***

Forests are in principle a natural climax ecosystem type but have been strongly altered in Europe via thousands of years of use and active introduction or at least promotion of very productive tree species. Forests that have been exposed to such active management can in

general not be considered to natural, however, they may be semi-natural if management is not too intensive. In some regions forest management and forest restoration can involve active planting of native tree species. Hence, forests that are planted with native species can be considered semi-natural if at stand maturity they resemble or will resemble naturally regenerating forest. The criteria listed are inspired by work within the Forest Europe process (see annex 1).

The criteria proposed are:

- The original soil structure (e.g. in terms of stratification) and characteristics (e.g. pH value, nutrients) have not been altered in a substantial way.
- The site hydrology has been left largely untouched thus maintaining a water regime that corresponds to natural water cycles (incl. temporary flooding); however, limited historical drainage via surface ditches that allow a seasonally high groundwater table is acceptable.
- At least 90% of the forest area is composed of native tree species in their natural range and composition.
- The forest unit in question has a natural species composition and a diverse age structure (including trees that are at the end of their natural life cycle), within and not just between forest management blocks.
- A minimum share of deadwood in total biomass needs to be defined (the desirable share of deadwood will vary depending on climate zones and natural fire regimes).
- The species composition of ground vegetation (grasses, mosses, forbs etc) consists mainly of species native to natural forests of the region (and the presence of invasive species is very limited).
- Forest management practices limit clear-felling to a maximum plot size of 0.5 ha (or 1 ha? ) per harvest operation (emergency tree harvesting after storm damage is acceptable).
- The establishment of new stands after harvesting relies mainly on natural regeneration of native tree species. Any recently planted forest needs to be managed in a way that at stand maturity these forests resemble or will resemble naturally regenerating forest.

Reflections on thresholds and other questions to be resolved:

- Need to define the minimum area extent of forest units for which the above criteria are calculated. Should this be 10ha plots or 100 ha; would the target size vary by region as average forest size is very different in Northern v Southern Europe, for example?
- Need to establish a rule to what degree a contiguous forest which is substantially above the minimum size unit can be sub-divided in case only certain parts of the contiguous forest area meet the semi-natural criteria.
- Need to decide to what degree traditional (European) coppicing systems are qualify as semi-natural forests (they likely do not meet the deadwood % criterion). They are different from modern energy plantations as they comprise native species only, have a forest-dominated ground flora, contain many trees with old base stem and root systems.
- Need to consider how to categorise areas where nature restoration work aims to reestablish (semi-)natural habitat types but the restoration process is only at the beginning.

### **b) *Criteria for freshwater ecosystem types***

Freshwater ecosystem types come in many different variations, as standing water bodies (lakes and reservoirs) and running / linear water bodies. They can be natural or near-natural (such as alpine lakes or mountain rivers) or very much influenced or even created by man, such as canals. In most cases they will be assigned to the natural or the anthropogenic categories. Potential criteria for such an assignment can be developed on the basis of structural, environmental and biological parameters. Important parameters are hydrological alterations or other structural interventions (e.g. dams, hard infrastructure to narrow riverbeds, lake side promenades), water pollution of any kind, overfishing of naïve species, release of non-autochthonous fish species, spread of invasive plants, fish or crustacea.

For identifying the flowing or standing water bodies that belong to anthropogenic or (semi-) natural ecosystem types the environmental reporting and spatial data related to the implementation of the WFD will be very helpful in the EU-27 context. As discussed in section 1.3, the Directive contains provisions relevant to assessing the degree of naturalness. Within the WFD framework, the designation of Artificial Water Bodies (AWB) and Heavily Modified Water Bodies (HMWB) could provide a useful extent-based proxy for identifying anthropogenic freshwater ecosystems. However, the biological and physico-chemical quality elements defined under the WFD primarily reflect ecological condition and pressures, rather than ecosystem naturalness as currently described in the CBD guidance for Indicator A.2.

Given the strong alterations of freshwater systems in Europe it would be useful to add ecosystem condition parameters as an element in identifying (semi-)naturalness of at least certain ecosystem types. The WFD criteria for classifying ecological status would be a good starting point for developing indicators for the (semi-) naturalness of freshwater bodies.

