Ref. Ares(2023)5305032 - 01/08/2023

MAMBO

MODERN APPROACHES TO THE MONITORING OF BIODIVERSITY

D4.1 Review of habitat condition metrics used across the EU.

31/07/2023

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Funded by the European Union

Prepared under contract from the European Commission
Grant agreement No. 101060639
EU Horizon Europe Research and Innovation Action

Project acronym:	**MAMBO**
Project full title:	**Modern Approaches to the Monitoring of Biodiversity**
Project duration:	01.09.2022 – 31.08.2026 (48 months)
Project coordinator:	Dr. Toke Thomas Høye, Aarhus Universityy (AU)
Call:	HORIZON-CL6-2021-BIODIV-01
Deliverable title:	Review of habitat condition metrics used across the EU
Deliverable n°:	D4.1
WP responsible:	France Gerard (UKCEH)
Nature of the deliverable:	Report
Dissemination level:	Public
Lead beneficiary:	UKCEH
Due date of deliverable:	31/05/2023
Actual submission date:	31/07/2023

Deliverable status:

Version	Status	Date	Author(s)
1.2	final	31/07/2023	France Gerard, Jesper Moeslund, Daniel Kissling, Lois Kinneen

Table of Contents

1 Background

Effective ways to monitor biodiversity and the state of nature is becoming increasingly important in the light of the biodiversity crisis (REF). Today, monitoring is still mainly based on field-based inventories and surveying. However, significant advances in technologies such as artificial intelligence, sound and image recognition and remote sensing are now creating opportunities to provide more effective alternatives and/or complement field-based monitoring. One main goal of the EU project "Modern Approaches to the Monitoring of Biodiversity" is to trial and demonstrate the most promising technologies. This review focusses on identifying options for using remote sensing technology, in particular LiDAR sensing and drone imagine technology, to monitor habitat condition at site level (i.e., management relevant) in Europe.

Most European countries are EU members and are hence legally required to regularly assess the condition of habitats identified by the EU to be of particular interest to the community. Several non-EU states have adopted similar requirements. However, to date, there is no commonly agreed approach to assess condition and as a result individual countries, municipalities or site managers have developed their own. Still there is overlap in methodology and metrics. For example, most countries base a relatively large part of their nature condition assessments on species occurrence.

To identify remotely sensed based approaches that are the most relevant and useful across countries for site level habitat condition assessments (i.e., management relevant), we first need to establish the condition metrics that have been developed and are commonly used by field practitioners in current national, regional or local scale monitoring programmes. We also need to establish field practitioners' measurement requirements and evaluate if these can be achieved using remote sensing (specifically Lidar and drone-based RS). In this review we extracted and summarised this information from several European countries from publicly available national, regional and local technical field manuals for habitat condition monitoring. We also asked field practitioners using online questionnaires. We then, consulting peer-reviewed remote sensing literature and using our own expertise, identified the metrics that could be delivered through Lidar and drone imaging.

2 Definitions

The term habitat can refer to the specific biotic and abiotic parts of the environment where an organism lives (e.g., the habitat of species x) or to a particular environment without reference to a specific species (e.g., the coastal dune habitat) (Bamford & Calver, 2014, other refs?). In either case habitat condition will depend on the species in question. It is about the habitat's capacity to support a particular species, i.e., whether the habitat's biotic and abiotic factors are at levels required for the species to thrive. Here, we focus on the condition monitoring of habitats that support (semi-)natural species communities and are generally found in protected areas (e.g., Natura-2000 sites).

3 Reviewing the grey literature: Existing metrics developed for field-based monitoring.

3.1 Method

This review was based on grey literature describing or instructing how to measure habitat condition metrics. We found literature by searching google.com for the following search terms in each respective country's native tongue: all combinations of (1) "habitat condition" and "monitoring", "assessment", "metric", "indicator", (2) "habitat survey" and "manual", "handbook", "method", "guide", and (3) "habitat assessment" and "manual", "handbook", "method", "guide". We supplemented this search by contacting our network in Denmark, Sweden, Norway, Czech Republic*, The Netherlands* and Poland. The countries marked by an "*" are countries where we made contact but did not receive a response leading to useful literature for reviewing and we did not possess native tongue skills for these countries good enough to search for native literature using search engines.
We aimed to identify habitat condition metrics that each country uses for monitoring, and when available, we also noted the precision typically used for a given metric (i.e., the numeric steps that a given metrics is recorded at. For example, presence/absence, cover in 1, 2, 5, 10% or coarser steps, number of abundance classes). Finally, as some metrics are habitat specific, we recorded the habitat type for which the metric was listed.

3.2 Results

An initial search found a total of 65 documents which showed some relevance (Annex- Table 4 lists all the documents found, including e.g., Australian literature). These were filtered down to 17 documents which were mainly national level field protocols for the collection of habitat specific condition metrics or summaries of habitat specific metrics to consider (Annex-Table 1). They represent 7 countries: England, Denmark, France, Italy, Poland, Norway, and Sweden.

We focused on terrestrial habitats only, and the review identified 35 different habitat condition metrics. Across the board we found that condition metrics were developed to reflect the habitat's composition, structure, function, and degradation/alterations. As a result, we also grouped our compilation using these 4 main categories.

Annex-Table 2A lists the metrics and identifies the country and EUNIS habitat type (total of 27 EUNIS habitat types) for which we found each metric.To summarize the findings, we further grouped the habitats into 11 groups as follows (Annex-Table3):

- all coastal habitats (old EUNIS codes B*),
- salt meadows, marshes and inland salt steppes and marshes (old EUNIS codes A and E6),
- mires bogs and fens (old EUNIS codes C and D),
- grasslands and forest fringes (old EUNIS codes E1 to E6),
- sparsely wooded grassland (old EUNIS code E7)
- forests (old EUNIS codes G*),
- tundra, arctic, alpine and subalpine scrub (old EUNIS codes F1 and F2),

- temperate Mediterranean-montane scrub and temperate shrub heathland (old EUNIS codes F3 and F4),
- maquis and garrigue and spiny Mediterranean heaths and xerophytic scrub (old EUNIS codes F5 to F8),
- riverine and fen scrub (old EUNIS code F9) and
- screes, inland cliffs, rock pavements, outcrops (old EUNIS codes H2 and H3).

We then counted the number of times (i.e., number of countries, maximum 7) the metric was listed under each habitat group. Because some of the 11 groups consisted of more of the original 27 habitats, to avoid bias, we divided this count with number of habitat types within the group.

The top metrics, in order of importance and relevant across most or many habitats, are:

1. Cover: Habitat extent (stable, increase or decrease),
2. Composition: Presence of positive indicator species,
3. Composition: Presence of problem species,
4. Composition, structure: Woody cover (%),
5. Degradation, alterations: Bare ground (%)
6. Cover: Fragmentation metrics (stable, increase or decrease of connectivity), landscape metrics (patch size, number),
7. Composition, structure, function: presence of (all) dynamic stages,
8. Dead material (litter, wood, drift material on beaches and dunes) – size not specified.

Other important metrics are more habitat specific:

9. Degradation, alterations: Abrasion, linear features (tracks or low vegetated areas due to traffic, digging, extraction),
10. Degradation, alterations: Evidence or high density of grazers, browsers (e.g., rabbit, large grazers such as cattle, horses, deer) / diggers (e.g., moles, wild boar),
11. Degradation, Alterations, productivity: evidence of grazing (not using indicator species e.g., vegetation height),
12. Composition, structure, function: Species indicating nutrient changes - e.g., grassland improvement; trophic changes,
13. Degradation, alterations: Human made objects or surfaces,
14. Degradation, Alterations: % burnt area (and frequency),
15. Degradation, Alterations: change in micro-topography (e.g., sunken peat, erosion channels, dune erosion).

Some metrics are country specific:

- 'Wetness (Ellenberg F)' is specific to Norway and Sweden.
- 'Degradation, alterations: Area without technical interventions in 1 km vicinity / distance from human activities' is specific to Norway and Italy
- 'Light condition/canopy cover – forest' is specific to Norway.

Some metrics are habitat specific:

- 'Coarse dead wood >30 cm dbh' and 'Cover: old growth forest' are specific to forest habitats

- ‘Function: Dune morpho-dynamic metrics’ are specific to dune habitats.
- ‘Composition, Structure: Woody vegetation, presence/absence or quantification of understory/natural regeneration’ and ‘Composition, Structure: Woody vegetation height, dbh’ are specific to woody habitats.

And some metrics are specific to a single country and habitat:

- ‘Cover: area without dead or damaged Calluna’ is specific to Norway for the habitat ‘Temperate shrub heathland’
- ‘N° of hollow broadleaved trees’ is specific to Norway for the habitat ‘Deciduous broadleaved forests’
- ‘Composition, structure: tree-shrub ratio’ is specific to Italy for the habitat ‘Broadleaved evergreen forests’

When provided, metric measurement, and threshold steps (i.e., precision) indicating favourable and levels of less favourable condition consistently vary with habitat type (ANNEX-Table 2B). So, for example, a positive indicator species could refer to different proportions of species found listed as indicator species, different % covers of the indicator species, or more generic species richness and diversity indices. For % woody cover, the thresholds for a favourable condition will vary and depend on whether presence of woody vegetation is wanted (scrub, dune habitats) or not (grassland habitats), and in some cases a distinction between shrub and tree is required (e.g., Italy, Broadleaved evergreen forests, Norway, Pine forests).

3.3 Discussion

The review, although covering many of the habitats found in Europe, is limited to 7 countries. To avoid bias towards certain localities or habitats we ignored field protocols uniquely developed for a single site or niche habitat (e.g., a guide to monitor forested sites near Brussels – record 26 in ANNEX-Table 4) and worked with documents outlining habitat specific guides at national level. The documentation found varied substantially in content and level of detail, reflecting the purpose of the published document. Also in some cases, it was clear that for certain habitats the protocols were still a work in progress. Although, additional on-line searches or contacting authors is likely to generate more data and detail, our review as it stands is already providing a good insight into the number and type of habitat condition metrics used across habitats and Europe.

To ensure cost-effectiveness, metrics that are potential candidates for a remote sensing approach need to be relevant to many habitats. Our review suggests that there are at least 8 such metrics and another 7 relevant to several habitats. However, when looking at the detail it becomes clear that the manner in which the metric is measured is not exactly the same across all habitats. This is crucial when considering using remote sensing, because a variation in the measurement (or required precision) could signify a substantial difference in remote sensing approach used (i.e., choice of data set and retrieval algorithm). For example, the metric ‘presence of (all) dynamic stages’ implies different observations when dealing with a salt marsh, a dune system, a heathland or a bog or fen.

Presence of one or more indicator species (positive or negative) are after habitat extent the most dominant metrics. There is scope to use automated species identification using imagery and deep learning, but this needs fine-detailed imagery, focussing on the plant in question. Also, when using remotely sensed imagery we are generally limited to identifying plants that are present in the top canopy, and we face the challenge of first isolating individual plants within the imaged vegetation.

Another top scoring metric group are the habitat fragmentation and landscape metrics. These need mapping of the habitat (and/or vegetation communities within the habitat) first. Automating habitat mapping is challenging and many still rely on manual interpretation. The main issue is that each habitat type or site can come with specific mapping challenges, including the spatial detail required. As a result, successful mapping often requires a site-specific approach.

Seven of the top 15 metrics are indirect indicators of a degradation process or an altered habitat. From these, % bare ground, linear features (e.g., number or length), burnt area (%, presence/absence, frequency), changes in topography (e.g., height, width, slope), and human-made objects are well suited for a remote sensing solution. Other metrics are less specific. This is because, often the surveyor is left to provide an (qualitative) expert opinion on degradation level, based on a list of observed features or interventions. To develop a remote sensing solution, we would first have to establish quantitative alternatives through dialogue with the experts and ideally (like % bare ground) these would be applicable across many habitats.

