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Ecosystem service fact sheet on recreation

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1. Introduction

In line with the fundamental role Nature and its services play in the healthy functioning of human society and economy, Target 2 of the EU Biodiversity Strategy to 2020 calls Member States (MS) to maintain and restore the ecosystems and their services. To meet these goals an EU wide ecosystem assessment (the EU MAES assessment: "Mapping and Assessment of Ecosystems and their Services" – Maes et al., 2013; 2014; 2018; Erhard et al., 2016) will evaluate the condition of Europe's ecosystems and the services they provide to the society based on an analysis of available data. The assessment will cover the whole EU territory, including EU regional seas, and it complements the Member States' activities on mapping and assessment of ecosystems and their services. The EU MAES assessment serves two main policy requests: (1) provide an evaluation of Target 2 of the EU Biodiversity Strategy to 2020 and (2) provide support to the definition of smarter targets under the post-2020 biodiversity policy.

Ecosystem condition has a key role in the EU MAES assessment: adequate service provision requires healthy ecosystems in good condition (Fig. 1.1; Maes et al., 2014). The EU MAES assessment will evaluate the condition of ecosystems based on a set of key indicators in the context of 'thematic ecosystem assessments', grouped according to broad ecosystem types (urban ecosystems, agroecosystems (croplands and grasslands), forests, heathlands, wetlands, freshwater, and marine ecosystems; Maes et al., 2018). The assessment aims to evaluate the trends in the condition of Europe's ecosystems relative to a baseline situation (2010) and provide evidence on where ecosystems are in a degraded state. This series of fact sheets produced by ETC/BD gives additional guidance on how ecosystem condition can be meaningfully defined and measured for various services and in various ecosystems, based on a review of scientific studies (Czúcz et al., 2017, 2018). This fact sheet also relies on previous ETC/BD work on ecological requirements for recreation (Götzl et al., 2016).

In the following pages key messages are summarized first from a policy perspective: what can these studies teach about designing a relevant set of ecosystem condition indicators for the EU MAES assessment? Then, in the subsequent chapters these lessons will be expanded, giving a detailed account of how recreation can be defined, which characteristics of the various ecosystem types are relevant for recreation, and what kind of indicators are available for these characteristics. A discussion on the options for improving the integration of condition indicators into ecosystem service modelling is particularly relevant for ensuring coherence between the different components of the EU MAES assessment. The fact sheet is concluded by a set of annexes, which contain all relevant metadata behind the whole analysis.

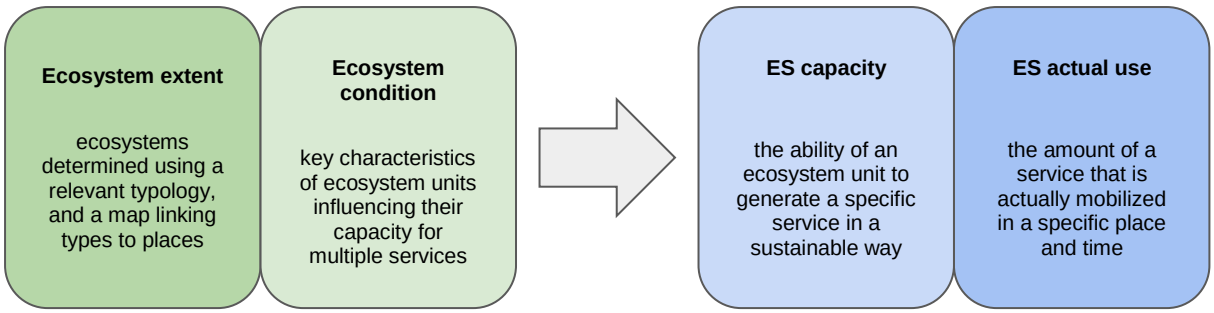

Figure 1.1: A simplified representation of the MAES conceptual framework (based on Maes et al., 2014; Burkhard et al., 2018; and MAES-INCA, 2018). The four boxes describe the main elements which need to be quantified (mapped and assessed) during the EU MAES assessment process.

2. Key messages

The definition of recreation as an ecosystem service is challenging, in this fact sheet the focus was set on *the capacity of ecosystems to support general recreation activities*. There are several relevant ecosystem condition aspects that have been identified in this fact sheet based on a small systematic review of the published literature. All ecosystem types can relevantly contribute to human recreation, and the most important characteristics underlying the 'recreational capacity' of ecosystems involve aspects of management, biodiversity, and landscape diversity.

There are several indicators available for these characteristics (Fig. 2.1). Starting out from the 5th MAES report (Maes et al., 2018), the availability of potential indicators has been assessed in a systematic way. The proposed indicators are all state indicators, but many of them are related to specific key pressures relevant for recreation (see Czúcz et al., 2018).

- A general indicator of the degree of human influence (e.g. *hemeroby*) could be highly relevant for recreation. A simple hemeroby indicator has already been created by JRC, which could be updated based on the European map of ecosystem types (ETM) underlying the EU MAES assessment (ETM v3.1, Weiss & Banko 2018). This indicator would combine aspects of biodiversity (naturalness) and management intensity in a simple but straightforward metric.
- In urban contexts, where the demand for recreation is the highest, the presence (share, density) of *urban green* surfaces is of key importance. Remote sensing products (*NDVI*, *LAI*, or *imperviousness*), as well as local GIS data can be used to develop an appropriate simple indicator.

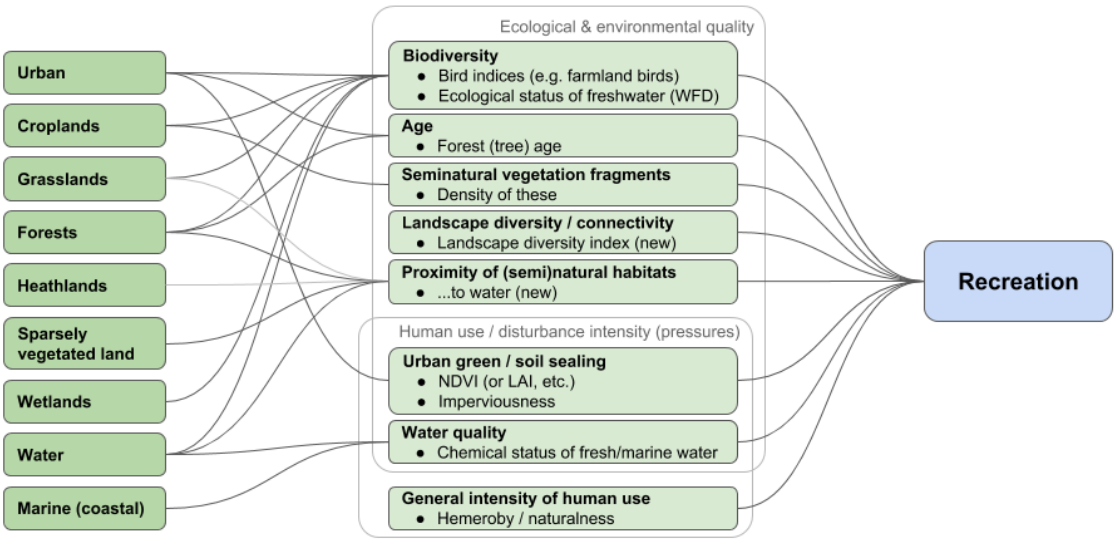

Figure 2.1: A graphical summary of this fact sheet. *Ecosystem types* (column 1) are connected to their *relevant characteristics* ('condition aspects'; column 2) and a possible set of *key indicators* (bullet points in column 2), which determine their *capacity for recreation* (column 3). Characteristics not connected to any ecosystem type are landscape-level characteristics. Condition-service connections are drawn based on a systematic review (Czúcz et al., 2018). The negative relationships and the most important data gaps are highlighted in red.

- People value a diverse and natural environment for recreational activities, which makes several aspects of biodiversity are highly relevant for recreational potential. The presence / abundance of charismatic (iconic, popular) species and useful species (ones that are "harvested" in the frame of recreational activities, e.g. mushrooms), which can be partly characterized by general biodiversity indicators, most of which are of insufficient spatial resolution or coverage. *Bird abundance indices* (farmland birds, forest birds, etc) are perhaps the ones with best spatial resolution, and they also directly characterize an important group of charismatic species. The rest of the existing biodiversity indicators seem to be more suitable for ecosystem accounting than for MAES (which involves mapping, i.e. needs spatial detail), unless their spatial resolution can be improved.
- Diversity is also relevant at the landscape level: a harmonious pattern of open and closed vegetation is also highly valued by recreational users. It is possible to create a simple and easily implementable indicator for this ('*landscape diversity*' as Shannon diversity of the ecosystem type map). Fine-scale pattern of agricultural landscapes can be addressed by the density of *tiny (semi)natural habitats* (hedgerows, lines of trees, etc.) in croplands available from the JRC.
- The presence of water (freshwater and marine ecosystems) is also highly valued by recreational users. The quality of these waters can be mapped/assessed with appropriate *chemical status* and *ecological status* indicators from Water Framework Directive and Marine Strategic Framework Directive reporting streams.
- The age of trees, or the presence of old trees (primarily in forests, but also in any ecosystem type) seems to contribute disproportionately to recreation capacities. A new indicator characterizing the average (or maximum) *age of trees* should be developed if possible.
- The primary use intensity of croplands (e.g. *intensification/extensification*), grasslands (e.g. *livestock density*), forests (e.g. *length of felling cycle*) can highly influence recreative uses. Recreation activities tend to favour low or medium use intensities instead of a complete absence of human uses.

3. What is recreation?

Cultural services are the non-material, and normally non-consumptive outputs of ecosystems which enable non-material benefits (positive changes in the physical or mental states of people). Most ES classifications struggle with the 'taxonomy' of cultural ES, where definitions tend to fail as 'service' (still connected to nature) and benefits (more connected to the people and their well-being) can hardly be separated (Table 3.1). Most cultural ES assume non-consumptive uses, and some don't even require direct interactions between the provider (nature) and the beneficiary.