The practical suitability of WFD data and other available data sets for developing Indicator A.2 in the EU-27 context still needs to be further explored.

### **c) *Criteria for marine ecosystem types***

Marine ecosystem types are likely the ecosystem types that have been least influenced by human activity (apart from high mountain areas). However, if we consider that natural ecosystems are those where human impacts on ecosystem composition, structure and function are low compared to natural factors then we need to acknowledge that the impact of humans on marine and coastal ecosystems is already very large. In a European context this concerns disruptions to the trophic chain by taking out top predators (sharks, seals, whales) or over-fishing of important fish populations (e.g. herring or cod) and extends to environmental pollution, the alteration of nutrient cycles (via pollution and alterations of the trophic chain), noise pollution and infrastructure development (e.g. shipping and energy infrastructure, aquaculture, communication cables, etc).

If one considers the currently proposed use of IUCN GET framework for the purposes of Indicator A.2, many marine areas under direct human use and pressures (e.g. fishing areas, shipping lanes, vessel traffic corridors) are not recognised as anthropogenic ecosystem types. This may not sufficiently recognise that some human uses strongly affect ecosystem naturalness and species richness. Currently, only the physical footprint of seaports and associated infrastructure is classified as anthropogenic, while surrounding marine areas, often

characterised by altered communities and reduced species richness, yet remain classified as natural. This means that the A.2 categories do not consistently reflect the influence of human activities on ecosystem naturalness or species richness.

While it is debatable whether European marine ecosystems are sufficiently undisturbed to be considered 'natural', the main distinction that matters for the purposes of GBF Indicator A.2 is the one between 'anthropogenic' and 'semi-natural/natural' ecosystem types. The further discussion in this section will therefore focus on this distinction. However, please note the review of the term 'semi-natural' at the end of this section.

The area that can be considered truly anthropogenic in the marine context (defined as reaching to the average high tide line on the coast) is rather limited in % area terms. IUCN GET proposes two functional ecosystem groups: M4.1 Submerged artificial structures and M4.2 Marine aquafarms. The EU ecosystem typology has similar Level 2 ecosystem types for its L1 ecosystem types 'Marine inlets and transitional waters' and 'Marine ecosystems'. These include the following components: (aquatic part of) Ports and harbours, Aquaculture sites, Energy infrastructure, Seabed mining and dredging; dumping zones; and Other anthropogenic structures.

Related data sets can be derived from reporting under the MSFD, some EU land cover data sets as well as national data sets related to permitting processes, marine mapping etc. Their availability and geo-spatial integration need to be explored. Furthermore, future reporting under Indicator A.2 would require a regular updating process for at least the most important data sets used for anthropogenic area.

While reporting under Indicator A.2 does not require a division between natural and semi-natural components, such a division seems desirable for reasons of transparency and understanding the current state of ecosystems. Potential criteria to assess the naturalness of marine ecosystems can include share of undisturbed seabed, parameters of chemical pollution or eutrophication, disturbance by human activities (e.g. marine transport, fishery, diving, wind power parks etc.), population size of fish and other species, algal blooms etc.

When building on EU legislation the following ecosystem features are particularly important:

- Species & habitat integrity: characteristic species present
- Functional ecological processes maintained: food web interactions, recruitment / regeneration, nutrient cycles, substrate processes.
- Structural features: habitat complexity, physical structure (seabed, hydrodynamics)
- Thresholds of disturbance due to human activities as under MSFD, such as seabed integrity descriptor, noise etc.

In this context it is important to recognise that aquaculture installations, for example, can generate environmental degradation beyond their immediate footprint; therefore, restricting their impact assessment to the aquafarm area alone may underestimate their influence. These examples highlight the need to assess marine ecosystems' *naturalness* by integrating both *extent* and *condition*. By evaluating the residual ecological condition beyond the infrastructure itself can we determine whether a functioning ecosystem persists?