4 Relevant metrics identified by stakeholders: Questionnaire.

4.1. Method

To gain insight into stakeholders' needs, we developed a questionnaire guided by the metrics identified in the grey literature review (see ANNEX-Table 2). The aim was to identify the most and least used metrics and those that stakeholders believe could be delivered through remote sensing. The questionnaire consisted of the following questions:

- Question 1: To begin, which habitat conditions metrics do you currently use?
- Question 2: Please now rank these habitat conditions metrics that you use in terms of their importance, with 1 indicating the most important metric.
- Question 3: Please now rank the habitat conditions metrics you use according to their ease of implementation, with 1 indicating the easiest metric to use
- Question 4: Which other habitat conditions metrics (not listed would you use given the opportunity (i.e. if you had more resources, better tools etc.)?
- Question 5: Now thinking about remote sensing, for which habitat conditions metrics do you use remote sensing?
- Question 6: Which habitat conditions metrics do you think remote sensing could deliver?
- Question 7: Considering the habitat conditions metrics you do use, please indicate how precise do their estimates need to be (indicators)?
- Question 8: What countries/regions does your habitat conditions monitoring cover?

For questions where we requested a ranking by integers (i.e., Q2 and Q3) we calculated the median rank and weighed this by 1/ Nº stakeholders ranking the metric in question. This adjusted rank was then used to evaluate the importance or ease of implementation of the different metrics.

4.2. Results

Fifteen individuals from at least 5 countries answered the questionnaire (not all stakeholders shared their country of work). Generally, all listed metrics are used by at least 2 individuals, most metrics are used by 5 or more.

The most often used habitat condition metrics are:

- positive and negative indicator species,
- habitat extent,
- woody cover,
- % bare ground,
- evidence of drainage or other alterations to hydrology,
- forest floor light conditions,
- the amount of coarse dead wood, and
- number of large trees.

The most important habitat condition metrics are:

- habitat extent,
- positive, negative, and nutrient indicator species,
- habitat fragmentation, and
- woody cover.

followed by:

- mowing or grazing regime indicator species,
- number of large or hollow broad-leaved trees,
- forest floor light conditions and
- altered/degraded water/hydrological factors.

The least important habitat condition metrics with 2-3 ratings from the participants are:

- area without technical interventions close by,
- % dung,
- area without dead or damaged heather, and
- whether or not there is a high density of smaller natural grazers or diggers like rabbits and moles.

The condition metrics which stakeholders felt are the easiest to implement are:

- habitat extent,
- indicator species,
- forest floor light conditions,
- water extent, and

- evidence of drainage,

followed by:

- percent bare ground,
- area with either dead or damaged heather or with at least two life-stages of it,
- evidence of grazing and,
- presence of human made objects.

The metrics thought to be hardest to implement are:

- area without technical interventions close by,
- natural reduction in population of different species, and
- % dung present.

The stakeholders had several suggestions for habitat condition metrics that they would like to use if given the opportunity. These included: seed bank viability, predictions of future habitat condition, sociological perception of the habitat, vegetation structural types of grasslands, different measures related to rare species, ground water quality and level, soil chemistry, assessment of disturbance level, and generally finer spatial scale metrics.

The habitat condition metrics for which most individuals already use remote sensing are:

- habitat extent,
- water extent,
- habitat fragmentation,
- and woody cover,

while fewer are using remote sensing to assess

- old growth forest,
- number of large trees,
- human made objects in general, and
- forest floor light conditions.

When asked about which habitat condition metrics remote sensing could possibly deliver, overall, individuals identified the same metrics.

Answers regarding precision requirements for the different metrics revealed that in most cases a precision of 5% is sufficient (e.g., habitat extent, positive species, nutrient indicator species, coarse wood cover) while in several cases an even coarser precision is acceptable. Only in some rare cases a precision corresponding to 1% step changes is required (e.g., problem, or alien species).

4.3. Discussion

Generally, there was a large overlap between the most used habitat condition metrics and the ones deemed most important by the participants. These include habitat extent, indicator species of all sorts, number of large trees, forest floor light conditions, evidence of drainage or other alterations to hydrology. One metric stands out as important but not typically used by the participants: evidence of grazing. This would suggest that grazing is quite hard to systematically quantify in the field.

A large majority of the participants already use remote sensing to assess habitat extent. Apart from this metric, remote sensing is not widely used, although the participants see potential in using remote sensing for assessing habitat condition metrics and have suggested several metrics that they believe could easily be computed using remote sensing. They also suggested a number of metrics not listed that they would like to use, if possible, in the future. A common theme is that respondents believe metrics are easy to implement using remote sensing, while in fact they are quite hard to derive. For example, as highlighted in section 3.3 the presence of an indicator species requires the ability to isolate a plant first and then identify the species. Depending on the species the latter may be relatively easy to achieve, however the former is notoriously difficult to do with remote sensing data. Another example is the belief that detecting evidence of drainage is feasible using remote sensing, while this is not necessarily the case. It is possible to identify linear features like ditches, but assessing the degree to which they are active and connected is challenging (Bailly et al. 2008; Bhattacharjee et al.2021; Rapinel et al. 2013; Roelens et al. 2018a; Roelens et al. 2018b). However, other suggested metrics for remote sensing such as forest floor light conditions and water extent are relatively easy to develop. Often remote sensing approaches already exist and refining these are obvious next steps.

From the questionnaire answers it seems that aiming for methods that can deliver habitat condition metrics with a 5% precision is likely to be useful for most real-life monitoring purposes. So, although, achieving this level of precision is often hard using remote sensing, it clearly should be a key aim when developing remote sensing approaches for habitat condition metrics in the future.

By having only 15 stakeholders responding to the questionnaire there is a high uncertainty associated with the results outlined above. Still, we believe most of the results make sense and represent reality. In this context it is worth noting that the authors of this report have worked on remote sensing of habitat condition metrics for at least 10 years.

5 Metrics developed from LiDAR data.

LiDAR (Light Detection and Ranging) is an active sensor that measures the time for reflected near-infrared light (i.e., laser signal sent by the sensor) to return to the receiver. The time measure is converted into distance and then 3D height point clouds. LiDAR is capable of penetrating canopies and as a result, LiDAR can describe the terrain's topography and measure a vegetation's 3-dimensional structure and to some extent describe a habitat's abiotic gradients and continuity. LiDAR also records the intensity of the returned signal, which can be used to determine the surface type that was hit by the laser footprint or point. The overview below and in Table 1 describes the habitat condition related metrics that so far have successfully been derived from LiDAR on board crewed aircraft or uncrewed drones, and highlight were LiDAR is showing the most promising potential for future cost-effective habitat condition measurements.

5.1 Vegetation structure

The structural metrics and features derived from LiDAR point clouds typically capture the vertical structure of vegetation, landscape characteristics or topography. A variety of statistical measures and techniques are available to characterize the structure of animal, plant, and fungal habitats from LiDAR point clouds (Bakx et al., 2019; Davies & Asner, 2014; Moeslund et al., 2019).

Among the most widely used LiDAR metrics in habitat condition assessments are those that measure the 3D vegetation structure. The most robust and most often used metric is vegetation height (Bakx et al., 2019, Koma et al., 2021c, Valbuena et al., 2020), but LiDAR can also be used to quantify vegetation cover in general or in specific layers (including the understory) (Bakx et al., 2019, Valbuena et al., 2020) or the vertical variability and profile of vegetation (Bakx et al., 2019, Valbuena et al., 2020, Devries et al., 2021). Most of the research on LiDAR-derived vegetation structure has been performed in forests (Stereńczak et al., 2022, Bakx et al., 2019; Davies & Asner, 2014), for instance for forestry applications (Maltamo, Naesset & Vauhkonen, 2014). However, LiDAR is also increasingly used to measure the vertical structure of vegetation in other habitat types, for instance in grasslands, shrublands, savannahs, wetlands, agricultural areas, riparian habitats, and deserts (Bakx et al., 2019; Koma, Seijmonsbergen & Kissling, 2021b; Davies & Asner, 2014). For these non-forest habitats, drone mounted LiDARs are proving particularly effective at quantifying vegetation height (e.g., in a saltmarsh: DiGiacomo et al 2021), vegetation gaps (e.g., Getzin et al 2022) and woody encroachment (Hantson et al 2012). An important process that affects the vegetation structure and several other habitat condition factors is grazing by large herbivores. There is an increasing demand for being able to measure the degree to which an area is affected by these animals. Developing lidar based tools that can deliver this information is challenging, but attempts have been made (Listopad et al. 2018; Michez et al. 2019) and to our knowledge several research groups are currently working on this.

We can also use LiDAR to quantify the 3dimentional composition of a landscape. For instance, we can derive the size, shape, and number of open areas within a forested landscape (e.g., Stereńczak et al., 2022), or derive the forest edge (edge between open and wooded areas) length. Both are important for the occurrence of birds and insects (de Vries et al., 2021; Koma et al., 2021a). LiDAR point clouds can also be processed to map specific landscape structures such as hedges and treelines (Broughton et al., 2021; Lucas et al., 2019; Graham et al., 2019), individual trees (Wang, Lindenbergh & Menenti, 2018), or the amount of deadwood (e.g., fallen trees) in forests (Marchi, Kellner et al., 2019; Pirotti & Lingua, 2018; Martinuzzi et al., 2009).

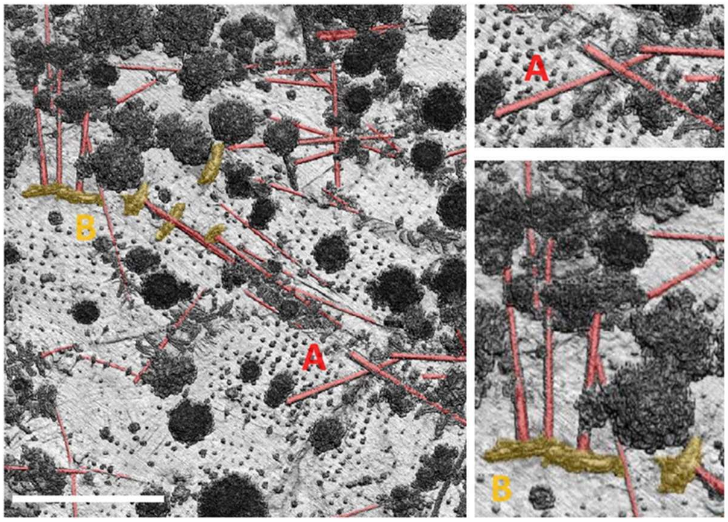

Figure 1: Example of Drone Lidar height point cloud data used to identify fallen trees; the grey colour gradient shows the lowest features in light grey and tallest in black (Source: Kellner et al., 2019).

5.2 Abiotic variables

Besides measuring and mapping vegetation, LiDAR can also be used to quantify abiotic variables or features controlling these abiotic variables. This includes terrain-related measures of ecological interest such as topographic slope, aspect, wetness (through identifying hollows or lower lying patches) and solar irradiation (Zellweger et al., 2016; Moeslund et al., 2013; Assmann et al., 2022). With respect to solar irradiation, LiDAR has been used to determine surface light conditions, both on forest floors but also in more open herb dominated landscapes, although so far, most studies have focused on light conditions in forests (see e.g., Vehmas et al. 2011, Piasecka et al., 2022). LiDAR can also shed light on the degree of human alterations or disturbance, for example identifying and quantifying ditch and channel networks provides indirect information on a wetland site's hydrology, although determining if drainage channels are connected and active is not straightforward (Bailly et al. 2008; Bhattacharjee et al.; 2021; Rapinel et al. 2013; Roelens et al. 2018a; Roelens et al. 2018b). Other examples are the mapping of compacted tracks in managed forest (e.g., Mohieddinne et al. 2023) and dune morphology (Bazzichetto et al., 2016).

Table 1: Examples of using Light Detection and Ranging (LiDAR) to quantify habitat condition.