This factsheet focusses at the capacity of an ecosystem or a landscape to support human activities that give rise to a specific group of cultural benefits: recreation (regeneration of physical and mental state). The goal is to identify the 'factors' (ecosystem and landscape characteristics) that determine the capacity of a place or landscape to support recreation activities, also called as 'outdoor' recreation. Outdoor recreation is, however, not equal to tourism. While tourism is an occasional activity, local outdoor recreation affects the daily life of people (EC, 2013). Accordingly, every landscape of Europe has a role in providing recreation opportunities for nearby human populations. A goal of the MAES assessment is to assess this role of the landscapes in accordance with the MAES conceptual framework, including their characteristics underlying recreation (condition), their capacity to support recreation activities, the actual magnitude of recreation uses (MAES-INCA, 2018).

Table 3.1: The position of recreation in CICES (v5.1, Haines-Young & Potschin, 2018) and other major ES classification systems (IPBES: Pascual et al., 2017; TEEB, 2010; MA, 2005)

	CICES v5.1	Other classifications
Classification	**Section:** **3** Cultural (Biotic) **Division:** **3.1** Direct, in-situ and outdoor interactions with living systems that depend on presence in the environmental setting **Group:** **3.1.1** Physical and experiential interactions with natural environment **3.1.2** Intellectual and representative interactions with natural environment **Class:** **3.1.1.1** Characteristics of living systems that that enable activities promoting health, recuperation or enjoyment through active or immersive interactions **3.1.1.2** Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions **3.1.2.4** Characteristics of living systems that enable aesthetic experiences	**IPBES**: **NCP 16** Physical and psychological experiences **TEEB**: Recreation and ecotourism; Inspiration for culture, art and design, aesthetic information **MA**: Recreation and ecotourism; Knowledge systems and educational values, cultural diversity, aesthetic values
Definition	**Scientific**: The biophysical characteristics or qualities of species or ecosystems (settings/ cultural spaces) that are… … engaged with, used or enjoyed in ways that require physical and cognitive effort (3.1.1.1); or … viewed/observed by people or enjoyed in other passive ways by virtue of sounds and smells etc. (3.1.1.2); or … that are appreciated for their inherent beauty (3.1.2.4). **Simple**: Using the environment for sport and recreation, using nature to help stay fit (3.1.1.1); or watching plants and animals where they live, using nature to destress (3.1.1.2); or the beauty of nature (3.1.2.4).	**IPBES**: Provision, by landscapes, seascapes, habitats or organisms, of opportunities for physically and psychologically beneficial activities, healing, relaxation, recreation, leisure, tourism and aesthetic enjoyment based on the close contact with nature.
Example for service	Ecological qualities of woodland that make it attractive to hiker; private gardens; opportunities for diving, swimming (3.1.1.1); mix of species in a woodland of interest to birdwatchers; whales, birds, seals and reptiles can be enjoyed by wildlife watchers (3.1.1.2); areas of Outstanding Natural Beauty; panorama sites (3.1.2.4).	**IPBES:** hiking, recreational hunting and fishing, birdwatching, snorkeling, gardening
Example for benefits	Recreation, fitness; de-stressing or mental health; (artistic) inspiration, etc. (If connected to tourism recreation can also generate direct material / economic benefits.)	

Nevertheless, there are several major issues that need to be considered when recreation is assessed. Firstly, there are several possible recreation activities all of which imply a different relationship

between nature and beneficiary, and individual preferences for the various activities might differ greatly. Secondly, the recreation activities realised always reflect a balance of supply and demand, both of which vary spatially.

To reduce this complexity, this factsheet addresses recreation at a very fundamental level. The primary focus is 'short-distance' recreation with no distinction of the different activities, and aspects of demand are not taken into consideration. Accordingly, this fact sheet describes the *contribution of ecosystems* and their mosaic *to the general appeal of the landscape for recreation* (often also called 'aesthetics' or *'aesthetic beauty'*), and tries not to be sidetracked by the singular (and often abiotic) requirements of specific activities, like snorkeling, climbing, or whale watching. This approach highly conforms to the logic of the MAES framework, according to which the (extent and) condition of ecosystems determines their capacity to provide services, and the actual flow of services is influenced both by this capacity and other factors. Spatial information about capacity to support recreation (*recreational potential*) is essential for regional planning and development (Gret-Regamey et al., 2015; Burkhard et al., 2014).

4. Ecosystem characteristics influencing the supply of recreation

Ecosystems greatly vary in their recreational potential, and even sites belonging to the same ecosystem type (e.g. two different forests) can be of greatly different recreational value. Table 4.1 provides a general overview on the importance of various characteristics of the main ecosystem types from the perspective of recreation. According to the scientific literature sampled in the underlying systematic review, the most relevant characteristics are the management and the diversity (biodiversity, landscape diversity) of the ecosystems, with people favouring diverse sites of intermediate management intensity. The review focuses primarily on terrestrial ecosystem types, so freshwater and coastal/marine ecosystems are largely missing from this overview. If this work will be continued, more emphasis should be laid on these ecosystem types, too.

Table 4.1: Results of the systematic review: ecosystem characteristics that have been documented to influence the recreational potential, and the ecosystem types in which these relationships had been documented (Czúcz et al., 2018). Total / positive / negative / mixed: the number of papers which document any (or positive / negative / mixed) relationships between the studied characteristics and recreation. A more detailed and fully referenced version of table can be found in Annex 1.

Characteristics type	Total	Positive	Negative	Mixed	Ecosystem types*
Management / disturbance intensity	6	1	5	0	forest, crop, urban, grass, SVL
clearcutting	1	1	0	0	forest
Biodiversity (in general)	4	4	0	0	forest, urban, crop, grass, wet
The extent (abundance) of the target ecosystem type (or a specific subtype)	4	2	0	2	crop, grass, urban, water
hedgerows, treerows	2	2	0	0	crop, grass, urban
Landscape diversity	3	3	0	0	crop, forest, grass, urban, heath, SVL
Age of site / community	1	1	0	0	urban
Biomass at the site	1	1	0	0	urban
Site structure	1	0	1	0	forest
The proximity of specific ecosystem types to water	1	1	0	0	crop, forest, SVL, water

** MAES ecosystem types: crop: cropland; grass: grassland; forest: woodland and forest; heath: heathland and shrub; SVL: sparsely vegetated land; wet: wetlands; water: rivers and lakes*

The intensity of **human pressures** (management activities) seem to be the most influential aspects for recreation, with people preferring lower intensity management for recreation use in almost all ecosystem types. This can be considered as a typical ES trade-off: an increasing use for provisioning ES (which are typically the primary targets of the management activities, e.g. agricultural production) comes at the price of a reduction in cultural ES. However, in most cases it is not the complete abandonment of management, that is optimal for recreation, but a sort of medium intensity or traditional management (Hunziker & Kienast, 1999; van Berkel & Verburg, 2014). Examples include shelterwood cutting regimes instead of clearcut systems in forests (Holgén et al., 2000), medium intensity management of city parks (Heyman, 2012), and traditional practices in agriculture (García-Llorente et al., 2012; Lindemann-Matthies et al., 2010; van Berkel & Verburg, 2014).

Local biodiversity also seems to play an important role in enhancing the recreational capacity of sites in many different ecosystem types (Horne et al., 2005; Hofmann et al., 2012; Lindemann-Matthies et al., 2010). It is particularly the diversity of conspicuous and charismatic taxa, like flowering plants (Lindemann-Matthies et al., 2010) or charismatic wild animals (van Berkel & Verburg, 2014) that add to the aesthetic appeal, or the wilderness feeling of the sites, which is often being rewarded by visitors.

The presence/absence of various (semi)natural habitat types (e.g. grasslands, forests), and the resulting **landscape diversity** also has a well-documented positive influence on the capacity of the landscapes to support recreation activities (García-Llorente et al. 2012; Dramstad et al., 2006; van Berkel & Verburg, 2014). "*Timber plantations" in contrast to real forests can offer a significantly lower capacity for recreation service (Vihervaara et al., 2010).* Landscapes consisting of a coarse-scale irregular mosaic of 'open' (e.g. grassland, cropland) and 'closed' (e.g. forest) ecosystem types seem to be more appealing to people then either completely open or completely closed landscapes (Heyman, 2012). The presence of various ecosystem "subtypes" can also create landscape heterogeneity in otherwise **Small scale semi-natural features** embedded into agroecosystems, like hedgerows or lines of trees can also play a huge role in making the landscape attractive by breaking its monotonicity (Oreszczyn & Lane, 2000; Lindemann-Matthies et al., 2010).

In **urban** contexts the mere presence/abundance of **green and blue spaces** can be seen as critical in supporting the everyday recreation activities of the vast majority of the European population (Snep et al., 2009). These areas encourage recreational activities, increase aesthetic appeal, and provide mental and physical health benefits. Sites used for recreational activities (walking, dog walking, swimming) also serve as meeting points with friends (which can be seen as a social benefit of recreation, or also as a different "social" ES; Plieninger et al., 2013). The mere (**bio**)**mass of green** is also documented to increase the aesthetic appeal of urban areas (Snep et al., 2009). **Age** can also matter: urban forests consisting of older trees/forests are preferred to younger ones (Heyman, 2012).

The visible **presence/proximity of open water** (rivers and lakes, and coastal / marine ecosystems) can play a particularly important role in increasing the aesthetic appeal of landscapes (García-Llorente et al., 2012; Zulian et al., 2013). This is true both in urban and rural contexts, even if the water body is not directly used for active recreation (swimming, bathing, canoeing, angling, etc.).