An argument can also be made that it would be important to take into account the influence of temporal dynamics. For example, offshore wind farms undergo distinct phases: site exploration

(e.g. seabed testing), construction (with the most intense impacts), operation (when marine life re-colonizes and stabilizes), and eventual decommissioning. These stages correspond to significant changes in ecosystem condition. Therefore, indicators of naturalness should reflect this temporal evolution rather than automatically labelling a site as semi-natural or anthropogenic immediately after construction. Reliance on ecosystem condition data is essential to determine whether a site remains, becomes, or ceases to be natural over time.

Another example is that buried submarine cables physically alter the seabed locally, but natural substrates and benthic communities often re-establish above the cable, and the marine ecosystem continues to function throughout the water column. In such cases, the antecedent natural ecosystem may remain largely recognisable, particularly above the seabed layer.

This highlights the need for caution in applying a definition of anthropogenic ecosystems developed for terrestrial ecosystems to marine environments. The current definition may unintentionally constrain how anthropogenic marine ecosystem types are identified. A more marine-specific interpretation may be necessary.

## 4. Practical approach for, and initial results of, calculating Indicator A.2 at EU-27 level

The development of the EEA approach began with a qualitative assessment of the likely share of the three main categories of indicator A.2 in the overall extent of the Level 1 ecosystem types of the EU ecosystem typology (see Table 1).

**Table 1: Qualitative assessment of the share of naturalness in main EU ecosystem types**

EU ecosystem type L1	Anthropogenic	Semi-natural	Natural	Comments
Settlements and other artificial areas				This ET is considered fully anthropogenic
Cropland				This ET is mostly classified as anthropogenic, apart from remaining extensive systems
Grassland				This ET can be part of all three categories
Forest and woodland				This ET can be part of all three categories
Heathland and shrub				This ET has natural and semi-natural expressions

Sparsely vegetated ecosystems				This ET is mostly natural but may be of artificial origins in part
Inland wetlands				This ET has natural and semi-natural expressions
Rivers and canals				This ET can be part of all three categories
Lakes and reservoirs				This ET can be part of all three categories
Marine inlets and transitional waters				This ET is mostly natural but some areas or features may be impacted by human activity, such as pollution or fishing
Coastal beaches, dunes and wetlands				This ET has natural and semi-natural expressions
Marine ecosystems (offshore coastal, shelf and open ocean)				This ET is mostly natural but some areas or features may be impacted by human activity, such as pollution or fishing

In a second step the EEA used the CORINE Land Cover (CLC) 2018 which provides consistent, continental coverage with a well-known legend of 44 classes. A crosswalk from the 44 CLC classes to the EU ecosystem typology allows the use of CLC for EU extent accounts and its application in the context of Indicator A.2.

In the context of Indicator A.2 the CLC Level-3 land-cover classes were converted into the three A.2 categories (natural, semi-natural, anthropogenic) using a traceable crosswalk.

In a third step spatial data on ecosystem condition were overlaid with some terrestrial ecosystem types (agro-ecosystems and forest ecosystems) to achieve the final assignment of the spatial CLC data to the three A.2 categories.

The following reflections and data sets informed the initial calculations of the EEA.

### ***Agro-ecosystem types:***

The Level 1 ecosystem type Cropland in the EU ecosystem typology is considered mostly anthropogenic (in line with CBD guidance). However, ecosystem type Grassland in the EU ecosystem typology has different sub-types that can fall in all three A.2 categories.

Spatial data on grassland vegetation types that match the A.2 categories are not available in a consistent way. This means that for the initial approach presented here the EEA employed a Europe-wide data set that estimates the spatial distribution of High Nature Value farmland.

### ***Forest ecosystem types***

There are various research papers that aim to assess the management intensity of European forests and have produced spatial data sets. These were explored for their use in distinguishing semi-natural native forests from intensively managed plantations. To refine forests, we used the Forest Management Map of Europe (FME) as primary management intensity layer, classifying “Unmanaged forest” and “Close-to-nature forestry” as natural, “Combined objective forestry” as semi-natural, and “Intensive” or “Very intensive forestry” as anthropogenic. Where available and as time allowed, we optionally overlaid the Planted Tree Database (SDPT) to further identify anthropogenic plantation areas, and the European Primary Forest Database (EPFD) to confirm or add natural forest status. This was supplemented by national data sets for Romania.