Example	Measuring habitat condition with LiDAR point clouds	Reference
Vertical structure of vegetation		
Canopy height and cover	LiDAR metrics of canopy height and cover are effective predictors of bird species distributions and bird species richness	(Bakx *et al.*, 2019)
Forest vertical variability	Vertical variability metrics derived from LiDAR (i.e., average absolute deviation of height, skew and L-moments of height distribution) distinguish small patches of structurally complex suitable habitat within a matrix of structurally simple intermediate-aged forest and determine the nest site occupancy of an owl	(Hagar, Yost & Haggerty, 2020)
Horizontal variability of vegetation	Horizontal variability (e.g., standard deviation of vegetation height) in reedbeds distinguishes habitat suitability and ecological niches of different reed warbler species	(Koma *et al.*, 2021a)
Understory density	Depending on habitat and species, the density of the understory as derived from LiDAR point clouds can increase or decrease the diversity, abundance and/or occupancy of animal species	(Davies & Asner, 2014)
Landscape characteristics		
Hedges & treelines	Mapping linear vegetation elements for biodiversity conservation within agricultural landscapes by classifying and segmenting LiDAR point clouds with point-based and neighbourhood-based features	(Lucas *et al.*, 2019; Graham *et al.*, 2019)
Tree inventories	Mapping and counting individual trees and predicting single tree characteristics (e.g., height, crown and stem diameter, biomass) from LiDAR point clouds to characterize wildlife habitat and forest structure and composition	(Wang *et al.*, 2018; Stereńczak *et al.*, 2020; Maltamo *et al.*, 2014)
Amount of dead wood	Identifying and mapping deadwood components (e.g., snags, logs, stumps) to measure habitat suitability for woodpeckers	(Marchi *et al.*, 2018; Martinuzzi *et al.*, 2009)
Patchiness of open areas	Quantifying extent of open vegetation (i.e., a low number of open patches derived from a digital surface model using LiDAR point clouds) to measure the probability of occurrence of butterflies in dry grasslands	(de Vries *et al.*, 2021)
Extent of edges	Measuring the extent of woodland edges (i.e., edge length between interfacing low and high vegetation derived from LiDAR point clouds) to determine the probability of occurrence of dry woodland butterflies	(de Vries *et al.*, 2021)
Topography		
Soil moisture	Topographic wetness index (TWI) is an important driver for various plant communities in different habitats. TWI is a proportional measure of water retention for a given area based on calculations of flow accumulation and flow direction using a digital elevation model derived from LiDAR.	(Moeslund *et al.*, 2013)
Terrain properties	Steep terrain slopes and a high heat load index derived from a digital terrain model based on LiDAR point clouds increases the local species richness of macrofungi, lichens and bryophytes	(Moeslund *et al.*, 2019)

6 Metrics developed from Drone imaging data.

Drone and drone sensors are a fast-developing technology that offer an increasing range of observations from visible and near-infrared, hyperspectral and thermal imaging to lidar sensing. The key advantages of using drone technology compared with crewed aircraft and satellite sensing are (i) the achievable mm to cm spatial detail (Figure 2) and (ii) a relatively easy and affordable deployment. The main disadvantage is the limited areal coverage achievable within a single campaign which is determined by the drone's battery.

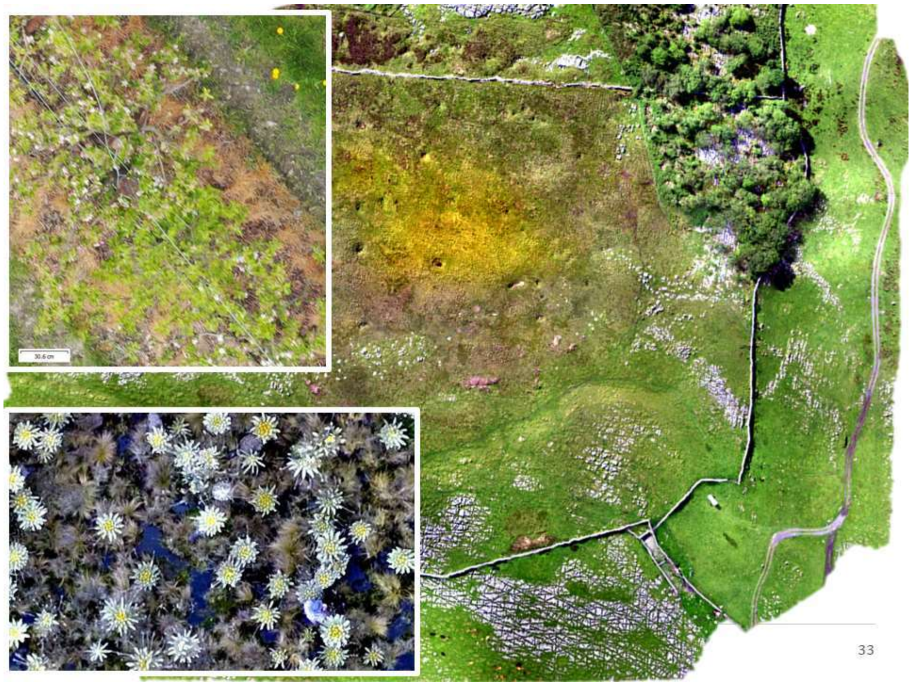

Figure 2: Examples of drone images, demonstrating the mm and cm detail that can be achieved.

At the moment, the most cost-effective and operational drone-sensor setup is a rotary drone with a camera that records three visible bands and one near-infrared band. This setup delivers mm to cm detailed imagery, 3-dimensional point clouds and a digital surface model. The latter two data are derived from combining many overlapping images using a processing routine referred to as 'structure from motion' (SfM). These data are very similar to LiDAR-derived point clouds, except that in the case of drone-based SfM, the 'distance' observations are derived using trigonometry principles as applied in stereoscopy. So, unlike LiDAR, height observations from layers below the top canopy layer are highly unlikely, especially when the top canopy is dense. Below (and Table 2) lists a summary of the condition metrics that can be derived from drone-based RGB-NIR imagery.

6.1 Vegetation: individuals and structure

Access to mm and cm resolution imagery combined with machine learning classifiers has created the opportunity to distinguish individual plants and in certain cases plant species (e.g., Figure 3) (James & Bradshaw, 2020; Zhang et al., 2020). This is possible when plant species in question has distinct features, patterns, shapes and/or colour combinations and, when dealing with vertically layered vegetation, are present in the top canopy. Examples are mapping woody cover, individuals, or species in grasslands (James & Bradshaw, 2020), mapping rare (Zhang et al., 2020) or invasive/ problem species (Hill, et al. 2016; de Sá et al. 2018; Oldeland et al 2021; Lui et al., 2022), and monitoring plant population dynamics (Rominger et al., 2021) and plant life cycles by monitoring flowering events (Nuemann et al., 2019). Mapping is done either manually (Hill, et al 2016) or automatically (e.g., de Sá et al. 2028; Lui et al. 2022)

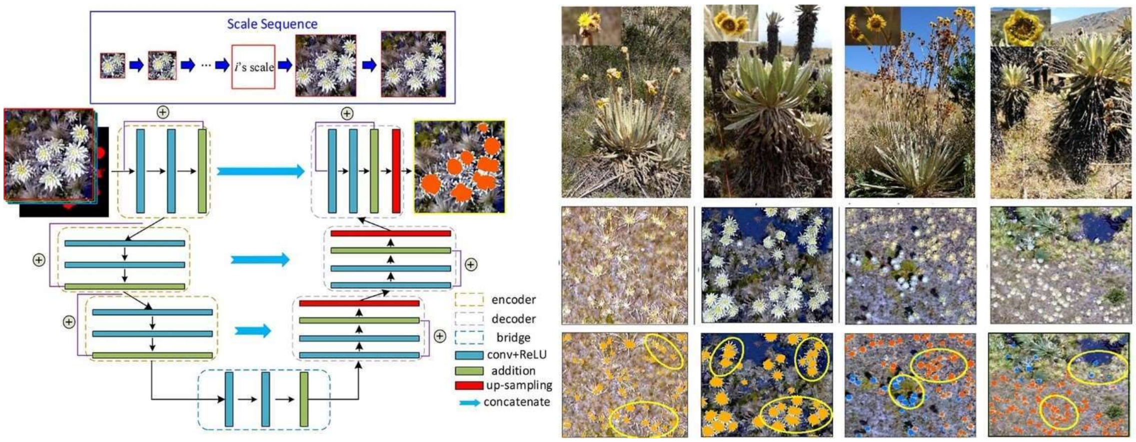

Figure 3: Centimetre resolution drone image showing large individual plants which are identified and mapped using a deep learning U-NET algorithm (source: Zhang et al., 2020)

Like LiDAR, SfM point clouds provide opportunities to characterise vegetation structure variables such as vegetation height, volume and biomass. A typical example is the mapping of woody plant cover in a grassland (Olariu et al., 2022). Van Iersel et al., (2018) show how SfM can capture temporal changes of herbaceous vegetation throughout the growing season. Plant canopy height distributions, volume and biomass derived from SfM helped characterise a dryland grass-shrub ecotone (Cunliffe et al., 2016). Zhang et al. (2022) used SfM point clouds to estimate understorey biomass by flying a drone below the tree canopy of a plantation.

6.2 Abiotic variables

Drone imagery is well suited for spatially detailed mapping of bare ground (Eischeid et al., 2021; Barnas et al., 2019; Cunliffe et al., 2016). When vegetation cover and/or height is low, it can be used to capture (through SfM) micro-topography (Harris and Baird 2018), quantify ditch or channel networks or peatland elevation changes (Ikkala et al., 2022) and there is evidence that for wetlands like peat bogs, soil moisture and water table levels can be inferred by using RGB, thermal and multi-spectral image derived indices (Lendzioch et al., 2021).

Table 2: Examples of drone imaging data use to quantify habitat condition.

Example	Measuring habitat condition with drone acquired imagery	Reference
Invasive herbaceous plant mapping	Mapping patches of Elymus athericus, a tall grass which encroaches higher parts of saltmarshes. Invasive species mapping in a lacustrine fringe environment: yellow flag iris (*Iris pseudacorus* L.), at two lakes in the central interior of British Columbia Identification of Mangrove Invasive Plant Derris Trifoliate	Oldeland et al., 2021; Hill et al., 2016 Lui et al., 2022
Rare or protected plant species mapping	Mapping frailejones species with diverse morphology in a biodiverse mountain biome.	Zhang et al., 2020
Invasive woody plant mapping	Map native woody invader in South Africa's fynbos biome Exploiting flowering event to map invasive *Acacia longifolia* shrub/small tree.	James & Bradshaw, 2020 de Sá et al., 2018
Flowering events	Quantifying spatial patterns of phenology in Calluna (heath) life-cycle phases	Nuemann et al., 2019
Plant population dynamics	Examined the feasibility of carrying out drone-based demographic studies for dwarf bear poppy	Rominger et al., 2021
Vegetation structure	Understory biomass measurement in a dense plantation forest. Woody plants in a semiarid grassland Monitoring height non-woody floodplain vegetation Woody plant height distribution, Woody plant volume and biomass in a dryland ecotone	Zhang et al., 2022 Olariu et al., 2022 van Iersel et al., 2018 Cunliffe et al., 2016
Bare ground	Geese grubbing/herbivory impact on vegetation Classification of surface cover between bare and vegetated classes on the basis of modelled canopy height from SfM	Barnas et al., 2019; Eischeid et al., 2021 Cunliffe et al., 2016
Topography	Micro-topography (elevation and wind exposure) driving vegetation patterning and recovery in blanket peatlands	Harris & Biard, 2018
Hydrology	Soil moisture and water table from RGB, multispectral, and thermal orthoimages Characterising elevation changes and wetness in minerotrophic peatlands	Lendzioch et al., 2021 Ikkala et al., 2022

7 Candidate metrics selection

Table 3 Combines the results of the grey literature with the responses from the questionnaire to highlighting the commonly used and important metrics and identify candidate metrics for a LiDAR or drone image based remote sensing approach.

The metrics that were identified by the questionnaire responders as both most used and most important match the top 4 most listed metrics in the grey literature. They are ‘Cover: Habitat extent’, ‘Composition: Presence of positive indicator species’, ‘Composition: Presence of problem species’, and ‘Composition, structure: Woody cover (%)’. However, only % woody cover is currently a likely option for operational delivery through drone-based imaging. The other three are possible options but will require further habitat specific method development and testing. In particular, identifying and counting indicator species using remote sensing will be limited to plant species that are present in the top canopy, are unique in shape and/or reflectance, and larger than the image pixel size.

‘Degradation, alterations: Bare ground (%)’, although (according to the questionnaire results) not as important as other metrics is the 5th most common metric in the grey literature, is commonly used by the responders, and relatively easy to deliver using drone-based imagery. Another two of the top 15 metrics found in the grey literature have been identified as important: ‘Cover: Fragmentation metrics, landscape metrics’ and ‘Composition, structure, function: Species indicating nutrient changes - e.g., grassland improvement; trophic changes’, but only the former is expected to be deliverable through drone imagery, after some further habitat specific method development and testing.