5. Ecosystem condition indicators relevant for recreation

The ecosystem characteristics listed in the previous chapter (Table 4.1) are not independent from each other. Biodiversity, for example, is roughly determined by habitat type, landscape context, and land use intensity. Thus not all of the identified / proposed aspects need to be covered by an ideal indicator system in order to be relatively comprehensive, and a focus on 'low hanging fruits' (aspects for which there are better / more readily available data) can be justified. Table 5.1 & Annex 2 provide an overview of the potential condition indicators and their underlying data sources for each of the condition aspects listed in Table 4.1, with the exception of the pressure (management / disturbance intensity) indicators, which will be discussed in the next chapter.

Table 5.1: Indicators available for the ecosystem characteristics relevant for recreation. The 'usefulness' of each indicator is highlighted with a 'traffic lights' colour scheme.* Proposed **key indicators** are highlighted in bold.

U*	Indicator name	Comments
	Biodiversity (diversity/abundance of major species groups)	
	species in general	
2	Conservation status and trends of species of community interest (for multiple ET)	multiple indicators (one for each ET), only available at a very low resolution
2	Red List Index of threatened species	multiple indicators (one for each ET), only available at a very low resolution
2	Invasive alien species (richness)	the number of IAS can be negatively correlated with general biodiversity
3	Species diversity, richness (number and abundance of species, including vascular plants, vertebrates, etc)	proposed by forest pilot but can be relevant for more ETs, needs to be developed, data source unclear
	plants	
3	Plant functional types (diversity)	proposed by forest pilot but can be relevant for more ETs, needs to be developed, data source unclear
2	Forest tree species (richness)	
3	Understory vegetation (richness)	still needs to be developed
3	Bryophyte, moss, liverwort, lichen and fungal species richness (index)	still needs to be developed, fungal diversity can be directly relevant (for active recreation)
	birds	
2	EU Population status and trends of bird species (%)	only available at a very coarse spatial resolution
2	**Bird indices (farmland, forest...)**	multiple indicators (one for each ET), the most accessible biodiversity indicator (probably the only one which can be refined to a spatial resolution beyond NUTS2 based on existing data)
	insects	
2	Grassland Butterfly Indicator	only available at a very low resolution
	habitats	
2	Conservation status and trends of habitats of community interest	multiple indicators (one for each ET), only available at a very low resolution
2	Threatened habitat cover	multiple indicators (one for each ET), only available at a very low resolution
2	Deadwood	only available at a very coarse spatial resolution
1	Naturalness (index or typology)	is conceptually close to "hemeroby", still needs to be implemented, unimodal relationship
2	Red List Index of threatened habitats	multiple indicators (one for each ET), still needs to be developed, will be of a low resolution, & no time series
1	**Ecological status of surface water bodies**	multiple indicators (components most relevant for aesthetic beauty / recreation should be focussed at)
	Age of site / community	
2	**Forest age (% of forest in age categories)**	still needs to be developed
3	Community age (time since last major intervention/ disturbance: felling, fire, abandonment, etc)	see above

Table 5.1 continued.

U*	Indicator name	Comments
	Biomass at the site	
1	Normalized difference vegetation index (NDVI)	instantaneous values are too variable, but (multi)annual characteristics can make useful condition indicators; a single biomass indicator can be enough
1	Leaf Area Index (LAI)	see above
2	Tree height	needs to be developed, can be redundant with other age & biomass indicators
2	Tree cover density	as above
3	Tree crown size (diameter)	as above
	Site structure	
2	Structural heterogeneity	needs to be developed, can be redundant with other indicators
	Water availability	
2	Water and wetness probability index (WWPI)	stable open water surfaces are better for recreation
3	Water levels	needs to be developed, data source unclear, stable high water levels are good for recreation
	The extent (abundance) of a specific subtype (of the target ecosystem type)	
1	**Extent of ETM subtypes**	urban green (I2) is directly relevant, other EUNIS (level 2) subtypes can be considered through a naturalness (or hemeroby) index
3	Extent of forest types	still under development (?)
1	**Density of embedded seminatural elements (hedgerows, lines of trees, etc.)**	seminatural elements greatly contribute to the aesthetics of agricultural landscapes
2	HNV area	the share of this highly relevant 'subtype' might be redundant with other indicators (seminatural elements, pressures, etc.)
	The coexistence / proximity of two different ecosystem types	
2	Proximity to (any) natural habitat	can increase recreational potential
2	Proximity to forests	can increase recreational potential
2	**Proximity to water**	greatly increases recreational potential
	Landscape diversity	
1	**Landscape diversity**	can be relatively easily developed
	Landscape fragmentation & connectivity	
2	Landscape fragmentation from urban and transport infrastructure	a new EEA indicator based on the joint fragmentation (effective mesh size) of all natural & managed ecosystems
2	Fragmentation patterns of natural/seminatural landscapes	could be (re)calculated using effective mesh sizes for coherence (fragm.geom: nat. ecosystems vs. everything else)

** U: 'usefulness' score, which follows the 'traffic lights' scheme of the 2nd MAES report (Maes et al., 2014):*

1 *highly relevant for the specified aspect of forest condition, appropriate data are available at European scale, and easily understood by non-technical audiences (relevance, representativity, and data availability are all high – see details in in Annex 2)*

2 *relevant for the specified aspect of forest condition, some data are available, but still needs some work, or the indicator is difficult to be interpreted for non-technical audiences (relevance, representativity, or data availability is moderate)*

3 *relevant for the specified aspect of forest condition, but there are significant data or interpretation challenges (e.g. the indicator is just weakly linked to the characteristics that it is intended to indicate, thus representativity or data availability is low)*

Local **biodiversity**, especially the presence of charismatic or 'useful' species can attract recreation activities. **Charismatic species** groups include unanimously liked species, including *birds, butterflies*, marine mammals, ungulates, or *large trees*; but there are also some more controversial species, like large carnivores, or reptiles, which still attract some people. Unfortunately, most of the available biodiversity indicators do not focus explicitly on charismatic species. The abundance/diversity of bird species may be an exception, which is extractable from large EU monitoring programs in the form of habitat-specific bird indices (e.g. farmland bird index). Other EU databases on charismatic species, like the grassland butterfly indicator, struggle with more serious coverage and resolution issues.

In addition to charismatic species, there are many **'useful' species** that are being 'harvested' as a recreation activity, thus forming an undividable combination (bundle) of provisioning and cultural services. Such species might include *mushrooms* and *berries*, *fish*, and even *game* for hunting depending on cultural traditions and conceptual considerations. In most countries there are some data on fish and game species, although these data are of varying quality, weakly harmonized, and come with serious conceptual issues (e.g. there is considerable human input, as populations are often increased artificially). As excessive game densities can exert a major pressure on forests, game

density can also be validly considered as a pressure indicator, so it will be discussed in the next chapter in order to be consistent with the other fact sheets published in this series.

As the abundance and diversity of many natural species groups is correlated, and depends on the general 'conservation status' of the habitats, **general biodiversity indicators** can also be seen to influence the recreational potential of sites and landscapes. Owing to their key role in many recreation activities, the *ecological status of freshwater* and (coastal / transitional) *marine* ecosystems is of key importance for recreational potential, with indicators available from Water Framework Directive (WFD) and Marine Strategic Framework Directive (MSFD) reporting streams. In terrestrial ecosystems, general biodiversity indicators can also be seen to indicate a 'wilderness' character that makes a place appealing (up to a certain degree, as discussed in the previous chapter). A simple *naturalness* (or *hemeroby*) indicator based on the European map of ecosystem types (ETM v3.1: Weiss & Banko, 2018), could probably be efficiently used for this purpose (see also next chapter). There are also many other options, as e.g. diversity data for other major taxonomic group, or *outcomes from EU reporting obligations* (as listed in Table 5.1) can also be considered as general biodiversity indicators, but most of these data have insufficient spatial resolution or coverage for the EU MAES assessment (e.g. most of them are known only at the MS level, see Table 5.1 & Annex 2).

In forests the homogeneity of species composition and **age** can be useful indicators of condition relevant for recreational potential (people favour large and old trees). Nevertheless, even though MS forest inventories contain a lot of information about tree ages, an EU-wide harmonized indicator still needs to be developed.

Biomass, i.e. the mere amount of green (area of green spaces, volume / height / age of trees) can also be a useful indicator for recreation capacities, especially in urban areas. There are several easily accessible vegetation coverage indicators based on remote sensing data (normalized difference vegetation index, NDVI; leaf area index: LAI), the mean (or minimum / maximum) values of which could be used as meaningful condition indicators with a reasonable spatial resolution.

Indicators highlighting (spatial) **proximity to** 'nature' are relatively poorly represented among the MAES condition indicators proposed so far, but such indicators could be easily deduced from any relevant ecosystem map (e.g. ETM v3.1 underlying the EU MAES assessment). Proximity to *forests*, and to major *water bodies* (rivers, lakes, marine ecosystems) seem to be particularly relevant in terms of recreation.

The **diversity of the landscape** especially, the balance of open and closed spaces seems to be a landscape characteristic that is particularly important for recreation, which is also missing from the MAES condition toolbox. Such indicators can also be developed based on ETM (or any relevant ecosystem map) and auxiliary data sources (e.g. to classify the ecosystem types into finer categories, relevant for recreation). Several MAES ecosystem types involve **subtypes** which exhibit higher recreative capacities than the bulk of the MAES type (e.g. *vineyards* shown as category FB among heathlands on ETM v3.1; or *urban green* shown as category I2 among croplands), and the share of these subtypes in the 'landscape' can be seen as an important condition information, relevant for recreation. In croplands, and grasslands the **presence/absence of hedgerows, lines of trees**, etc. can be derived from remote sensing imagery (e.g. García-Feced et al., 2015). Viewsheds can also be considered when computing landscape diversity or water proximity (Peña et al., 2015), but computations involving viewsheds might be too specific to a single ES (i.e. recreation), and thus should rather be considered in the ES capacity 'box' of the MAES framework (i.e. as ES indicators rather than condition indicators).