Some further detail on the algorithm and spatial data processing approach in calculating indicator A.2 at EU-27 level is provided in Annex 2.

Given the conceptual concerns as well as methodological challenges discussed with regard to freshwater and marine ecosystem types in chapter 3 this initial calculation of Indicator A.2 for the EU-27 area focused on terrestrial ecosystem types only. In follow-up work Indicator A.2 results for freshwater and marine ecosystem types will be developed as soon as feasible.

The initial approach employed in calculating Indicator A.2 for the terrestrial area (i.e. excluding freshwater and marine ecosystem types) gave the following results:

### **Initial result for Indicator A.2 for terrestrial ecosystem types of the EU-27 (based on CLC 2018 data and additional condition parameters):**

Share of anthropogenic ecosystem types: 54.5 %

Share of semi-natural and natural ecosystem types: 45.5 %

of which natural: 11.3 % of total terrestrial area

and semi-natural: 34.2 % of total terrestrial area

## 5. Summary and outlook

This paper discussed potential approaches for implementing GBF indicator A.2 in the European context, with a particular focus on identifying semi-natural ecosystem types. It introduced the European concept of semi-natural habitat types that are kept in an early successional stage via regular human intervention in the form of extensive agricultural practices. Identifying such habitat types requires combining parameters that represent key extensive management practices with ecological criteria that relate to species diversity and environmental parameters.

### General reflections:

The long land use history of the European continent and its population density mean that all terrestrial ecosystem area is influenced by human impact one way or the other. This is evident in the large share of terrestrial anthropogenic ecosystems (about 54.4%, excluding freshwater ecosystem types). Much of the (semi-)natural ecosystem component is also not in a natural state; however, the correct share of semi-natural area is difficult to estimate.

The European continent hosts a range of near-natural vegetation types which are the result of traditional human land use (e.g. livestock grazing) and can be ecologically very diverse. Such traditional or low-intensity use suppresses the transition to climax vegetation but can maintain (or help restore) species-rich habitat types – examples are semi-natural grasslands and many heathland types.

This approach does not work for all European ecosystem types, however. Furthermore, few European ecosystem types are always anthropogenic or (semi-)natural. This means that for these ecosystem types the assignment to any of the three main A.2 categories must rely on criteria that relate to ecosystem condition. Which implies that ecosystem extent data alone are not sufficient in developing data sets to underpin indicator A.2 and need to be complemented with geo-spatial data on ecosystem condition. This limited review needs to be complemented with a closer look at relevant guidance for assessing the condition of European ecosystems (e.g. JRC, 2022).

It was not possible for this first reporting round to properly assess the state of freshwater and marine ecosystem types. These are therefore reported as belonging to the natural ecosystem component. However, many rivers and lakes as well as marine areas are significantly impacted by human activity and should be considered to be in a semi-natural state. It is foreseen to analyse this in more detail during follow-up work, which will be available at the latest for the next CBD report in 2029.

### Methodological considerations to inform the next steps:

Further work is required to review potential data sets available for measuring relevant ecosystem condition parameters at a geo-spatial scale that corresponds to the size of ecosystem patches in Europe. Existing experience from reviewing potential condition indicator data sources in preparing the EU ecosystem accounting module as well as ongoing work for updating the EU ecosystem assessment (Maes, et al., 2020) indicates that few EU-wide data sets suitable for such an exercise exist. However, at country level the data foundation could be stronger, as demonstrated by an example from Estonia (Linder, 2025).

A further step is a transposition of the draft A.2 indicator data set (based on the EU ecosystem typology and additional information) into the IUCN GET ecosystem typology that is meant to be the basis for reporting under the GBF (as far as feasible).

To develop an operational approach for implementing Indicator A.2 at EU-level it is important to review the following main conceptual and methodological questions:

- a) Which are the ecological criteria that can be used to distinguish anthropogenic ecosystems from (semi-)natural ecosystem types in the European context? Are different criteria required for terrestrial, freshwater and marine ecosystems?
- b) What is the potential role of ecosystem condition parameters in helping to define or identify natural and semi-natural ecosystem types in Europe?
- c) What are suitable thresholds or indicators for implementing the identified criteria where transitions between the main three categories are gradual?
- d) What data sets are (or will become) available for measuring the above thresholds and indicators at a geo-spatial scale that corresponds to ecosystem distribution in Europe?
- e) How could existing (or future) ecosystem extent accounts at national and EU-level support the calculation of Indicator A.2 for individual countries, or the EU-27 level?
- f) How to translate European ecosystem classifications and related data sets into a presentation of results building on the IUCN GET functional ecosystem types that are recommended in the CBD methodological guidance?