Five metrics, which the responders identified as either commonly used, important or both, did not appear in the grey literature top 15 list. And similarly, 8 metrics listed in the grey literature top 15 list were not identified as commonly used or important by the responders. This could be because a large proportion of questionnaire responders were involved with monitoring habitat types for which these metrics were not relevant. For 5 of these metrics there could be a relative easy remote sensing solution either using LiDAR, SfM or drone-based imagery: ‘Degradation, alterations: Abrasion, linear features’, ‘Degradation, alterations: Human made objects or surfaces’, ‘Degradation, Alterations: % burnt area’, ‘Degradation, Alterations: change in micro-topography’, and ‘Forest floor light conditions’.

Two metrics that describe the 3-dimensional structure of woody habitats (i.e., ‘Composition, Structure: Woody vegetation, presence/absence or quantification of understory/natural regeneration’ and ‘Composition, Structure: Woody vegetation height’) do not feature in table 3. However, they suit LiDAR and SfM approaches particularly well. There is also great potential for related 3-dimensional metrics, that are not yet considered by field practitioners, but would be relatively easy to derive from LiDAR (see section 5 and Table 1).

Table 3: Most often used and important metrics (grey literature and questionnaire) and their suitability for LiDAR and/or drone image based derivation (Light green: possible – needs further method development and testing; Dark green: likely - needs operationalisation of existing methods)

Metric	Grey literature – top 15	Questionnaire – used most often	Questionnaire - most important	RS-LiDAR	RS-SfM	RS-drone imagery	Candidate Metric
1. Cover: Habitat extent (stable, increase or decrease)	V	V	V			*	V
2. Composition: Presence of positive indicator species	V	V	V			*	V
3. Composition: Presence of problem species	V	V	V			*	V
4. Composition, structure: Woody cover (%)	V	V	V			*	V
5. Degradation, alterations: Bare ground (%)	V	V					V
6. Cover: Fragmentation metrics (stable, increase or decrease of connectivity), landscape metrics (patch size, number)	V		V			**	V
7. Composition, structure, function: presence of (all) dynamic stages,	V						
8. Dead material (litter, wood, drift material on beaches and dunes) – size not specified	V						
9. Degradation, alterations: Abrasion, linear features (tracks or low vegetated areas due to traffic, digging, extraction)	V						V
10. Degradation, alterations: Evidence or high density of grazers, browsers (e.g., rabbit, large grazers such as cattle, horses, deer) / diggers (e.g., moles, wild boar)	V						
11. Degradation, Alterations, productivity: evidence of grazing (not using indicator species e.g., vegetation height)	V						
12. Composition, structure, function: Species indicating nutrient changes - e.g., grassland improvement; trophic changes	V		V				
13. Degradation, alterations: Human made objects or surfaces	V						V
14. Degradation, Alterations: % burnt area (and frequency)	V						V
15. Degradation, Alterations: change in micro-topography (e.g., sunken peat, erosion channels, dune erosion)	V						V
Degradation, Alterations: Evidence of drainage or other alterations to hydrology		V					
Forest floor light conditions		V					V
The amount of coarse dead wood		V	V				
Number of large trees (or hollow broad-leaved trees)		V	V				
Composition, Structure, Function: species indicating mowing regime or grazing regime, or drying/drainage (for wetlands)			V				

** May benefit from combining imagery with SfM or LiDAR*
*** Requires habitat extent map as input*

8 Conclusions

Data collected from habitat condition field manuals for 7 countries and from answers from 15 field practitioners, representing at least 5 countries, helped us identify the following 11 habitat condition metrics that could potentially be derived using Lidar or drone imaging remote sensing:

- Habitat extent
- Fragmentation metrics and landscape metrics
- Presence of positive indicator species
- Presence of problem species
- Woody cover (%)
- Bare ground (%)
- Abrasion, linear features
- Human made objects or surfaces
- Burnt area (%) (and frequency)
- Change in micro-topography
- Forest floor light conditions

Condition metrics that describe the 3-dimensional structure of woody habitats should also be considered for LiDAR sensing.

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10 Annex

ANNEX- Table1: List of on-line grey literature used in habitat condition review.

Record	Language	Country	Year	Authors	Title	doi
29	Italian	Italy	2014	AA.VV 2014	Guida del monitoraggio degli habitat proposte a scala regionale nel progetto life gestire (aa.vv., 2014)	https://www.isprambiente.gov.it/public_files/direttiva-habitat/Manuale-142-2016.pdf
32	Spanish	Spain	2019	Daniel Goñi, Ramón Reiné, Sonia Roig	Selection and description of ecological variables that allow diagnosing the conservation status of the parameter 'structure and function' of the different types of habitat of meadows and pastures sensu lato	https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/pradosypastizales_3_estructurayfuncion_tcm30-506053.pdf
41	Spanish	Spain	2019	David S. Pescador, Jordi Vayreda, Adrián Escudero, Francisco Lloret	Identificación y descripción de las variables utilizadas en el inventario forestal nacional para la evaluación de la 'estructura y función' de los tipos de hábitat de bosque	https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/04bosquesymatorralesnofluviales_2_metodosestructurayfuncionifn_tcm30-506048.pdf
44	Spanish	Spain	2019	Subdirección General De Biodiversidad Y Medio Natural, Dirección General De Biodiversidad Y Calidad Ambiental	Criterios utilizados por la subdirección general de biodiversidad y medio natural para la determinación del perjuicio a la integridad de espacios de la red natura 2000 por afección a hábitats de interés comunitario.	https://www.miteco.gob.es/es/biodiversidad/temas/espacios-protegidos/criteriossgbymnperjuiciohabitats_tcm30-481533.pdf
45	Spanish	Spain	2019	Francisco Lara Juan Antonio Calleja Ricardo Garilleti	Selección y descripción de variables que permitan diagnosticar el estado de conservación del parámetro 'estructura y función' de los diferentes tipos de hábitat de bosque y matorral de ribera	https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/05bosquesymatorralesderibera_3_variablesestructurayfuncion_tcm30-506058.pdf
47	Spanish	Spain	2019	Noemí Silva Sánchez Antonio Martínez Cortizas	Selección y descripción de variables ecológicas que permitan diagnosticar el estado de conservación del parámetro 'estructura y función' de los diferentes tipos de hábitat herbáceos con componente turbófilo (paraturberas y tremedales mesoeutróficos)	https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/ecosistemasturbofilos_3_estructurayfuncion_tcm30-540525.pdf
53	English	Poland	2022	Forest Research Institute, Poland	The current state of białowieża forest based on the results of the life+ forbiosensing project	http://www.forbiosensing.pl/documents/20182/68588/Monografia+EN/d97f33cf-0f9c-4d2d-937d-e957f55a6fc9
57	Norwegian	Norway	2019	NINA, Norway	Test av fagsystemet for økologisk tilstand for terrestriske økosystemer i trøndelag	https://brage.nina.no/nina-xmlui/handle/11250/2599977
58	Norwegian	Norway	2022	Environmental Agency, Norway	Kartleggingsinstruks - kartlegging av terrestriske naturtyper etter nin2	https://www.miljodirektoratet.no/sharepoint/downloaditem?id=01FM3LD2SHXAQSGY6VWNDYTTXQNC34U2IG
62	Swedish	Sweden	2016	Jordbruksverket	Ängs- och betesmarksinventeringen metodik för inventering från och med 2016	https://www2.jordbruksverket.se/download/18.48a7452e15c7b4a5a65a3a6b/1496908244029/ra17_9.pdf
64	French	France	2015	*L'Inventaire national du patrimoine naturel (INPN)*	Évaluation De l'état De Conservation Des Habitats Agropastoraux Guide d'application Pour l'évaluation Des Prairies De Fauche	https://inpn.mnhn.fr/docs/N2000_EC/Eval_EC_habitats_agropastoraux_version3_MNHN-SPN_2015.zip
65	French	France	2015	EPICOCO C., VIRY D	Epicoco C., Viry D., 2015 - État De Conservation Des Habitats Tourbeux d'intérêt Communautaire, Méthode d'évaluation À l'échelle Du Site. Rapport d'étude. Version 1 – Mars 2015. Rapport Spn 2015-	https://inpn.mnhn.fr/docs/N2000_EC/SPN-2015-57-Methodologie_d_evaluation_E_C_tourbieres.pdf

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					57, Service Du Patrimoine Naturel, Muséum National d'histoire Naturelle / Office National De l'eau Et Des Milieux Aquatiques, Paris, 76 P.	
66	English		2015	Gerard et al	Gerard, France; Acreman, Mike; Mountford, Owen; Norton, Lisa; Pywell, Richard; Rowland, Clare; Stratford, Charlie; Tebbs, Emma. 2015 Earth Observation To Produce Indices Of Habitat Condition And Change. Peterborough, Joint Nature Conservation Committee, 86pp. (Ceh Project No. C05534, Jncc Ref. C14-0171-0901) (Unpublished)	https://nora.nerc.ac.uk/id/eprint/511212/
67	French	France	2016	MACIEJEWSKI, L.	Maciejewski, L., 2016. État De Conservation Des Habitats Forestiers d'intérêt Communautaire, Evaluation À l'échelle Dusite Natura 2000, Version 2. Tome 1 : Définitions, Concepts Et Éléments d'écologie. Mars 2016. Rapport Spn 2016-75,Service Du Patrimoine Naturel, Muséum National d'histoire Naturelle, Paris. 82 P.	https://inpn.mnhn.fr/telechargement/documentation/natura2000/evaluation
68	French	France	2022	Hugo Clément, Mathilde Reich, François Botcazou, Baptiste Crouzeix, Margaux Mistarz et Julie Garcin	Évaluation De l'état De Conservation Des Bas-Marais Calcaires d'intérêt Communautaire Cahiers d'évaluation À l'échelle Des Sites Natura 2000 Version 3; Guide d'évaluation À l'échelle Des Sites Natura 2000: État De Conservation Des « Marais Calcaires À Cladium Mariscus Et Espèces Du Caricion Davallianae » (Ue 7210*) ; Des « Sources Pétrifiantes Avec Formation De Travertins (Cratoneurion) » (Ue 7220*) ; Des « Tourbières Basses Alcalines » (Ue 7230); Des « Formations Pionnières Alpines Du Caricion Bicoloris-Atrofuscae » (Ue 7240*)	https://inpn.mnhn.fr/docs-web/docs/download/397190
70	French	France	2013	Viry Déborah	État De Conservation Des Habitats Humides Et Aquatiques d'intérêt Communautaire, Méthode d'évaluation À l'échelle Du Site. Guide d'application. Version 1 – Avril 2013. Rapport Spn 2013-13, Service Du Patrimoine Naturel, Museum National d'histoire Naturelle / Office National De l'eau Et Des Milieux Aquatiques, Paris, 33 P.	https://inpn.mnhn.fr/docs/N2000_EC/SPN-2013-13-Etat_de_conservation_des_habitats_humides_et_aquatiques_d_interet_communautaire_Methode_d_evaluation_a_lechelle_du_site_Natura_2000_Guide_d_application_V1.pdf
71	French		2011	Léonore GOFFÉ	Goffé L., 2011. Etat De Conservation Des Habitats d'intérêt Communautaire Des Dunes Non Boisées Du Littoral Atlantique - Méthode d'évaluation À l'échelle Du Site Natura 2000 - Version 1. Rapport Spn 2011-18. Museum National d'histoire Naturelle / Office National Des Forêts /Conservatoire Botanique National De Brest, 67 P.	https://inpn.mnhn.fr/docs/N2000_EC/SPN-2011-18-Rapport_Goffe_2011_18.pdf

ANNEX – Table 2A: Condition metrics use across countries and terrestrial habitats (NOT including man-made (V or I), miscellaneous (U5), volcanic (U6), permanent glacier, snow dominated and cave habitats).