6. How can pressures be taken into account?

The intensity (frequency or magnitude) of recurrent human management activities and/or (semi)natural disturbance regimes can be seen as characteristics of the ecosystems that highly influence their capacity to supply various services. In the MAES conceptual framework (Maes et al., 2013; 2014; 2018) these characteristics are listed under the heading "pressures", as which are considered an "indirect approach" for measuring ecosystem condition (Erhard et al., 2016, p.31). Nevertheless, pressures often directly alter specific components of the ecosystems, and in the case of many pressures, there is an underlying degradation process, which is measurable with a state variable (a 'degradable environmental stock', see Czúcz et al., 2018). The main purpose of this chapter is to identify such state variables as indicators, which can be linked to specific pressures (as identified in Maes et al., 2018) and the recreational potential of the ecosystems (as identified in the systematic review; Table 6.1).

The **general intensity of land use** / management activities is the most import group of factors determining the capacity of places for human recreation according to the outcomes of the systematic review. An overall indicator for *hemeroby*, could address just the human perception of being close to nature, which is highly relevant in this context. As the concept of naturalness and hemeroby are closely related (complementary), just either of these indicators would be enough – both of them would be redundant. Such a hemeroby indicator would be relatively easy to be developed based on ETM (see the discussion at naturalness).

High intensity agriculture in **croplands** negatively affects biodiversity and landscape diversity and thus undermines recreational capacities. Indicators of agricultural use intensity (e.g. the *intensification/extensification* indicator from Eurostat) can be of value here. Nevertheless, too low levels of agricultural intensity, and particularly abandonment (characterized e.g. the *share of fallows*) can also be seen negatively by recreational users.

In **grasslands**, the abundance of *grazing animals* influences recreation potential in an inverse way (unlike the typical "pressures"): more animals are generally more appealing to recreational users. Nevertheless, this is probably also a unimodal (bell-shaped) relationship, i.e. beyond a certain density additional animals become 'negative' to recreational potential (e.g. increased tick density, conflicts with shepherd dogs, etc.). Data for grazing intensity are available from the Eurostat farm structure surveys, and the CAPRI dataset, which can be used to construct such an indicator.

In **forests** the general intensity of use (e.g. *the length of felling cycle*), which largely determines tree ages and habitat diversity, has relevant influence on the recreational value of a forest or a forested landscape. *Game densities*, however, can be seen as positive, especially for some specific tourism activities (hunting). (This is, again, the opposite how these indicators influence most of the other ES, which are typically decreased with an increased game pressure.) Data for felling intensity are available from EEA at a low resolution (SEBI 017); more detailed data on felling cycles and game densities are collected by the MS in heterogeneous formats and reliability.

Various kinds of **pollution** can also seriously hamper the recreational potential of landscapes. Given the key role of surface waters in a broad range of possible recreational activities, the *chemical status of surface waters*, available from WFD (and MSFD) reporting, can be considered as key indicators. Excess *nitrogen*, *phosphorus*, and *sulphur* can also damage sensitive terrestrial ecosystems, which may cause them to lose their appeal for tourism (e.g. a forest damaged by acid rain).

Table 6.1: Indicators available for pressures relevant for recreation. The 'usefulness' of each indicator is highlighted with a 'traffic lights' colour scheme.* Proposed **key indicators** are highlighted in bold.

U*	Indicator name	Comments
	All ecosystems and land uses	
1	**Hemeroby**	a newly proposed condition indicator with a long history, conceptually close to "naturalness", unimodal relationship to recreation potential, still needs to be implemented
2	Human Appropriation of Net Primary Production (HANPP)	
	Farming intensity	
1	Intensification / extensification	only available at NUTS2 level, a unimodal relationship
2	Share of fallow land	negatively related to recreation (an impression of untidy landscape)
2	Crop diversity	
	Grazing intensity	
1	Livestock density	is in a positive (or unimodal) relationship w recreation (the opposite to what's expected from a pressure indicator)
	Forest use intensity	
2	Long term ratio of annual fellings to net annual increment	a key indicator for forest (use) sustainability, correlated with 'forest age'
2	Length of the felling cycle	a 'disturbance frequency' style simple indicator of forest use intensity (a slightly different simple indicator, which is more relevant for many ES), correlated with 'forest age'
3	Game density (or ratio to sustainable levels)	with a sign atypical for pressures (more game –> more potential (for active recreation)), still needs to be developed
	Nutrient / material balances	
2	Gross phosphorus balance	only available at a very coarse spatial resolution
1	**Chemical status of surface/ground water**	multiple indicators (components most relevant for recreation should be focussed at)
	Soil loss	
1	**Imperviousness**	can be correlated with biomass indicators in urban contexts (and also with the subtype 'urban green')
	Fire regime	
2	Number of fires	
2	Burnt area	slightly redundant w fire frequency

** U: 'usefulness' score, which follows the 'traffic lights' scheme of the 2nd MAES report (Maes et al., 2014):*

1 *highly relevant for the specified aspect of forest condition, appropriate data are available at European scale, and easily understood by non-technical audiences (relevance, representativity, and data availability are all high – see details in in Annex 2)*

2 *relevant for the specified aspect of forest condition, some data are available, but still needs some work, or the indicator is difficult to be interpreted for non-technical audiences (relevance, representativity, or data availability is moderate)*

3 *relevant for the specified aspect of forest condition, but there are significant data or interpretation challenges (e.g. the indicator is just weakly linked to the characteristics that it is intended to indicate, thus representativity or data availability is low)*

Soil sealing (the amount/share of sealed vs green surface) can be the major factor determining the 'value' of neighborhoods in urban contexts, but it is of relatively smaller significance in other ecosystem types. *Imperviousness* (the share of paved surfaces), is a readily available Copernicus product, which directly reflects an adequate state variable underlying this degradation process.

Recurrent **fire**s, which may be enhanced by climate change, can also reduce the recreational potential of a landscape. This disturbance can be best characterized by the new *fire frequency* indicator derived from remote sensing products by JRC.

7. How can condition indicators be integrated into recreation capacity models?

To ensure a high level of consistency across the different elements of the EU MAES assessment (=the main 'boxes' in Fig. 1.1), it is important that these elements would be interlinked as much as possible. The integration of condition indicators into ecosystem service modelling is particularly relevant for ensuring the internal coherence of the EU MAES assessment. Accordingly, it would be beneficial, if all relevant aspects of ecosystem condition (e.g. the ones identified in this fact sheet) would also be integrated into the model(s) used for mapping (and/or assessing) the capacities for that service. The main EU toolkit for modelling recreation is a rule-based GIS model implemented in the ESTIMAP modelling framework (ESTIMAP-R: Zulian et al., 2013, 2018a; Paracchini et al., 2014). Globally relevant tools either use a very similar approach (e.g. the "new" ARIES: Matínez-López et al., 2019), or apply a spatial statistical modelling approach (e.g. InVEST: Sharp et al., 2015). The following paragraphs discuss the degree to which the proposed condition indicators are compatible with the ESTIMAP-R model, and make tentative recommendations in order to increase this compatibility.

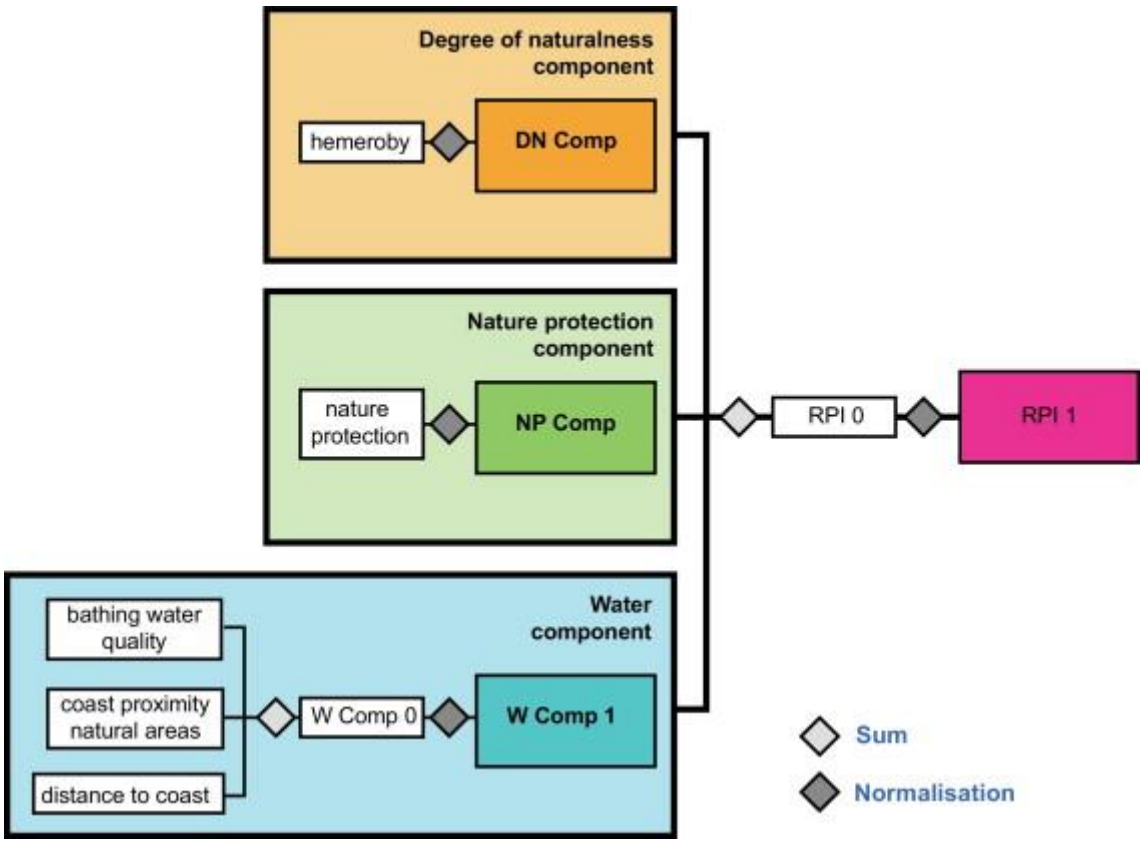

Figure 7.1: The structure of the ESTIMAP recreation module after Zulian et al. (2013).