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## Annex 1: Definitions for ‘semi-natural’ found via web search

a) **IPBES:** Semi-natural ecosystems - An ecosystem with most of its processes and biodiversity intact, though altered by human activity in strength or abundance relative to the natural state.

<https://ipbes.net/glossary/semi-natural-habitats>

b) **Naturespots:** Grassland existing as a result of human activity (mowing or livestock grazing), where environmental conditions and the species pool are maintained by natural processes.

<https://www.naturespots.net/habitats/grassland-shrubs/12666-semi-natural-grassland>

c) Web encyclopedia:

<https://www.encyclopedia.com/earth-and-environment/ecology-and-environmentalism/environmental-studies/semi-natural-community>:

"semi-natural community vegetation altered by human influence or management in the past, which has taken on a natural aspect owing to the length of time over which the influences have persisted. For example, [heathland](#) and chalk grassland in [Great Britain](#) have long been subject to management and members of each [community](#) have adapted to it. In chalk grassland many plant species are low-growing [rosette plants](#) which avoid being grazed. Compare [near-natural community](#)."

d) European Commission, Knowledge for policy, Semi-natural habitats  
Glossary item | 01 Sep 2021

[https://knowledge4policy.ec.europa.eu/glossary-item/semi-natural-habitats\\_en](https://knowledge4policy.ec.europa.eu/glossary-item/semi-natural-habitats_en):

Semi-natural habitats: Europe is one of the most densely populated regions in the world. Human activity has shaped its landscapes over centuries and contributed much to its biodiversity, e.g. semi-natural habitats such as extensive hay meadows and semi-natural dry grasslands. However, human activity has also caused deterioration and decline for many native species and habitat types — particularly (and much faster) in the past 100 years.

The most frequently reported pressures for both habitats and species stem from agriculture, which reflects the relative scale of agricultural land-use and changes in farming practices (intensification and abandonment of extensive agriculture). Extensive agricultural management creates and maintains semi-natural habitats with diverse fauna and flora. Since the 1950s, however, more intensive and specialised farming has contributed increasingly to ongoing biodiversity loss. Grasslands, freshwater habitats, heaths and scrubs, and bogs, mires and fens have been most severely affected. Semi-natural habitats depending on agriculture, such as grasslands, are particularly threatened and their conservation status is significantly worse than for other habitat types that do not depend on agriculture (45% are assessed as bad, as compared with 31% for other habitats).

Compared to 2015, assessments of agricultural habitats show an overall deterioration in conservation status: good status decreased from 14% to 12% and bad status increased from 39% to 45%. Only 8% of agricultural habitats show an improving trend, whereas 45% are deteriorating. Many species of birds, reptiles, molluscs, amphibians, arthropods and vascular plants are also impacted and farmland biodiversity continuous to decline.

e) UK national ecosystem assessment: In the UK, Semi-natural Grasslands are the remnants of habitats created by low-intensity, traditional farming, or, in some cases, the natural vegetation on poor soils or in exposed locations (Pigott & Walters 1954; Bullock et al., 2011)

f) Halada et al. (2011): Semi-natural habitat types are established under regular - usually low-intensity - agricultural management. The species composition has been subject to selection over many decades or centuries and corresponds both to the site conditions and to type and intensity of human management. Both cessation of this management and significant changes in the management intensity result in (usually irreversible) changes in the habitat structure and species composition leading to a change to other habitat types.

### ***Semi-natural forest definition under the 'Forest Europe' process (Indicator 4.3)***

Naturalness is defined by distinguishing the following classes:

#### ***1) Undisturbed by man (forest/other wooded land)***

Naturally regenerating forest of native tree species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed.