Generic condition metric from field manuals (grey literature)	Coastal dunes and sandy shores	Coastal shingle	Rock cliffs, ledges and shores, including the supralittoral	Salt meadows, marsh	Mires, bogs and fens	Dry grasslands	Mesic grasslands	Seasonally wet and wet grasslands	Alpine and subalpine grasslands	Forest fringes and clearings and tall forb stands	Inland salt steppes and salt marshes	Sparsely wooded grasslands	Deciduous broadleaved forest	Broadleaved evergreen forest	Coniferous forest	Hedgerows	Tundra	Arctic, alpine and subalpine scrub	Temperate and mediterranean-montane scrub	Temperate shrub heathland	Maquis, arborescent matorral and thermo-Mediterranean scrub	Garrigue	Spiny Mediterranean heaths	Thermo-Atlantic xerophytic scrub	Riverine and fen scrubs	Screes	Inland cliffs, rock pavements and outcrops
Habitat: New EUNIS code	***N1***	***N2***	***N3***			***R1***	***R2***	***R3***	***R4***	***R5***	***R6***	***R7***	***T1***	***T2***	***T3***	***T4***	***S1***	***S2***	***S3***	***S4***	***S5***	***S6***	***S7***	***S8***	***S9***	***U2***	***U3***
Habitat: Old EUNIS code	***B1***	***B2***	***B3***	***A***	***C, D***	***E1***	***E2***	***E3***	***E4***	***E5***	***E6***	***E7***	***G1***	***G2***	***G3***	***G4***	***F1***	***F2***	***F3***	***F4***	***F5***	***F6***	***F7***	***F8***	***F9***	***H2***	***H3***
Cover: Extent of habitat (stable or increase, decrease)	en; fr; it; sp;	en; it;	en; it;	it;	no; en; fr; it; sp;	en; fr; it; sp;	en; it; sp;	en; fr; it; sp;	en; it; sp;	fr; it;	it;		en; fr; it; sp;	en; fr; it; sp;	no; en; fr; it; sp;	en;		en; it; sp;	en; it;	no; en; it;	it;	it; sp;	it;		fr; it;	it;	en; it;
Cover: Fragmentation metrics (stable or increased connectivity, decreased connectivity), landscape metrics (e.g., patch size, number, distance between patches)	it; sp		it;	it;	it;	fr; it;	it;	fr; it;		it;	it;		fr; it; sp;	fr; it; sp;	fr; it; sp;			it; sp;	it;	it; sp;	it;	it; sp;	it; sp;		it;	it;	it;
Composition, Structure, Function: presence of positive indicator species	fr; en; it; sp;		it;	no; it;	se; fr; en;; it;	se; no; en; fr; it; sp;;	en; se; it; sp;	se; en; fr; it; sp;	se; en;; it; sp;	fr; it; sp;	it;		en; fr; it; sp;	en; fr; it; sp;	no; en; fr; it; sp;	en;		en; it; sp;	en; it;	no; en; it; sp;	it; sp;	it; sp;	it;		it;	it;	no; it;
Composition, Structure, Function: species indicating nutrient changes - e.g., grassland improvement; trophic changes	fr;				fr; sp;	fr; it; sp;	it; sp;	it; sp;	it; sp;	sp;					no;					it;					fr; it;		

Composition, Structure, Function: species indicating mowing regime or grazing regime, or drying/drainage (for wetlands)					no; fr; it;	fr; it;	it;		it;											no;							
Composition, Structure, Function: presence of problem (negative) species and alien species	no; en; fr; it;		it;	no; it;	se; No; en; it	se; no; fr; it; sp;	se; en; sp;	se; fr; en; it; sp;	se; en; sp;	fr; it;	it;		no; en; fr; it;	en; fr;	no; fr;		no;	en; it;	en; it;	no; en; it;	it; sp;		it; sp;		fr; it;	it;	no; it;
Composition, Structure, Function: Presence of (all) dynamic stages	no; en; it; sp;		en;	no; it;	no; it; sp;					fr;	it;		en; fr; sp;	en; fr;	fr;			it;	it;	no; it;	it;	sp;	it;		fr; it;		
Composition, Structure: woody cover (%)	fr;			no; it;	se; en; fr; sp;	se; no; en; fr; it; sp;	no; en; se; sp;	se; no; en; fr; sp	se; en; it; sp;			sp;	no; en;	en;	no; en;	en;		en;	en; it;	en;		sp;					en; it;
Composition, Structure: planted tree cover (%)																		sp;									
Composition, Structure: herbaceous cover (%) or all (sparse) vegetation cover (%) or perennial vegetation cover (%)	fr; it; sp;		it;	it;															it;			sp;	sp;				
Light condition/canopy cover - forest													pl;	pl;	pl;								sp;				
Forest gaps/glades					se	se	se	se	se				pl;	pl;	pl;												
Indicator value for nutrient level (Ellenberg N)						no;	no;	no;			no;		no;	no;	no;		no;			no;							
Light condition - herb vegetation (Ellenberg L)						no;	no;	no;			no;						no;			no;							
Degradation, Alterations: Area without technical interventions in 1 km vicinity / distance from human activities									it;				no;	no;	no;		no;										
Dead Material (litter, wood, drift material on beaches and dunes) - size not specified	fr; it; sp;				se; en; fr;	se; en; sp;	se; en sp;	se; en it; sp;	se; en sp;			se;	no; en; it; sp;	no; en; it; sp;	no; it; sp;			en;	en;	en;	it;	sp;	sp;				
Coarse dead wood >30 cm dbh													no; en; fr;	no; en; fr;	no; en; fr;												
Cover: old growth forest													no; fr;	no; fr;	no; fr;												
Wetness (Ellenberg F)					se; no;	se;	se;	se; no;									se;										
Cover: area without dead or damaged Calluna																				no;							
Degradation, Alterations: % burnt area (and frequency)	it;				en; fr; sp;	fr; it;		it;						it;	sp;			sp;	en;	en;	it;						
Degradation, Alterations: % bare ground	en; it;			it;	se; en fr;;	se; en fr;;	se; en sp;	se; en fr; sp;	en; sp;	fr;	it;		en;	en;	sp;			en;	en;	en		it;	it;		fr; it;		

					it; sp;	it; sp;																					
Degradation, Alterations: evidence or high density of grazers, browsers (e.g., rabbit, large grazers such as cattle, horses, deer) / diggers (e.g., moles, wild boar)	fr; it; sp;			it;	fr; it; sp;	fr; sp;	sp;	fr; it; sp;	sp;	fr;		sp;	sp;	it; sp;	it; sp;			sp;			it;	sp;					
Degradation, Alterations: hydrology - evidence of drainage (as alternative for water table level and indicator of drying); surface water cover					en; fr; it; sp;			fr; it;		fr;																	
Degradation, Alterations: % dung						sp;	sp;	fr; sp;	sp;	fr;																	
Degradation, Alterations: Abrasion, linear features (tracks or areas with low veg due to traffic, digging, peat extraction)	no; en; sp;			no;	no; en; fr; it; sp;	no; sp;	sp;	fr; sp	sp;	fr;			fr; it;	fr;	no; fr;		no;					sp;					no;
Degradation, Alterations: Stream/river regulation					no;								no;		no;										fr; it;		
Degradation, Alterations: change in micro-topography (e.g., sunken peat, erosion channels, dune erosion)	en; fr; it; sp;			it;	no; en; fr; sp;																	sp;					
Degradation, Alterations, productivity: evidence of grazing (not using indicator species e.g., vegetation height)	fr; it;			no;	no; en; fr;	en;	en;	en;	en; sp;				en;	en;	en;	en;		en;	en;	en;							
Degradation, Alterations: Human made objects or surfaces	en; fr; it; sp;	en;	en;	it;	fr;						it;		it;				no;			no;		it; sp;				en;	en;
No. of large trees					se;	se	se	se	se				no; it; sp;		it;												
Composition, Structure, Function: Natural reduction in population													no;						it;								
No of hollow broadleaved trees													no;														
Composition, Structure: % cover and average height of tree, shrub, and herbaceous layer						sp;	sp;	sp;	sp;				it;	it;	it;												
Composition, Structure: Forested habitats, presence/absence, or quantification of understory/natural regeneration	it;											sp;	it; sp;	it; sp;	it; sp;					sp;		sp;					
Composition, Structure: Woody vegetation height, dbh												sp;	sp;	sp;	sp;			it;		sp;	it;						
Composition, Structure: shrub-grass ratio																				sp;							
Composition, Structure: tree-shrub ratio														it;													
Composition, Structure: Graminoid - Forb ratio	en;				en;	en;	en;	en;	en;																		

Composition, Structure: herbaceous vegetation height						sp;	sp;	sp;	sp;																		
Cover: water extent	en;		en;	en;	en;																						
Stone, rock, boulder cover					se;	se	se	se	se																		
Base rich soil indicators					se;	se	se	se	se																		
Function: Water dynamic regime (altered/degraded) or water flow changes				it;	no; it;					fr; it;			no;		no;										it;		
Function: Dune morpodynamic metrics	fr; it; sp;																					sp;					

ANNEX -Table 2B: Condition metrics use across countries and terrestrial habitats – metric measurement details (when provided) and references consulted.

Generic condition metric from field manuals (grey literature)	Metric measurement details	Reference
Cover: Extent of habitat (stable or increase, decrease)	in FR for EUNIS R1 ANNEX1 6210, 6510, 6520, EUNIS R3 ANNEX1 6410, EUNIS R5 ANNEX1 6430 (ref 64); ANNEX1 7110, 7120, 7130, 7140, 7150 (ref 65); ANNEX1 7210, 7220, 7230, 7240 (ref 68); forests (ref 67); ANNEX1 3220, 3250,3230, 3240 (ref 70); dune systems (ref 71). in NO, most conif. forest types, broadleaved forest > 20-50.000 m2, heathland > 300.000 m2, meadow, swamp > 10-15.000 m2, salt meadow > 5000 m2, fen > 100.000 m2, rainfed fens > 50.000-200.000 m2 (ref58). in IT for 21 coastal and dune habitats, 16 shrublands and scrub, 15 grassy formations, 8 peat bogs and swamps, 10 rocky habitats and 39 forest habitats (ref 29). in SP meadows and pasture (ref 32); in SP (ref 44)	58; 64; 65; 67; 68; 70; 71; 29; 32; 41; 45; 47; 44
Cover: Fragmentation metrics (stable or increased connectivity, decreased connectivity), landscape metrics (e.g., patch size, number, distance between patches)	in FR for EUNIS R1 ANNEX1 6210, 6510, 6520; for EUNIS R3 ANNEX1 6410 (ref 64); for forest: distinction between within forest fragmentation and connectivity within the surrounding landscape (ref 67). in IT (ref 29). in SP (ref 41) (ref 44).	64; 67; 29; 41; 45; 44
Composition, Structure, Function: presence of positive indicator species	in FR: for EUNIS R1 ANNEX1 6210, EUNIS R3 ANNEX1 6410, EUNIS R5 ANNEX 6430: min thresholds vary from 15%, 30% to 33% of species listed are indicator species (ref 64); ANNEX1 7110, 7120, 7130, 7140, 7150 (ref 65): herbaceous species not fixed yet, distinction between red/brown bryophytes and green bryophytes; ANNEX 7240: %species cover in steps of 10% (ref 68); Forests: 1%, 5%, 15%, 30% cover of indigenous tree species (ref 67); Dune systems: 30%, 35%, 40%, 45%, 55%, 60% of species presence (ref 71). in NO: forest blueberries >60% (ref57), grassland/heathland bumblebees, day-butterflies: index value > 0.6 (ref 57). In NO: Bare mountain/rock, lime grassland, salt meadows, meadows, dunes, tundra, snow-grassland, heathland, boreal rainforest, pine forest, broadleaved forest, swamps > 3-15 habitat specific species or >1-10 NT, > 1-3 VU or > 1 EN/CR species, in calcareous fens, southern limestone indicator species widespread (ref 58). in EN for bogs and supralittoral sediments: bryophytes (ref 66). in SE, open habitats; more than 5 positive indicator species being well established or appearing over a very large share of the area (ref 62). in IT for dune systems: % cover established using <1m image resolution taken in spring (ref 29). in SP meadows and pasture: also, species richness and diversity indices (ref 32); forest habitats: cover of species, proportion of cover by indicator species, % cover of woody understorey species, species richness and diversity, woody species diversity, liana-, shrub-, moss- and lichen-richness and -cover (ref 41), alpine and subalpine shrub: % cover and density of Pinus and juniper species ref (44).	57; 64; 65; 66; 62; 67; 68; 71; 29; 32; 41; 45; 44
Composition, Structure, Function: species indicating nutrient changes - e.g., grassland improvement; trophic changes	in FR for EUNIS R1 ANNEX1 6510, 6520: max threshold 20% of species listed are indicator species (ref 64); for EUNIS R1 ANNEX 6210: max threshold 10-30% of species listed are indicator species (ref 64); for ANNEX1 7210: %species cover < 5% and number of indicator species (ref 68); for ANNEX1 7220: 10% species cover threshold and number of indicator species threshold of 2 (ref 68); for ANNEX 7230: %species cover <10% (ref 68); ANNEX1 3220, 3250,3230, 3240: < 20 % species presence threshold (ref 70); Dune systems %cover of nitrophilic species (ref 71). In NO, boreal rainforests < 10% algae growth on stems < 2 m. in IT (ref 29). in SP (ref 44), (ref 47)	64; 68; 70; 71; 29; 32; 47; 44
Composition, Structure, Function: species indicating mowing regime or grazing regime, or drying/drainage (for wetlands)	in FR for EUNIS R1 ANNEX1 6210, 6510, 6520: min threshold 40% of species listed are indicator species (ref 64); for ANNEX 7230: %species cover in steps of 20% (ref 68); for ANNEX 7220 % species cover < 20%. In NO, assessed on a scale between 1 (no signs of grazing) and 8 (overgrazed), assessed by species and overall impression, in meadow, tundra, snow-grassland, cold heathland < index 3, heathland = 2 or3 (ref58). in IT for E3: hydrology regime changes	58; 64; 68
Composition, Structure, Function: presence of problem (negative) species and alien species	in FR for EUNIS R1 ANNEX1 6210, 6510, 6520, EUNIS R3 ANNEX1 6410: max threshold 30% cover, EUNIS R5 ANNEX 6430: max thresholds 10% or 25% cover (ref 64). In NO: Tundra, Forest, fen/meadow, grassland/heathland: area without invasive species > 95% (ref 57), grassland/heathland: areas without problem species > 75% (ref 57); for forests: absence or < 30% presence of invasive woody and herbaceous species (ref 67); ANNEX1 3220, 3250,3230, 3240: <30% presence threshold (ref 70); Dune systems: <10% cover threshold (ref 71). In NO: Bare mountain/rock, lime grassland, salt meadow, dunes/sand beach, pine forest, broadleaved forest: < 3 (on index 0-7), boreal rainforest, swamps < 2, pine forest: overgrowth with Pteridium aquilinum < xx (not given) (ref 58). in EN (ref 66). in SE, open habitat; More than 30% coverage (ref 62). in IT (ref 29). in SP (ref 44).	57; 58; 64; 66; 62; 67; 70; 71; 29; 32; 44
Composition, Structure, Function: Presence of (all) dynamic stages	in FR for EUNIS R5 ANNEX 6430: 3 stages (ref 64); for forests regeneration capacity or 5%, 20% cover of young trees (ref 67); ANNEX1 3220, 3250,3230, 3240 different tree/shrub heights in steps of 0.10 m present (ref 70). in NO, river-meadows 3,4 zones of water-spring-intensity, dunes: 3 succession stages, heathland: intact succession = open with a few single trees, (salt and fresh) meadow: intact = open with no encroachment (ref 58). in IT: Dune systems, salt marshes and salt meadows, inland salt steppes: changes in biomass, alpine rivers with willow: changes in woody vertical structure, xerothermophilous formations with Buxus: % cover of herbaceous, shrub and tree layers (ref 29). in SP mires, bogs, and fens: transformation of the vegetation (ref 47) (ref 44).	58; 64; 67; 70; 29; 47; 44