ESTIMAP-R characterizes nature's contributions to (potential) recreation activities as a 'recreation potential index' (RPI). RPI is then spatially overlaid with accessibility and demand (population density) to produce a recreational opportunity spectrum (ROS). As ecosystem characteristics should be reflected in the natural component (RPI), this discussion focuses on RPI, and not ROS. In the original version of ESTIMAP-R (Fig. 7.1; Zulian et al., 2013; Paracchini et al., 2014) RPI consists of three main components: the degree of naturalness (DN), a protection status component (NP), and a

water (W) components, which are all formed by overlying appropriate GIS layers weighted by expert scores. In the later regional and thematic adaptations of the model (e.g. Liquete et al., 2016; Zulian et al., 2018ab) this logic was kept, but the components were refined (e.g. the concept of naturalness was replaced with the concept of "suitability of land to support nature-based recreation"), and the inclusion of all kind of locally available relevant datasets was encouraged (Zulian et al., 2018b). Table 5 summarizes the most important data sources applied in the various versions of ESTIMAP, and matches them to the ecosystem characteristics and condition indicators suggested by this work.

Table 7.1: Matching the main spatial input variables used in ESTIMAP-R (Zulian et al., 2013; Paracchini et al., 2014; Liquete et al., 2016; Zulian et al., 2018a) **to the key ecosystem characteristic types** (Table 4.1) **and indicators** (Tables 5.1 & 6.1) identified in this study.

Condition aspect	Ecosystem characteristic and indicator	ESTIMAP version	Comments
Biodiversity (in general)	*Hemeroby* as a general naturalness biodiversity indicator, based on an ETM (CLC) weighted by expert scores (determining 'suitability for recreation'; DN in Fig. 7.1)	all papers (some don't use the word hemeroby)	Hemeroby will probably calculated anyway (by JRC) to assess recreation in the frame of the EU MAES assessment. It would be a good idea to take this opportunity, and use it as an overall ecosystem condition indicator as well (and perform the computations with this in mind)
	Protection status as an expert scored overlay of polygons from Natura 2000 areas and other protected sites (e.g. the Common Database on Designated Areas; CDDA) (NP in Fig. 7.1)	Zulian et al., 2013; Paracchini et al., 2014	The use of response indicators to characterise ecosystem condition is problematic and should be avoided, see discussion in Czúcz et al., 2018.
	Ecological status of coastal waters (from MSFD reporting)	Liquete et al., 2016	
	Bird indices (e.g. farmland bird index)	–	This has not been used in ESTIMAP models yet
Age (of trees/forests)	A *forest age* indicator (see Table 5.1)	–	This has not been used in ESTIMAP models yet
The presence, extent (abundance) or proximity of a specific ecosystem type or subtype			
	Distance from water (sea and inland water bodies) quantified by simple GIS calculations	all papers	Coastal geomorphology (also used as a weighing factor in Liquete et al., 2016; Zulian et al., 2018a) is highly abiotic and exclusively specific to this single ES, so should not be considered as a condition indicator.
	Constellations of *natural areas in the proximity of water* are awarded extra scores.	Zulian et al., 2013; Paracchini et al., 2014	Quite specific to recreation (thus probably should not be considered as a condition indicator)
	Riparian zones (from Copernicus)	Liquete et al., 2016; Zulian et al., 2018a	
	Urban green infrastructure (as an expert scored overlay of GIS data)	Liquete et al., 2016; Zulian et al., 2018a	
	Embedded seminatural features in agricultural fields (e.g. from Garcia-Feced et al. 2015)	–	This has not been used in ESTIMAP models yet
Landscape diversity	a *landscape diversity* indicator (see Table 5.1)	–	This has not been used in ESTIMAP models yet
Pressures			
farming/ grazing/ forest use intensity	any indicators (see Table 6.1)	–	Such indicators have not been used in ESTIMAP models yet
soil sealing	*Imperviousness* (from Copernicus, see Table 6.1)	–	This has not been used in ESTIMAP models yet, probably because it is highly correlated with other indicators for 'urban green'
nutrient / material balances	Bathing *(chemical) water quality* (WFD and MSFD reporting)	all papers	

Altogether many of the relevant ecosystem characteristics identified in this fact sheet are already present in ESTIMAP-R, but there are also some condition aspects / indicators that are still missing.

Given the rule-based nature of ESTIMAP-R, it is relatively easy to flexibly integrate further condition indicators. If in the frame of the EU MAES assessment there will be a new round of ESTIMAP-R calculations, then it would be desirable to also update the model, and include all relevant characteristics/indicators (or at least the ones that had been identified as condition indicators in the same assessment). The integration of these cross-cutting linkages between the different components would make the whole EU MAES assessment more consistent and reliable.

References

Burkhard, B., Kandziora, M., Hou, Y., Müller, F. (2014): Ecosystem service potentials, flows and demands – concepts for spatial localisation, indication and quantification. Landscape Online 34:1-32.

Burkhard, B., Santos-Martin, F., Nedkov, S., & Maes, J. (2018). An operational framework for integrated Mapping and Assessment of Ecosystems and their Services (MAES). One Ecosystem, 3, e22831.

Czúcz, B., Götzl, M., Schwaiger, E., Schwarzl, B., & Sonderegger, G. (2017). Working paper on functional relationships between ecosystem characteristics and services in support of condition assessment. ETC/BD report to the EEA. https://bd.eionet.europa.eu/Reports/ETCBD TechnicalWorkingpapers/PDF/Functional_relationships_ecosystem_condition_assessments.pdf

Czúcz, B., Götzl, M., Schwaiger, E., Sonderegger, G., & Condé S. (2018): Fact sheets on ecosystem condition: a synthesis. ETC/BD report to the EEA (Task 175A).

Dramstad, W.E., M. Sundli Tveit, W.J. Fjellstad and G.L.A. Fry (2006) Relationships between visual landscape preferences and map-based indicators of landscape structure. Landscape and Urban Planning. 76: 465-474.

Erhard M, Teller A, Maes J, Meiner A, Berry P, Smith A, ..., Christiansen T (2016): Mapping and Assessment of Ecosystems and their Services. Mapping and Assessing the condition of Europe's ecosystems: Progress and challenges. 3rd Report. Publications office of the European Union, Luxembourg. http://catalogue.biodiversity.europa.eu/uploads/document/file/1328/ 3rdMAESReport_Condition.pdf

García-Feced, C., Weissteiner, C. J., Baraldi, A., Paracchini, M. L., Maes, J., Zulian, G., … Pérez-Soba, M. (2015). Semi-natural vegetation in agricultural land: European map and links to ecosystem service supply. Agronomy for Sustainable Development, 35(1), 273-283

García-Llorente, M., B. Martín-López, I. Iniesta-Arandia et al. (2012) The role of multi-functionality in social preferences toward semi-arid rural landscapes: An ecosystem service approach. Environmental Science & Policy. 19-20: 136-146.

Götzl, M., Sonderegger, G., Schwaiger, E., Schwarzl, B., Tramberend, P., Condé, S., Czúcz, B. (2016): Elements for a better knowledge on biological characterisation of ecosystems, their pressures and conditions. ETC/BD report. (Task 175A)

Gret-Regamey, A., Weibel, B., Kienast, F., Rabe, S.E., Zulian, G. (2015): A tiered approach for mapping ecosystem services. Ecosystem Services 13/2015, 16-27.

Haines-Young, R., & Potschin, M.B. (2018). Common International Classification of Ecosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure. http://www.cices.eu

Heyman, E. (2012) Analysing recreational values and management effects in an urban forest with the visitor-employed photography method. Urban Forestry & Urban Greening. 11: 267-277

Hofmann, M., J.R. Westermann, I. Kowarik and E. van der Meer (2012) Perceptions of parks and urban derelict land by landscape planners and residents. Urban Forestry & Urban Greening. 11: 303-312.

Holgén, P., L. Mattsson and C.-Z. Li (2000) Recreation values of boreal forest stand types and landscapes resulting from different silvicultural systems: an economic analysis. Journal of Environmental Management. 60: 173-180.

Horne, P., P.C. Boxall and W.L. Adamowicz (2005) Multiple-use management of forest recreation sites: a spatially explicit choice experiment. Forest Ecology and Management. 207: 189-199.

Hunziker, M., & Kienast, F. (1999). Potential impacts of changing agricultural activities on scenic beauty – a prototypical technique for automated rapid assessment. Landscape Ecology, 14(2), 161–176.

Lindemann-Matthies, P., R. Briegel, B. Schüpbach and X. Junge (2010) Aesthetic preference for a Swiss alpine landscape: The impact of different agricultural land-use with different biodiversity. Landscape and Urban Planning. 98: 99-109.

Liquete, C., Piroddi, C., Macías, D., Druon, J.-N., & Zulian, G. (2016). Ecosystem services sustainability in the Mediterranean Sea: assessment of status and trends using multiple modelling approaches. Scientific Reports, 6, 34162.

MA (Millennium Ecosystem Assessment) (2005). Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

Maes J, Teller A, Erhard M, Liquete C, Braat L, Berry P, … Bidoglio G (2013). Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020. Publications office of the European Union, Luxembourg. http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/MAESWorkingPaper2013.pdf

Maes J, Teller A, Erhard M, Murphy P, Paracchini ML, Barredo JI, … Lavalle C (2014). Mapping and Assessment of Ecosystems and their Services: Indicators for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020. 2nd Report. Publications office of the European Union, Luxembourg. http://catalogue.biodiversity.europa.eu/uploads/document/file/1230/2ndMAESWorkingPaper.pdf

Maes J, Teller A, Erhard M, Grizzetti B, Barredo JI, Paracchini ML, … Werner B (2018). Mapping and Assessment of Ecosystems and their Services: An analytical framework for ecosystem condition. Publications office of the European Union, Luxembourg. https://biodiversity.europa.eu/maes

MAES-INCA (in prep.): Natural Capital Accounting: Overview and Progress in the European Union. Publications office of the European Union, Luxembourg. https://biodiversity.europa.eu/maes (the 6th MAES report, still in progress...)