*Explanatory notes:*

Includes both pristine and managed forests that meet the definition. Management practices in primary forests should imply minimum human intervention and aim for the long-term conservation of native vegetation and wildlife habitat.

Includes forests where Indigenous Peoples and local communities engage in traditional forest stewardship and management/use activities that meet the definition.

Includes forests with visible impacts of natural disturbances (such as storms, snow, drought, wildfire or insects, pests and diseases outbreaks).

Excludes forests where hunting, poaching, trapping, or gathering have caused significant native species loss or disturbance to ecological processes.

Some key characteristics of 'primary forests':

i. they show natural forest dynamics, such as natural tree species composition, occurrence of dead wood, natural age structure, and natural regeneration processes;

ii. the area is large enough and retains a degree of connectivity such that its natural ecological processes are maintained; and

iii. there has been no known significant human intervention or the last significant human intervention was long enough ago to have allowed natural ecosystem elements (including species diversity) and functions to have become re-established.

(Source: FRA 2025, Primary forest)

## **2) ‘Semi-natural forest/other wooded land’:**

Forest/other wooded land which is neither “forest/other wooded land undisturbed by man” nor “plantation” as defined separately.

(Source: MCPFE 2003, from TBFRA 2000)

## **3) ‘Plantation’:**

Planted Forest that is intensively managed and meets ALL the following criteria at planting and stand maturity: one or two species, even age class, and regular spacing.

Explanatory notes

Specifically includes: short rotation plantation for wood, fibre and energy.

Specifically excludes: forest planted for protection or ecosystem restoration.

Specifically excludes: Forest established through planting or seeding which at stand maturity resembles or will resemble naturally regenerating forest.

(Source: FRA 2025, Plantation forest)

## **Annex 2: Description of main steps in technical approach for calculating Indicator A.2 for the EU-27**

The computation proceeds in three broad stages: establishing the accounting areas, assigning ecosystem categories through the crosswalk and targeted overlays, and compiling the extent accounts for the A.2 calculation at Member State and EU scales.

As an initial step mutually exclusive and collectively exhaustive accounting areas are established for terrestrial (including inland waters) and marine realms, based on SEEA EA compliant extent accounts. Terrestrial territory is derived from CLC 2018.

In the next step land-cover/use classes are converted to the A.2 categories. This step yields an initial mask of areas classified as natural/semi-natural or anthropogenic. Specific domains where management intensity is decisive for the anthropogenic classification are refined. Forests are the primary domain requiring refinement. The Forest Management Map of Europe (FME) is overlaid on the set of CLC forest classes. “Unmanaged forest” and “Close-to-nature forestry” are classified as natural, “Combined objective forestry” as semi-natural, and “Intensive” and “Very intensive forestry” as anthropogenic. This overlay either fills attributes inside the CLC forest polygons where FME provides coverage or leaves gaps where FME is absent. Where available and as resources permit, the Planted Tree Database (SDPT) is added to identify additional anthropogenic plantation areas; depending on the chosen option, SDPT can overwrite the FME classification where it provides higher-confidence plantation information, or it can be applied as gap-filling where FME has no data. Optionally, the European Primary Forest Database (EPFD) is brought in to confirm natural forest areas; EPFD may either override the FME classification or be applied as gap-filling only, depending on the chosen pathway. These European data sets are

supplemented by national data sets in the case of Romania. In all cases, precedence rules are documented and lineage maintained for transparency.

For the Outermost Regions, the continental workflow is replicated where CLC exists. Where CLC does not exist or is incomplete, conservative, documented assumptions are applied. In French Guiana, the unmapped interior is treated as natural forest based on the predominantly dominance of forest cover in the region, while mapped coastal anthropogenic areas from CLC are retained. In Saint-Martin, without CLC, the very small terrestrial area is classified as anthropogenic given the dominance of built surfaces at island scale; the impact on EU totals is negligible, but this is flagged for local data substitution. All OR EEZs are treated as natural due to the absence of an EU-wide inventory of marine anthropogenic footprints for those waters.

Once the classification masks are finalised for each accounting area, area totals for natural plus semi-natural and for anthropogenic classes are computed at the Member State level, then aggregated to the EU level.