Composition, Structure: woody cover (%)	in FR for EUNIS R1 ANNEX1 6510, 6520, EUNIS R3 ANNEX1 6410: max threshold 10% (ref 64), EUNIS R1 ANNEX1 6210: max threshold 20% (ref 64), ANNEX1 7110, 7120, 7130, 7140, 7150: distinction between shrub (heathers etc..) and tree (trees found are low in stature <1m) is required (ref 65); for ANNEX 7210, 7230: woody shrub height threshold 7m, %cover < 5% (ref 68); Dune systems: 5%, 20% cover of young plants (ref 71). in NO it varies for fens/meadows (ref 57). In NO dry grassland and salt meadows: < 10-25% (ref57), pine-forest, broadleaved forest: shrub-cover < 25%, broadleaved forest < 5% conifer., leaf-meadows: cover of trees harvested > 15 years ago (ref 58). in SE in open habitats, they record woody cover from < 10% to >30% (ref 62). in IT for salt meadows (ref 29). in SP meadows and pastures where woody is invasive: 1m, >3m height (ref 32), for mires, bogs, and fens: to establish deforestation (ref 44, 47).	57; 58; 64; 65; 66; 68; 71; 29; 32; 44; 47
Composition, Structure: planted tree cover (%)	in SP (ref 44).	44;
Composition, Structure: herbaceous cover (%) or all (sparse) vegetation cover (%) or perennial vegetation cover (%)	in FR for Dune systems: 50%, 75% cover (ref 71). in IT for Dunes systems % of all vegetation cover; for Coastal rocks: rock/vegetation ratio (ref 29). in SP dune systems (ref 44), spiney heath S7: perennial cover (ref 44).	71; 29; 44
Light condition/canopy cover - forest		53; 44
Forest gaps/glades	in SE, open habitat: Forest transition are recorded in <50 m, 50-250 m and > 250m (62)	53;
Indicator value for nutrient level (Ellenberg N)	Tundra: lower th: 1.14 - 3.39, upper th: 1,36-3.74 (ref 57), Forest: lower th: 1.55-4.94, upper th: 1.78-5.38 (ref57), fens/meadows: lower th: 1.07-4.95, upper th: 1.35-5.34 (ref57), grasslands/heathlands, incl coastal: lower th: 2.01-4.48, upper th: 2.72-4.90 (ref57). in SP (ref 44)	57;
Light condition - herb vegetation (Ellenberg L)	Tunda: lower th: 5.76-7.43, upper th: 6.46-7.73 (ref57), fens/meadows: lower th: 5.33-7.52, upper th: 6.28-8.14 (ref57), grasslands/heathlands incl coastal: lower th: 5.86-7.03, upper th: 6.31-7.23	57;
Degradation, Alterations: Area without technical interventions in 1 km vicinity / distance from human activities	in NO Tundra, Forest, fen/meadow: area threshold 60% (ref 57). in IT alpine and subalpine grasslands E4.3: distance (ref 29)	57; 29
Dead Material (litter, wood, drift material on beaches and dunes) - size not specified	In FR ANNEX 7210, 7220, 7230, 7240 (ref 68), Dune systems: presence/absence (ref 71). In NO Forest (total > 10 cm dia): poor soil; >25, medium; >43, good soil >74 m3/ha (ref 57). In EN (ref 66). In SE, in open habitats: litter layer below 3-5 cm thick on between 20-80% of the area. in IT Coniferous Forest: m3/ha (ref 29). in SP meadows and pastures: % litter (ref 32), (ref 44).	57; 66; 62; 68; 71; 32; 41; 44
Coarse dead wood >30 cm dbh	In NO, Forest: poor soil; >10, medium; >17, good soil >30 m3/ha (ref 57), boreal rainforest, pine forest, broadleaved forest, swamp-forest > 1-8 stems /1000m2 (ref 58). in EN size of wood is not specified (ref 66). in FR, Forest: number of dead trees (standing or fallen) (ref 67).	57; 66; 67
Cover: old growth forest	in NO Forest: >36% (ref57). in FR for forests: number of very large trees per ha or ratio of large tree cover and other tree cover (ref 67).	57; 67
Wetness (Ellenberg F)	In NO fens/meadows: lower th: 6.44-8.20, upper th: 6.79-9.59 (ref 57). in SE, open habitats: registered in four levels from wet to dry based in plant list but not using Ellenberg (ref 62)	57, 62
Cover: area without dead or damaged Calluna	coastal Heathland: > 70% (ref 57)	57;
Degradation, Alterations: % burnt area (and frequency)	in FR for EUNIS R1 ANNEX 6510, 6520 (ref 64); ANNEX 7210, 7220, 7230, 7240 (ref 68). in EN (ref 66). in IT Coastal dunes with Juniper, Coastal dunes with Pine (ref 29). in SP Forest ANNEX 5930 (ref 41).	64; 66; 68; 29; 41; 47; 44;
Degradation, Alterations: % bare ground	in FR example metric for EUNIS R1 ANNEX 6210, 6510, 6520, R3 ANNEX 6410, R5 ANNEX 6430 (ref 64), ANNEX1 7110, 7120, 7130, 7140, 7150: combined with erosion indicator species (ref 65); ANNEX1 3220, 3250,3230, 3240 (ref 70). in EN (ref 66). in SE, open habitats: it is registered if there are batches of bare sand or soil larger than 0,5 m2 given in 10% cover intervals (ref 62). in IT for salt meadows and B1 Wooded Dune systems: trampling impact, for F6 and E6 possible measure for human impact (ref 29). in SP meadows and pastures (ref 32), forest ANNEX 5920 (ref 41), (ref 47).	64; 65; 66; 62; 70; 29; 32; 41; 47; 44
Degradation, Alterations: evidence or high density of grazers, browsers (e.g., rabbit, large grazers such as cattle, horses, deer) / diggers (e.g., moles, wild boar)	in FR for EUNIS R1 ANNEX 6210, 6510, 6520, R3 ANNEX 6410, R5 ANNEX 6430 (ref 64); for ANNEX 7210 (ref 68), Dune systems (ref 71). in IT Salt marshes, Coastal dunes with Juniper (ref 29). in SP dune systems (ref 44).	64; 68; 71; 29; 32; 41; 47; 44
Degradation, Alterations: hydrology - evidence of drainage (as alternative for water table level and indicator of drying); surface water cover	in FR for EUNIS R3 ANNEX 6410, R5 ANNEX 6430 (ref 64); ANNEX1 7110, 7120, 7130, 7140, 7150 (ref 65); ANNEX 7210, 7220, 7230, 7240 (ref 68) . in EN (ref 66). in IT salt marshes, E3: surface water time-series, C and D: density of wild boar (ref 29)	64; 65; 66; 68; 29; 47;
Degradation, Alterations: % dung	in FR for EUNIS R3 ANNEX 6410, R5 ANNEX 6430 (ref 64)	64; 32;