Martínez-López, J., Bagstad, K. J., Balbi, S., Magrach, A., Voigt, B., Athanasiadis, I., … Villa, F. (2019). Towards globally customizable ecosystem service models. Science of The Total Environment, 650, 2325–2336.

Oreszczyn, S. and A. Lane (2000) The meaning of hedgerows in the English landscape: Different stakeholder perspectives and the implications for future hedge management. Journal of Environmental Management. 59: 101-118.

Paracchini, M. L., Zulian, G., Kopperoinen, L., Maes, J., Schägner, J. P., Termansen, M., … Bidoglio, G. (2014). Mapping cultural ecosystem services: A framework to assess the potential for outdoor recreation across the EU. Ecological Indicators, 45, 371–385.

Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M., … Yagi, N. (2017). Valuing nature's contributions to people: the IPBES approach. Current Opinion in Environmental Sustainability, 26-27, 7-16

Peña, L., Casado-Arzuaga, I., & Onaindia, M. (2015). Mapping recreation supply and demand using an ecological and a social evaluation approach. Ecosystem Services, 13, 108–118.

Plieninger, T., Dijks, S., Oteros-Rozas, E., & Bieling, C. (2013). Assessing, mapping, and quantifying cultural ecosystem services at community level. Land Use Policy, 33, 118–129.

Sharp, R., Tallis, H.T., Ricketts, T., Guerry, A.D., Wood, S.A., Chaplin-Kramer, R., … Bierbower, W. (2015) InVEST 3.4.2. User's Guide. The Natural Capital Project, Stanford University, University of Minnesota, The Nature Conservancy, and World Wildlife Fund. https://www.naturalcapitalproject.org/invest/

Snep, R.P.H. , E.C. van Ierland and P. Opdam (2009) Enhancing biodiversity at business sites: What are the options, and which of these do stakeholders prefer?. Landscape and Urban Planning. 91: 26-35.

TEEB (2010) The Economics of Ecosystems and Biodiversity: Ecological and economic foundations. Routledge, Abingdon, UK (410 p.)

van Berkel, D.B. & Verburg P.H. (2014) Spatial quantification and valuation of cultural ecosystem services in an agricultural landscape. Ecological Indicators 37: 163-174

Vihervaara, P., Kumpula, T., Tanskanen, A., & Burkhard, B. (2010). Ecosystem services–A tool for sustainable management of human–environment systems. Case study Finnish Forest Lapland. Ecological Complexity, 7(3), 410–420.

Weiss, M., Banko, G. (2018). Ecosystem Type Map 2012 v3.1 – Terrestrial ecosystems and integration of marine part. ETC/BD report

Zulian, G., Paracchini, M.-L., Maes, J., & Liquete Garcia Maria Del, C. (2013). ESTIMAP: Ecosystem services mapping at European scale (EUR - Scientific and Technical Research Reports). Publications Office of the European Union. http://publications.jrc.ec.europa.eu/repository/handle/111111111/30410

Zulian, G., Thijssen, M., Günther, S., & Maes, J. (2018a): Enhancing Resilience Of Urban Ecosystems through Green Infrastructure (EnRoute): Progress Report. JRC Technical Reports. http://publications.jrc.ec.europa.eu/repository/handle/JRC110402

Zulian, G., Stange, E., Woods, H., Carvalho, L., Dick, J., Andrews, C., … Viinikka, A. (2018). Practical application of spatial ecosystem service models to aid decision support. Ecosystem Services, 29, 465-480.

Annex 1: The papers studied in the systematic review

Table A1: This table identifies the scientific papers related to the ES recreation ('aesthetic landscapes'), that were reanalysed from the OpenNESS systematic review (Smith et al., 2017). The table follows the structure of Table 4.1, linking each 'functional relationship' documented to the underlying papers using unique IDs, which are resolved below this table. The codes in brackets (e.g. "[T mi]") link the main types of characteristics to the types listed in Czúcz et al. (2017), where all further details about the characteristics typology and the reanalysis work can be found. Columns TI and NI give an overview on the importance of each characteristics for recreation:

- **TI**: total influence (the number of papers which document an effect of the characteristics on any of the studied ES in any ecosystem type);
- **NI**: net influence (the number of papers documenting a positive ES effect minus the number of papers with a negative effect; mixed effects are not counted).

Higher values of TI are highlighted in darker shades in order to give a better visual overview of the importance of each line, and negative numbers in column NI are highlighted in red. All of the remaining columns refer to specific MAES ecosystem types (urb: urban; cro: cropland; gra: grassland; for: woodland and forest; hea: heathland and shrub; SVL: sparsely vegetated land; wet: wetlands; wat: rivers and lakes; bra: marine inlets and transitional waters). The values in these columns are the unique IDs of the scientific papers, which document a 'functional relationship' and the specific ecosystem characteristic in the given ecosystem type. The IDs of the paper are resolved in a reference list at the end of this Annex.

Characteristics type	TI	NI	urb	cro	gra	for	hea	SVL	wet	wat	bra	coa
Management / disturbance intensity [T mi]	6	-4	347, 470	173, 466, 470	466, 470	91, 173, 197, 466, 470		173				
clearcutting	1	1				197						
Biodiversity (in general) [T di]	4	4	137, 470	466, 470	466	91, 466, 470			470			
Age of site / community [T ta]	1	1	347									
Biomass at the site [T bi]	1	1	476									
Site structure [T st]	1	-1				347						
The extent (abundance) of the target ecosystem type (or a specific subtype) [E ab]	4	2	215	175, 215, 466	175, 215					173		
hedgerows, treerows	2	2	215	215, 466	215, 466							
The proximity of specific ecosystem types to water [E pr]	1	1		173		173		173				
Landscape diversity [L di]	3	3	470	173, 175, 470	175, 470	173, 175, 470	175	173				

References

91 P. Horne, P.C. Boxall and W.L. Adamowicz (2005) Multiple-use management of forest recreation sites: a spatially explicit choice experiment. Forest Ecology and Management. 207: 189-199. https://doi.org/10.1016/j.foreco.2004.10.026

137 M. Hofmann, J.R. Westermann, I. Kowarik and E. van der Meer (2012) Perceptions of parks and urban derelict land by landscape planners and residents. Urban Forestry & Urban Greening. 11: 303-312. https://doi.org/10.1016/j.ufug.2012.04.001

173 M. García-Llorente, B. Martín-López, I. Iniesta-Arandia et al. (2012) The role of multi-functionality in social preferences toward semi-arid rural landscapes: An ecosystem service approach. Environmental Science & Policy. 19-20: 136-146. https://doi.org/10.1016/j.envsci.2012.01.006

175 W.E. Dramstad, M. Sundli Tveit, W.J. Fjellstad and G.L.A. Fry (2006) Relationships between visual landscape preferences and map-based indicators of landscape structure. Landscape and Urban Planning. 76: 465-474. https://doi.org/10.1016/j.landurbplan.2005.12.006

197 P. Holgén, L. Mattsson and C.-Z. Li (2000) Recreation values of boreal forest stand types and landscapes resulting from different silvicultural systems: an economic analysis. Journal of Environmental Management. 60: 173-180. https://doi.org/10.1006/jema.2000.0377

215 S. Oreszczyn and A. Lane (2000) The meaning of hedgerows in the English landscape: Different stakeholder perspectives and the implications for future hedge management. Journal of Environmental Management. 59: 101-118. https://doi.org/10.1006/jema.2000.0365

347 E. Heyman (2012) Analysing recreational values and management effects in an urban forest with the visitor-employed photography method. Urban Forestry & Urban Greening. 11: 267-277 https://doi.org/10.1016/j.ufug.2012.02.003

466 P. Lindemann-Matthies, R. Briegel, B. Schüpbach and X. Junge (2010) Aesthetic preference for a Swiss alpine landscape: The impact of different agricultural land-use with different biodiversity. Landscape and Urban Planning. 98: 99-109. https://doi.org/10.1016/j.biocon.2009.10.003

470 Derek B. van Berkel & Peter H. Verburg (2014) Spatial quantification and valuation of cultural ecosystem services in anagricultural landscape. Ecological Indicators 37: 163- 174 https://doi.org/10.1016/j.ecolind.2012.06.025

476 R.P.H. Snep, E.C. van Ierland and P. Opdam (2009) Enhancing biodiversity at business sites: What are the options, and which of these do stakeholders prefer?. Landscape and Urban Planning. 91: 26-35. https://doi.org/10.1016/j.landurbplan.2008.11.007

Czúcz, B., Götzl, M., Schwaiger, E., Sonderegger, G., & Schwarzl, B. (2017). Working paper on functional relationships between ecosystem characteristics and services in support of condition assessments. ETC/BD Working Paper. https://bd.eionet.europa.eu/Reports/ETCBD TechnicalWorkingpapers/PDF/Functional_relationships_ecosystem_condition_assessments.pdf

Smith, A. C., Harrison, P. A., Pérez Soba, M., Archaux, F., Blicharska, M., Egoh, B. N., … Wyllie de Echeverria, V. (2017). How natural capital delivers ecosystem services: A typology derived from a systematic review. Ecosystem Services, 26, 111-126.

Annex 2: Annotated list of potential MAES ecosystem condition indicators

Table A2: This table lists all indicators available and feasible to describe ecosystem characteristics relevant for recreation in the context of the EU MAES ecosystem condition assessment. All indicators are scored according to three aspects of 'usefulness':

- **rel**: relevance for recreation (1: relevant, 2: slightly/indirectly relevant);
- **rep**: the degree to which the indicator represents the underlying condition aspect (1: good representation, e.g. indicator fully covers a major aspect → 3: poor representation);
- **ava**: availability of indicator (1: available with a good quality & spatial resolution (at least NUTS2) for most of the EU (might still need some feasible update), 2: there is something available (but needs more work), 3: still to be developed (or needs major enhancements));

Relevance (rel), representativeness (rep), and availability (ava) are highlighted with a colour scheme following that of the 2nd MAES report (Maes et al., 2014). The overall 'usefulness' of each indicator (the coloured numbers in Tables 5.1 & 6.1) is calculated as the maximum (=worst) of these three scores. The remaining columns contain the following informations / metadata:

- **HI**: link to the HIPOC categories (just for pressures! – H: habitat loss, I: invasion, P: pollution, O: overexploitation, C: climate change);
- **indi.set**: link to high-level European indicator sets, if relevant (SEBI: Streamlining European Biodiversity Indicators, AEI: Agri-Environmental Indicators);
- **source**: the name of the data source / host institution, complemented with a weblink reference to a good description of the indicator where available;
- **unit**: the unit of the indicator;
- **pilot**: a list of previous studies (mainly MAES pilots: Maes et al., 2018) that had mentioned/proposed the indicator before (a: agroecosystems pilot; f: forest pilot; n: nature pilot);
- **date**: the reference period / years for which values of the indicator are available;
- **s.resol**: spatial resolution of the already available values of the indicator;
- **s.cover**: spatial coverage of the already available values of the indicator.

Unimplemented indicators (indicators under development) are highlighted in grey text, indicator families (which can/should be customized to the specific ecosystem types) are highlighted in *italics*, whereas the names of newly proposed indicators for filling gaps are highlighted in **bold**. The spatial resolution of indicators that don't reach the expected level of detail (at least NUTS2 region) is also highlighted in **bold**.

HI	rel	rep	ava	indicator name	indi.set	source	unit	pilot	date	s.resol	s. cover
				Biodiversity (diversity/abundance of major species groups)							
				species in general							
	2	1	2	*Conservation status and trends of species of community interest (for multiple ET)*	SEBI 003	Art17 DB	%	afn	2013, 2018	**MS x BGR**	EU
	2	1	2	*Red List Index of threatened species*	SEBI 002	EEA, IUCN	index	afn	1980s 2004, ...?	**EU (MS?)**	EEA39

HI	rel	rep	ava	indicator name	indi.set	source	unit	pilot	date	s.resol	s. cover
	2	1	2	Invasive alien species (richness)	SEBI 010	JRC-EASIN	1/area	f	?	10km	EU+
	2	1	3	Species diversity, richness (number and abundance of species, including vascular plants, vertebrates, etc)			index	f	?	?	?
				plants							
	2	3	3	Plant functional types (diversity)			?	f	?	?	?
	2	2	2	Forest tree species (richness)		AFOLU, MS?	1/area	f	~1998	100m	EU28, BY, MD
	2	3	3	Understory vegetation (richness)			1/area	f	?	?	?
	2	3	3	Bryophyte, moss, liverwort, lichen and fungal species richness (index)			?	f	?	?	?
				birds							
	1	2	2	EU Population status and trends of bird species (%)	SEBI 003	Art12 DB	index	afn	2013, 2018	**MS**	EU
	1	2	1	*Bird indices (farmland, forest...)*	SEBI 001	EBCC	index	afn	2002-	**MS**	EU
				insects							
	1	2	2	Grassland Butterfly Indicator	SEBI 001	EEA	index	a	1990-2015	**MS**	22 MS
				habitats							
	2	1	2	*Conservation status and trends of habitats of community interest*	SEBI 005	Art17 DB	%	afn	2013, 2018	**MS x BGR**	EU
	2	2	2	*Threatened habitat cover*		Art17 DB	%	fn	2013, 2018	**MS x BGR**	EU
	2	2	2	Deadwood	SEBI 018	EEA	m3/ha	f	2000-2010	**MS**	25 from EEA39
	1	1	1	Naturalness (index or typology)			index	f	?	?	?
	2	2	2	Red List Index of threatened habitats		IUCN EU RL	index	f	2017	?	?
	1	1	1	*Ecological status of surface water bodies*	SEBI 016	WISE	index		1992-	RBMP	EU
				Age of site / community							
	1	2	2	Forest age (% of forest in age categories)		JRC, MS?	% or y	f	?	?	?
	2	1	3	**Community age (time since last major intervention/ disturbance: felling, fire, abandonment, etc)**		?	y		?	?	?
				Biomass at the site							
	1	1	1	Normalized difference vegetation index (NDVI)		Copernicus	index	f	1998-	1km	Global
	1	1	1	Leaf Area Index (LAI)		Copernicus	index	f	1998-	1km	Global
	2	1	2	Tree height		JRC, MS?	m	f	?	?	?
	2	1	2	Tree cover density		JRC, MS?, Copernicus?	%	f	?	?	?
	2	3	3	Tree crown size (diameter)		JRC, MS?, Copernicus?	m	f	?	?	?
				Site structure							
	2	1	1	Structural heterogeneity		JRC	index	f	2006	250m	EU27
				Water availability							
	2	1	1	**Water and wetness probability index (WWPI)**		Copernicus	%		2009-	100m	EEA39

HI	rel	rep	ava	indicator name	indi.set	source	unit	pilot	date	s.resol	s. cover
	2	1	3	**Water levels**		?	?		?	?	?
				The extent (abundance) of a specific subtype (of the target ecosystem type)							
	1	1	1	Extent of ETM subtypes	SEBI 004	CLC	%		1985-	100m	EU27
	2	1	3	Extent of forest types		forest invento ries?	%	f			
	1	1	1	Density of embedded seminatural elements (hedgerows, lines of trees, etc.)		JRC	%	a	2006	1km	EU27
	2	1	1	HNV area		JRC	%	a	2000, 2006	100m	EU27
				The coexistence / proximity of two different ecosystem types							
	2	1	1	**Proximity to (any) natural habitat**		ETM	km (or m)		2012-	?	EU28+, TR, W. Balkan
	1	2	1	**Proximity to forests**		ETM	km (or m)		2012	?	EU28+, TR, W. Balkan
	1	2	1	**Proximity to water**		ETM	km (or m)		2012	?	EU28+, TR, W. Balkan
				Landscape diversity							
	1	1	1	**Landscape diversity**		ETM	index		2012	?	EU28+, TR, W. Balkan
				Landscape fragmentation & connectivity							
	2	1	2	Landscape fragmentation from urban and transport infrastructure	LSI 004, CSI 054	EEA	km2	af	2012	1km	EU28+, TR, W. Balkan
	2	1	1	Fragmentation patterns of natural/seminatural landscapes	SEBI 013	CLC (ETM?)	index	fn	2006-2012	100m	EEA39
	2	1	1	Connectivity of seminatural elements (hedgerows...)		JRC	index	a	2006	1km	EU27
				Management / disturbance intensity (pressures)							
				All ecosystems and land uses							
O	1	1	1	**Hemeroby**		CLC, CAPRI, AFOLU			2006	100m	EU27
O	2	1	2	Human Appropriation of Net Primary Production (HANPP)		UNI Klagenf urt	kg/m2 /y of C	a	1990, 2000, 2006	1km	25 MS
				Farming intensity							
OP	1	1	1	Intensification / extensification	AEI12	Euro-stat	index (EUR)	an	1996, 2006	NUTS2	EU 27
O(H)	2	1	1	Share of fallow land		FSS, CAPRI	%	a	2010; 2012	5km; HSU	EU28
O(I)	2	2	1	Crop diversity		FSS, CAPRI	1/area	a	2010; 2012	10km	EU28,HR : NUTS2
				Grazing intensity							
O	1	1	1	Livestock density		FSS, CAPRI	LU/ha	a	2010, 2012	5km, HSU(?)	EU28
				Forest use intensity							
O	2	1	2	Long term ratio of annual fellings to net annual increment	SEBI 017	EEA	%	f	1990-2010	**MS**	EEA39
O	1	1	2	**Length of the felling cycle**		EEA, MS	y		?	?	?
O	1	1	3	**Game density (or ratio to sustainable levels)**		MS for-estries	%		?	?	?
				Nutrient / material balances							

HI	rel	rep	ava	indicator name	indi.set	source	unit	pilot	date	s.resol	s. cover
OP	2	1	1	Gross phosphorus balance	AEI16	CAPRI	kg/ha/y of P	a	1990-2016	**MS**	EU
P	1	1	1	*Chemical status of surface/ground water*	SEBI 016	WISE	index	a	1992-	RBMP	EU
				Soil loss							
H	1	1	1	Imperviousness		Copernicus	%		2006-2015	20m	EEA39
				Fire regime							
C	2	1	2	Number of fires		JRC-EFFIS	1/ha/y	f	1980-	Point data	EU+
C	2	2	2	Burnt area		JRC-EFFIS	%/y	f	1980-	250m	EU+

References

Maes J, Teller A, Erhard M, Murphy P, Paracchini ML, Barredo JI, … Lavalle C (2014). Mapping and Assessment of Ecosystems and their Services: Indicators for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020. 2nd Report. Publications office of the European Union, Luxembourg. http://catalogue.biodiversity.europa.eu/uploads/ document/file/1230/ 2ndMAESWorkingPaper.pdf

Maes J, Teller A, Erhard M, Grizzetti B, Barredo JI, Paracchini ML, … Werner B (2018). Mapping and Assessment of Ecosystems and their Services: An analytical framework for ecosystem condition. Publications office of the European Union, Luxembourg. https://biodiversity.europa.eu/maes

Annex 3: Key definitions

Actual use or **flow** (of an ecosystem service): The amount of an ecosystem service that is actually mobilized in a specific area and time (based on OpenNESS, 2014).

Benefits: Positive change in wellbeing from the fulfilment of individual or societal needs and wants (based on TEEB, 2010).