Degradation, Alterations: Abrasion, linear features (tracks or areas with low veg due to traffic, digging, peat extraction)	in FR for EUNIS R3 ANNEX 6410, R5 ANNEX 6430 (ref 64); for ANNEX 7210, 7220, 7230, 7240 (ref 68); Forest soil degradation through disturbances (ref 67). In NO: Bare mountain/rock, lime grassland, meadows, dunes, tundra, snow-grassland, pine forest, some wetlands: < 1/16 of area (ref 58). in EN (ref 66). in IT for forest habitats: intensity and density of human activity (ref 29). in SP (ref 44)	58; 64; 66; 67; 68; 29; 32; 47; 44
Degradation, Alterations: Stream/river regulation	In FR ANNEX1 3220, 3250,3230, 3240 (ref 70). In NO non-significant regulation (doesn't affect species composition), also in wet forests	58; 70;
Degradation, Alterations: change in micro-topography (e.g., sunken peat, erosion channels, dune erosion)	in FR ANNEX1 7110, 7120, 7130, 7140, 7150 (ref 65), Dune systems: no, medium, high erosion (ref 71). in NO: bog, rainfed fens: no traces of turf-removal (ref 58). in EN (ref 66). in IT Coastal dunes with Juniper (ref 29). in SP (ref 44)	58; 65; 66; 71; 29; 47
Degradation, Alterations, productivity: evidence of grazing (not using indicator species e.g. vegetation height)	in FR ANNEX1 7110, 7120, 7130, 7140, 7150 (ref 65); Dune systems (ref 71). In NO, (salt and fresh) meadow clearly extensively managed (i.e. traces of long-term grazing, mowing or burning) (ref58). in EN height of vegetation & evidence of grazing/browsing (ref 66). in IT Coastal dunes with Juniper (ref 29)	58; 65; 66; 29; 47; 44
Degradation, Alterations: Human made objects or surfaces	In FR ANNEX 7210, 7220, 7230, 7240 (ref 68); Dune systems: 5%, 10%, 20% cover of artificial or human intervention (e.g., plantation) (ref 71). In NO, Tundra, snow-grassland, alpine heathland: 0 objects (ref58). in EN (ref 66). in IT (ref 29). in SP (ref 44)	66; 68; 71; 29; 47; 44
No. of large trees	In NO: Broadleaved Forest > 3 large trees/1000 m2 (ref 58), in SE, open landscapes; threes with a DBH over 1 m (62). in IT for Beech Forest G1.6: number of trees > 50cm dbh (ref 29). in SP riverine forests (ref 45)	58; 62; 29; 45
Composition, Structure, Function: Natural reduction in population	In NO: some broadleaved forest < xx % attacked by fungi (I don't understand why this should make sense but could be misinterpreted by me. Perhaps > xx % attacked) (ref 58). in IT xerothermophilous formations with Buxus affected by insect (alien invasive moth) herbivory (ref 29).	58; 29
No of hollow broadleaved trees	In NO: some broadleaved forest > 1 tree/1000 m2 (ref 58)	58;
Composition, Structure: % cover and average height of tree, shrub and herbaceous layer	in IT forested habitats (ref 29). in SP meadows and pastures where 3 layers naturally occur: only % cover (ref 32)	29; 32
Composition, Structure: Forested habitats, presence/absence, or quantification of understory/natural regeneration	in IT: Dune systems with Pine (ref 29). in SP (ref 45), alpine and subalpine shrub: regeneration after fire (ref 44).	29; 41; 45; 44
Composition, Structure: Woody vegetation height, dbh	in IT Alpine heaths: height F2, Arborescent matorral with Juniperus: dbh and height (ref 29). in SP forest habitats: full forest mensuration (ref 41), temperate shrub and heathland: average height, density and basal area.	29; 41;
Composition, Structure: shrub-grass ratio	in SP (ref 44)	44;
Composition, Structure: tree-shrub ratio	in IT (ref 29).	29;
Composition, Structure: Graminoid - Forb ratio	in EN (ref 66)	66;
Composition, Structure: herbaceous vegetation height	in SP meadows and pastures (ref 32)	32;
Cover: water extent	in EN (ref 66)	66;
Stone, rock, boulder cover	in SE, Open habitats, if > 5% cover then it is registered (62)	62;
Base rich soil indicators	in SE, Open habitats, its registered whether the flora indicates base-rich (calcareous) soils (62)	62;
Function: Water dynamic regime (altered/degraded) or water flow changes	in FR EUNIS R5 ANNEX 6430 (ref 64). in NO wet forests and wetlands. in IT saltmarshes, E5, F9 (ref 29)	58; 64; 29
Function: Dune morphodynamic metrics	in FR Dune systems: width of dune in 2m, 20m or 50m steps (ref 71); in IT (ref 29); in SP Dune systems: dune dimensions, height, width, slope (ref 44)	71; 29; 44

ANNEX – Table 3: Summary highlighting most frequently used condition metrics.

generic condition metric from field manuals (grey literature)	Coastal	Salt meadows, marshes & Inland salt steppes and marshes	Mires, bogs and fens	Grasslands & Forest fringes	Sparsely wooded grasslands	Forests	Tundra & Arctic, alpine and subalpine scrub	Temperate, mediterranean-montane scrub & Temperate shrub heathland	Maquis & Garrige & Spiny Med. Heaths & Xerophytic Scrub	Riverine and fen scrubs	Screes, Inland Cliffs, Rock pavements, Outcrops	TOTAL
	N	?, R6	?, ?	R1-R6	R7	T	S1, S2	S3, S4	S5, S6, S7	S9	U2, U3	
	B	A, E6	C, D	E1-E6	E7	G	F1, F2	F3, F4	F5, F6, F7, F8	F9	H2, H3	
Cover: Extent of habitat (stable or increase, decrease)	2.7	1.0	5.0	3.2	0.0	3.5	1.5	2.5	1.0	2.0	1.5	**23.9**
Cover: Fragmentation metrics (stable or increased connectivity, decreased connectivity), landscape metrics (e.g., patch size, number, distance between patches)	1.0	1.0	1.0	1.2	0.0	2.3	1.0	2.0	1.3	1.0	1.0	**12.7**
Composition: presence of positive indicator species	1.7	1.5	4.0	4.4	0.0	3.5	1.5	3.0	1.3	1.0	1.5	**23.3**
Composition: species indicating nutrient changes - e.g., grassland improvement; trophic changes	0.3	0.0	2.0	2.0	0.0	0.3	0.0	0.5	0.0	2.0	0.0	**7.1**
Composition: species indicating mowing regime or grazing regime, or drying/drainage (for wetlands)	0.0	0.0	3.0	0.8	0.0	0.0	0.0	0.5	0.0	0.0	0.0	**4.3**
Composition: presence of problem (negative) species and alien species	1.7	1.5	4.0	3.6	0.0	2.0	1.5	2.5	1.0	2.0	1.5	**21.3**
Composition, Structure, Function: Presence of (all) dynamic stages	1.7	1.5	3.0	0.2	0.0	1.5	0.5	1.5	0.8	2.0	0.0	**12.6**
Composition, Structure: woody cover (%)	0.3	1.0	4.0	3.8	1.0	1.5	0.5	1.5	0.3	0.0	1.0	**14.9**
Composition, Structure: planted tree cover (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	**0.5**
Composition, Structure: % cover herbaceous or all (sparse) vegetation or perennial vegetation	1.3	0.5	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	**2.8**
Light condition/canopy cover - forest	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.3	0.0	0.0	**1.0**
Forest gaps/glades	0.0	0.0	1.0	0.8	0.0	0.8	0.0	0.0	0.0	0.0	0.0	**2.6**
Indicator value for nutrient level (Ellenberg N)	0.0	0.5	0.0	0.6	0.0	0.8	0.5	0.5	0.0	0.0	0.0	**2.9**
Light condition - herb vegetation (Ellenberg L)	0.0	0.5	0.0	0.6	0.0	0.0	0.5	0.5	0.0	0.0	0.0	**2.1**
Degradation, Alterations: Area without technical interventions in 1 km vicinity / distance from human activities	0.0	0.0	0.0	0.2	0.0	1.0	0.5	0.0	0.0	0.0	0.0	**1.7**
Dead Material (litter, wood, drift material on beaches and dunes) - size not specified	1.0	0.0	3.0	2.6	1.0	2.8	0.5	1.0	0.8	0.0	0.0	**12.6**
Coarse dead wood >30 cm dbh	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	**2.3**
Cover: old growth forest	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	**1.5**
Wetness (Ellenberg F)	0.0	0.0	0.0	0.8	0.0	0.0	0.5	0.0	0.0	0.0	0.0	**1.3**

Cover: area without dead or damaged Calluna	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	**0.5**
Degradation, Alterations: % burnt area (and frequency)	0.3	0.0	3.0	0.6	0.0	0.5	0.5	1.0	0.3	0.0	0.0	**6.2**
Degradation, Alterations: % bare ground	0.7	1.0	5.0	3.0	0.0	0.8	0.5	1.0	0.5	2.0	0.0	**14.4**
Degradation, Alterations: evidence or high density of grazers, browsers (e.g., rabbit, cattle, horses, deer) / diggers (e.g., moles, wild boar)	1.0	0.5	3.0	1.6	1.0	1.3	0.5	0.0	0.5	0.0	0.0	**9.4**
Degradation, Alterations: hydrology - evidence of drainage (as water table level alternative, indicator of drying); surface water cover	0.0	0.0	4.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**4.6**
Degradation, Alterations: % dung	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.2**
Degradation, Alterations: Abrasion, linear features (tracks or low veg areas due to traffic, digging, extraction)	1.0	0.5	5.0	1.4	0.0	1.3	0.5	0.0	0.3	0.0	0.5	**10.4**
Degradation, Alterations: Stream/river regulation	0.0	0.0	1.0	0.0	0.0	0.5	0.0	0.0	0.0	2.0	0.0	**3.5**
Degradation, Alterations: change in micro-topography (e.g., sunken peat, erosion channels, dune erosion)	1.3	0.5	4.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	**6.1**
Degradation, Alterations, productivity: evidence of grazing (not using indicator species e.g. vegetation height)	0.7	0.0	3.0	1.0	0.0	1.0	1.0	2.0	0.0	0.0	0.0	**8.7**
Degradation, Alterations: Human made objects or surfaces	2.0	1.0	1.0	0.0	0.0	0.3	0.5	0.5	0.5	0.0	1.0	**6.8**
No. of large trees	0.0	0.0	1.0	0.8	0.0	1.0	0.0	0.0	0.0	0.0	0.0	**2.8**
Composition, Structure, Function: Natural reduction in population	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.5	0.0	0.0	0.0	**0.8**
No of hollow broadleaved trees	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	**0.3**
Composition, Structure: % cover and average height of tree, shrub and herbaceous layer	0.0	0.0	0.0	0.8	0.0	0.8	0.0	0.0	0.0	0.0	0.0	**1.6**
Composition, Structure: Forest habitats, presence/absence, quantification of understory/natural regeneration	0.3	0.0	0.0	0.0	1.0	1.5	0.0	0.5	0.3	0.0	0.0	**3.6**
Composition, Structure: Woody vegetation height, dbh	0.0	0.0	0.0	0.0	1.0	0.8	0.5	0.5	0.3	0.0	0.0	**3.0**
Composition, Structure: shrub-grass ratio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	**0.5**
Composition, Structure: tree-shrub ratio	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	**0.3**
Composition, Structure: Graminoid - Forb ratio	0.3	0.0	1.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**2.1**
Composition, Structure: herbaceous vegetation height	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.8**
Cover: water extent	0.7	0.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**2.2**
Stone, rock, boulder cover	0.0	0.0	1.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.8**
Base rich soil indicators	0.0	0.0	1.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.8**
Function: Water dynamic regime (altered/degraded) or water flow changes	0.0	0.5	1.0	0.4	0.0	0.5	0.0	0.0	0.0	1.0	0.0	**3.4**
Function: Dune morphodynamic metrics	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	**1.3**
TOTAL	**21**	**13.5**	**65**	**38.6**	**5**	**34.8**	**13**	**23**	**10**	**15**	**8**	

ANNEX – Table 4: Complete list of on-line grey literature found related to habitat condition monitoring for the following languages: English, French, Spanish, Italian, Polish, Swedish, Danish, Norwegian, and Dutch.

Record	Language	Country, Region	Year	Authors	Title	doi
1	english	australia	2021	Williams KJ, Harwood TD, Lehmann EA, Ware C, Lyon P, Bakar S, Pinner L, Schmidt RK, Mokany K, Van Niel TG, Richards AE, Dickson F, Mcvicar TR And Ferrier S	Habitat condition assessment system (hcas version 2.1): enhanced method for mapping habitat condition and change across australia. Csiro, canberra, australia.	https://doi.org/10.25919/n3c6-7w60
2	english	australia	2021	Lehmann EA, Williams KJ, Harwood TD And Ferrier S	A not-too-technical introduction to the hcas v2.x mechanics: a revised method for mapping habitat condition across australia. Publication number ep211609. Csiro, canberra, australia.	https://doi.org/10.25919/ek91-wj41
3	english	australia	2020	Williams KJ, Donohue RJ, Harwood TD, Lehmann EA, Lyon P, Dickson F, Ware C, Richards AE, Gallant J, Storey RJL, Pinner L, Ozolins M, Austin J, White M, Mcvicar TR And Ferrier S	Habitat condition assessment system: developing hcas version 2.0 (beta). A revised method for mapping habitat condition across australia. Publication number ep21001. Csiro land and water, canberra, australia	https://doi.org/10.25919/85f4-1k65
5	english	England	2010	Jncc, England	Handbook for phase 1 habitat survey, a technique for environmental audit	https://data.jncc.gov.uk/data/9578d07b-e018-4c66-9c1b-47110f14df2a/Handbook-Phase1-HabitatSurvey-Revised-2016.pdf
6	english	England	2022	Hazel Trenbirth And Adam Dutton	Habitat extent and condition methodology, natural capital, uk: 2022	https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/habitatextentandconditionmethodologynaturalcapitaluk2022
7	english	Great Britain	2020	Forestry Commission, GB	Nfi woodland ecological condition in great britain: methodology, national forest inventory, forestry commission, 231 corstorphine road, edinburgh, eh12 7at	https://frwordpressmedia.blob.core.windows.net/staging/2022/02/fr_nfi_condition_scoring_methodology_dj8ftgg.pdf
8	english	international	2021	Department Of Economic And Social Affairs Statistics Division United Nations, Statistical Commission	System of environmental-economic accounting—ecosystem accounting: final draft	https://unstats.un.org/unsd/statcom/52nd-session/documents/BG-3f-SEEA-EA_Final_draft-E.pdf
9	english	England	2021	Department For Environment, Food And Rural Affairs	Uk biodiversity indicators 2021 revised	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1058725/ukbi2021_summary_booklet_rev.pdf
10	english	England	2020, 2015	Forest Research, England	The nfi survey manual : it describes the assessments made during field data collection and the protocols used by the field surveyors in collecting the data. The nfi survey manual is a living document and contains steadily more explanations. New versions will appear on this page as they are created	https://www.forestresearch.gov.uk/tools-and-resources/national-forest-inventory/nfi-survey-manual-for-third-cycle-field-samples/
11	english	England	2021	Environmental Indicators, Statistics And Reporting Team, Department For Environment, Food And Rural Affairs	Biodiversity 2020: a strategy for england's wildlife and ecosystem services, indicators	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1058728/England_biodiversity_indicators_2021_FINAL_REVISED_version_3.pdf
12	english	Scotland	2018	Phil Baarda, Scottish Natural Heritage	Developing a habitat connectivity indicator for scotland	https://www.nature.scot/sites/default/files/2018-11/Publication%202018%20-%20SNH%20Research%20Report%20887%20-%20Developing%20a%20habitat%20connectivity%20indicator%20for%20Scotland.pdf