Biodiversity: The variability among living organisms from all sources, including inter alia terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part, this includes diversity within species, between species, and of ecosystems (based on CBD, 1992).

Capacity (for an ecosystem service): The ability of a given ecosystem to generate a specific ecosystem service in a sustainable way (based on SEEA-EEA, 2012).

Conceptual framework: A model describing the relevant elements of a physical or social system and the main connections between them for the purposes of understanding and communication.

Condition aspect: Meaningful groups / types of ecosystem characteristics, which should be taken into consideration for quantifying ecosystem condition in a particular assessment context. 'Condition aspects' are related to 'ecosystem condition' in the same way as 'ecosystem service types' are related to the concept of 'ecosystem services'. All condition aspects identified as relevant should be represented by quantitative condition indicators in the assessment process.

Conservation status (of a natural habitat): The sum of the influences acting on a natural habitat and its typical species that may affect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species (EEC, 1992).

Conservation status (of a species): The sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations (EEC, 1992).

Ecosystem: 1 (in a general context): A dynamic complex of plant, animal, and microorganism communities and their non-living environment interacting as a functional unit. Humans may be an integral part of an ecosystem, although 'socio-ecological system' is sometimes used to denote situations in which people play a significant role, or where the character of the ecosystem is heavily influenced by human action (based on CBD, 1992 and MA, 2005). 2 (in a MAES context): An instance of an ecosystem type.

Ecosystem accounting: Ecosystem accounting is a coherent and integrated approach to the measurement of ecosystem assets and the flows of services from them into economic and other human activity (SEEA-EEA, 2012)

Ecosystem assessment: A social process through which the findings of science concerning the causes of ecosystem change, their consequences for human well-being, and management and policy options are brought to bear on the needs of decision-makers (UK NEA, 2011).

Ecosystem characteristic: Key attributes of an ecosystem unit describing its components, structure, processes, and functionality, frequently closely related to biodiversity. The term characteristics is intended to be able to encompass all of the various perspectives taken to describe an ecosystem. (based on SEEA-EEA).

Ecosystem condition: The overall quality of an ecosystem unit, in terms of its main characteristics underpinning its capacity to generate ecosystem services. The concepts of 'ecosystem state', 'ecosystem health', 'ecosystem integrity', 'ecosystem quality', and 'naturalness' are closely related to the concept of ecosystem condition.

Ecosystem degradation: A persistent decline in the condition of an ecosystem.

Ecosystem extent: The spatial area covered by an ecosystem or ecosystem type (based on SEEA-EEA, 2012).

Ecosystem service (ES): The contributions of ecosystems to benefits obtained in economic, social, cultural and other human activity (based on TEEB, 2010 & SEEA-EEA, 2012). The concepts of 'ecosystem goods and services', 'final ecosystem services', and 'nature's contributions to people' are considered to be synonymous with ecosystem services in the MAES context.

Ecosystem status: Ecosystem condition defined among several well-defined categories with a legal status. It is usually measured against time and compared to an agreed target in EU environmental directives (e.g. Habitats Directive, Water Framework Directive, Marine Strategy Framework Directive), e.g. "conservation status".

Ecosystem type (ET): A specific category of an ecosystem typology.

Ecosystem typology: A classification of ecosystem units according to their relevant ecosystem characteristics, usually linked to specific objectives and spatial scales.

Habitat: 1. (in a general context): The physical location or type of environment in which an organism or biological population lives or occurs, defined by the sum of the abiotic and biotic factors of the environment, whether natural or modified, which are essential to the life and reproduction of the species (based on EEC, 1992). 2 (in a MAES context): A synonym of 'ecosystem type'.

Human well-being: A state that is intrinsically (and not just instrumentally) valuable or good for a person or a societal group, comprising access to basic materials for a good life, health, security, good physical and mental state, and good social relations (based on MA, 2005).

Indicator: An indicator is a number or qualitative descriptor generated with a well-defined method which reflects a phenomenon of interest (the indicandum). Indicators are frequently used by policy-makers to set environmental goals and evaluate their fulfilment (based on Heink & Kowarik, 2010).

MAES framework: The conceptual framework for the EU Mapping and Assessment of Ecosystem Services (MAES) programme (Target 2 Action 5 of the EU Biodiversity Strategy to 2020). The main elements of the MAES framework are the extent and condition of ecosystem types, and the capacities and flows of ecosystem service types, which need to be valuated with appropriate methods.

Mapping: The process of creating a cartographic representation (map) of objects in geographic space. In the MAES context mapping means a spatially detailed assessment of the elements of the MAES framework, which aims inter alia at creating cartographic representations of the studied elements (based on OpenNESS, 2014).

Pressure: 1 (in a general context): Human induced processes that alter the condition of ecosystems. 2. (in the context of this study): recurrent patterns (regimes) of human land use activities or natural disturbances that can characterize an ecosystem in a particular place.

This glossary of terms is principally based upon **Czúcz & Condé (2017)** and **Maes et al. (2018)**. The definitions for *actual use*, *ecosystem condition* and *pressure* have been adjusted, and the terms *condition aspect* and *MAES framework* are new.

References

CBD, 1992.Convention on Biological Diversity. United Nations.

Czúcz, B., Condé, S. (2017). Note on definitions related to ecosystem conditions and their services based on different glossaries. ETC/BD Technical Paper. https://bd.eionet.europa.eu/Reports/ETCBDTechnicalWorkingpapers/Definitions_ecosystem_conditions_and_services

EEC, 1992. Council directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.

MA, 2005. Ecosystems and Human Wellbeing: Current State and Trends, Volume 1, Island Press, Washington D.C.

Maes J, Teller A, Erhard M, Grizzetti B, Barredo JI, Paracchini ML, … Werner B (2018). Mapping and Assessment of Ecosystems and their Services: An analytical framework for ecosystem condition. Publications office of the European Union, Luxembourg. Will be available from: https://biodiversity.europa.eu/maes

OpenNESS, 2014. OpenNESS Glossary (V2.0). Grant Agreement No 308428. Available from: http://www.openness-project.eu/library/reference-book

OECD, 2016. Glossary of statistical terms. http://stats.oecd.org/glossary/

Parson, E.A., 1995. Integrated Assessment and Environmental Policy Making, in Pursuit of Usefulness, Energy Policy, 23(4/5), 463-476.

SEEA-EEA, 2012. System of Environmental-Economic Accounting 2012: Experimental Ecosystem Accounting. http://unstats.un.org/unsd/envaccounting/eea_white_cover.pdf

Smith, A. C., Harrison, P. A., Pérez Soba, M., Archaux, F., Blicharska, M., Egoh, B. N., … Wyllie de Echeverria, V. (2017). How natural capital delivers ecosystem services: A typology derived from a systematic review. Ecosystem Services, 26, 111-126.

TEEB, 2010. The Economics of Ecosystems and Biodiversity: Ecological and economic foundation. Earthscan, Cambridge.

UK NEA, 2011. The UK National Ecosystem Assessment Technical Report. UNEP-WCMC, Cambridge

Annex 4: List of abbreviations

AEI	Agri-Environmental Indicators
AFOLU	agriculture, forestry and other land use
Art12	Article 12 (assessments of species under the EU Birds Directive)
Art17	Article 17 (assessments of habitats and species under the EU Habitats Directive)
BGR	biogeographic region
CAPRI	Common Agricultural Policy Regionalised Impact
CBD	Convention of Biological Diversity
CICES	Common International Classification of Ecosystem Services
CLC	Corine land cover
Corine	Coordination of Information on the Environment
DB	database
DEM	Digital elevation models
EASIN	European Alien Species Information Network
EBCC	European Bird Census Council
EEA	European Environment Agency
EC	Ecosystem condition
EEC	European Economic Community
ES	ecosystem service(s)
ESTIMAP	European Ecosystem Services Mapping tool
ET	ecosystem type(s)
ETC/BD	European Topic Centre on Biological Diversity
ETC/SIA	European Topic Centre for Spatial information and Analysis
ETC/ULS	European Topic Centre on Urban, Land and Soil Systems
ETM	ecosystem type map
EU	European Union
EUNIS	the European Nature Information System (habitat classification)
Eurostat	the statistical office of the European Union
FSS	farm structure surveys
GIS	geographic information system
HANPP	human appropriation of net primary production
HIPOC	habitat change, invasive species, pollution, overexploitation, climate change (a common list of the main drivers of environmental change)
HNV	high nature value farmlands
HSU	homogeneous spatial units (of farmlands)
IAS	invasive alien species
IMAP	Integrated Monitoring and Assessment Programme
InVEST	integrated valuation of ecosystem services and tradeoffs
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IUCN	International Union for Conservation of Nature
JRC	Joint Research Centre
KIP INCA	Knowledge Innovation Project on an Integrated system for Natural Capital and ecosystem services Accounting
LAI	Leaf Area Index
LRTAP	Long Range Transfer of Air Pollution

LU	livestock units
LUCAS	Land Use/land Cover Area frame Survey
LU/LC	Land use / land cover
MA	Millennium Ecosystem Assessment
MAES	mapping and assessment of ecosystems and their services
MS	EU Member States
NCP	Nature´s Contribution to People
NDVI	Normalized Difference Vegetation Index
NDWI	Normalized Difference Water Index
NUTS	nomenclature of territorial units for statistics
OpenNESS	Operationalisation of natural capital and ecosystem services (EU FP7 project)
RBMP	River Basin Management Plan
SEBI	Streamlining European biodiversity indicators
SEEA-EEA	System of Environmental Economic Accounts - Experimental Ecosystem Accounts
SOC	soil organic carbon
SVL	sparsely vegetated land
TEEB	The Economics of Ecosystems and Biodiversity
TR	Turkey
UK NEA	United Kingdom National Ecosystem Assessment
UNI	University
W.Balkan	West Balkan
WFD	Water Framework Directive
WISE	Water Information System for Europe
WWF	World Wildlife Fund