13	english	England	2014	Natural England Joint Publication , Ne, Ceh, Ea	Priority river habitat in england – mapping and targeting measures (jp006)	http://publications.naturalengland.org.uk/publication/6266338867675136
14	english	Wales	2018	Natural Resources Wales, Naura, M., Bryden, A., Hearn, SM. And Pinder AC.	River habitat survey in wales: analysis for area statements 2018, nrw evidence report no. 248	https://www.therrc.co.uk/sites/default/files/general/Communications/Blog/nrw_evidence_report_248._river_habitat_survey_in_wales_analysis_for_area_statements_2018.pdf
15	english	Scotland	2021	Scottish Environment Protection Agency	The river basin management plan for scotland 2021 - 2027	https://www.sepa.org.uk/media/594088/211222-final-rbmp3-scotland.pdf
16	english	England	2013	Department For Environment, Food And Rural Affairs, England	Hedgerow survey handbook: a standard procedure for local surveys in the uk	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69285/pb11951-hedgerow-survey-handbook-070314.pdf
17	english	UK	2022	Office Of National Statistics	Habitat extent and condition, natural capital, uk: 2022	https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/habitatextentandconditionnaturalcapitaluk/2022#condition
18	english	England	2021	Natural England	The biodiversity metric 3.0: auditing and accounting for biodiversity condition assessment sheets (excel format); publishing biodiversity metric 3.0 was a landmark moment for biodiversity net gain, it will become the metric used to calculate and evidence whether a project has achieved the biodiversity net gain requirements set out in the environment bill	https://images.reading.gov.uk/2021/10/9d-Appendix-4-Biodiversity-Metric-3.0-habitat-condition-assessment-sheets-with-instructions.pdf http://nepubprod.appspot.com/publication/6049804846366720
19	english	England	2018	Natural England	Natural capital indicators: for defining and measuring change in natural capital - nerr076	http://publications.naturalengland.org.uk/publication/6742480364240896
20	english	England	2018	Natural England	Generating more integrated biodiversity objectives – rationale, principles and practice - nerr071	http://publications.naturalengland.org.uk/publication/5891570502467584
21	english	England	2015	Natural England	Managing ecosystem services evidence review (formally ecosystem services transfer toolkit necr159) - jp033	http://publications.naturalengland.org.uk/publication/5890643062685696
22	english	global	2000	Fao, The Forest Resources Assessment Programme	Assessing forest integrity and naturalness in relation to biodiversity	https://www.fao.org/3/ad654e/ad654e00.htm#TopOfPage
23	French	France	2012	Bensettiti F., Puissauve R., Lepareur F., Touroult J. Et Maciejewski L.	Evaluation de l'état de conservation des habitats et des espèces d'intérêt communautaire – guide méthodologique – dhff article 17, 2007-2012	https://inpn.mnhn.fr/docs/rapportages/Guide_methodologique_EVAL_fev-2012-2012-27.pdf
25	French	France			Évaluation à l'échelle du site natura 2000	https://inpn.mnhn.fr/telechargement/documentation/natura2000/evaluation
26	French	Brussels	2020	Environment.Brussels	Surveillance des habitats naturels en région bruxelloise	https://environnement.brussels/lenvironnement-etat-des-lieux/en-detail/espaces-verts-et-biodiversite/surveillance-des-habitats
27	dutch	Flanders	2009	T'jollyn Filiep, Bosch Hans, Demolder Heidi, De Saeger Steven, Leyssen An, Thomaes Arno, Wouters Jan, Paelinckx Desiré En Hoffmann Maurice	Ontwikkeling van criteria voor de beoordeling van de lokale staat van instandhouding van de natura 2000 habitattypen. Versie 2.0.	https://publicaties.vlaanderen.be/view-file/6501
28	Italian	Italy	2009	Bondi Et Al 2009	Manuale italiano di interpretazione degli habitat (mih; biondi et al., 2009)	http://vnr.unipg.it/habitat/cerca.do
29	Italian	Italy	2014	Aa.Vv 2014	Guida del monitoraggio degli habitat proposte a scala regionale nel progetto life gestire (aa.vv., 2014)	https://www.isprambiente.gov.it/public_files/direttiva-habitat/Manuale-142-2016.pdf
30	Italian	Lombardia	2016		Accordo per l'attuazione del protocollo d'intesa tra regione lombardia e fondazione lombardia per l'ambiente per supporto tecnico-scientifico alle attività dell'osservatorio regionale per la biodiversità della lombardia	http://www.biodiversita.lombardia.it/images/HABITAT/pdf/manuale-HABITAT-lombardia.pdf
31	Europe	Europe		Anne Schmidt & Chris Van Swaay	Monitoring of species and habitats	https://ec.europa.eu/environment/nature/info/pubs/docs/other_documents/A1_Monitoring-of-species-and-habitats_JRA.pdf
32	Spanish	Spain	2019	Daniel Goñi, Ramón Reiné, Sonia Roig	Selection and description of ecological variables that allow diagnosing the conservation status of the parameter 'structure and function' of the different types of habitat of meadows and pastures sensu lato	https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/pradosypastizales_3_estructurayfuncion_tcm30-506053.pdf

34	Spanish	Spain		Webpage	Metodologías para el seguimiento del estado de conservación de los tipos de hábitat	https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/Seguimiento_habitats_metodologia.aspx
35	Spanish	Spain	2019	Ministerio Para La Transicion Ecoologia	Guía metodológica de evaluación de impacto ambiental en red natura 2000	https://www.miteco.gob.es/es/biodiversidad/temas/espacios-protegidos/criteriossgbymnperjuiciohabitats_tcm30-481533.pdf
36	Spanish	Andalucia	2017	Álvaro Galicia González	Evaluación del estado de conservación del hábitat 6310 (dehesas perennifolias de quercus spp.) En andalucía a partir de datos del inventario forestal nacional	https://oa.upm.es/47719/1/TFG_ALVARO_GALICIA_GONZALEZ.pdf
37	Spanish	Aragon	2019	Daniel Goñi Martínez Y David Guzmán Otano	Manual de seguimiento para hábitats de interés comunitario	
38	Spanish	Spain	2019	Augusto Pérez-Alberti	Selección y descripción de variables ecológicas que permitan diagnosticar el estado de conservación de la 'estructura y función' de los tipos de hábitat rocosos y glaciares	https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/01rocososyglaciares_3_variablesestructurayfuncion_tcm30-506034.pdf
39	Spanish	Spain	2019	Daniel Goñi Ramón Reiné Sonia Roig	Selección y descripción de variables ecológicas que permitan diagnosticar el estado de conservación del parámetro 'estructura y función' de los diferentes tipos de hábitat de prados y pastizales sensu lato	https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/pradosypastizales_3_estructurayfuncion_tcm30-506053.pdf
41	Spanish	Spain	2019	David S. Pescador, Jordi Vayreda, Adrián Escudero, Francisco Lloret	Identificación y descripción de las variables utilizadas en el inventario forestal nacional para la evaluación de la 'estructura y función' de los tipos de hábitat de bosque	https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/04bosquesymatorralesnofluviales_2_metodosestructurayfunciónifn_tcm30-506048.pdf
43	Spanish	Spain	2019	Jordi Vayreda, Carles Batlles, Marta Lerner, Beatriz Vila, David S. Pescador, Julia Chacón-Labella, Francisco Lloret	Desarrollo de un procedimiento estandarizado para generar datos de las variables ecológicas estructurales que permitan estimar el estado de conservación de los tipos de bosque y matorral utilizando como fuente de datos la tecnología lidar	https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/04bosquesymatorralesnofluviales_6_metodosvariableslidar_tcm30-506049.pdf
44	Spanish	Spain	2019	Subdirección General De Biodiversidad Y Medio Natural, Dirección General De Biodiversidad Y Calidad Ambiental	Criterios utilizados por la subdirección general de biodiversidad y medio natural para la determinación del perjuicio a la integridad de espacios de la red natura 2000 por afección a hábitats de interés comunitario.	https://www.miteco.gob.es/es/biodiversidad/temas/espacios-protegidos/criteriossgbymnperjuiciohabitats_tcm30-481533.pdf
45	Spanish	Spain	2019	Francisco Lara Juan Antonio Calleja Ricardo Garilleti	Selección y descripción de variables que permitan diagnosticar el estado de conservación del parámetro 'estructura y función' de los diferentes tipos de hábitat de bosque y matorral de ribera	https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/05bosquesymatorralesderibera_3_variablesestructurayfuncion_tcm30-506058.pdf
47	Spanish	Spain	2019	Noemí Silva Sánchez Antonio Martínez Cortizas	Selección y descripción de variables ecológicas que permitan diagnosticar el estado de conservación del parámetro 'estructura y función' de los diferentes tipos de hábitat herbáceos con componente turbófilo (paraturberas y tremedales mesoeutróficos)	https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/ecosistemasturbofilos_3_estructurayfuncion_tcm30-540525.pdf
48	Spanish	Spain	2019	Noemí Silva-Sánchez Antonio Martínez-Cortizas Xabier Pontevedra-Pombal	Selección y descripción de variables para diagnosticar el estado de conservación de la 'estructura y función' de los tipos de hábitat de turberas ácidas	https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/turberasacidas_3_variablesestructurayfuncion_2_tcm30-540524.pdf
49	Spanish	Spain	2019	Antonio Camacho, Carolina Doña, Daniel Morant, Carmen Ferriol, Anna C. Santamans	Descripción de procedimientos basados en la utilización de sensores remotos para caracterizar el estado de conservación de cada tipo de hábitat lenítico de interior	https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/leniticos_3_metodosestadodeconservacion_tcm30-506081.pdf
50	Spanish	Spain	2019	Noemí Silva-Sánchez Antonio Martínez-Cortizas Xabier Pontevedra-Pombal	Selección y descripción de variables para diagnosticar el estado de conservación de la 'estructura y función' de los tipos de hábitat de turberas ácidas	https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/turberasacidas_3_variablesestructurayfuncion_2_tcm30-540524.pdf
51	Spanish	Spain	2019	María Aranda Francisco Javier Gracia Augusto Pérez-Alberti (Coords.)	Selección y descripción de variables que permitan diagnosticar el estado de conservación de la 'estructura y función' de los diferentes tipos de hábitat costeros	https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/10costeros_3_variablesestructurayfuncion_tcm30-506038.pdf
52	Spanish	Spain	2019	Miguel Ángel Esteve Selma Juan Miguel Moya Pérez José Antonio Navarro Cano	Manual de evaluación y gestión del hábitat 9570*: bosques de tetraclinis articulata	https://www.researchgate.net/publication/337906778_Manual_de_evaluacion_y_gestion_del_habitat_9570_Bosques_de_Tetraclinis_articulata

53	English	Poland	2022	Forest Research Institute, Poland	The current state of białowieża forest based on the results of the life+ forbiosensing project	http://www.forbiosensing.pl/documents/20182/68588/Monografia+EN/d97f33cf-0f9c-4d2d-937d-e957f55a6fc9
54	Norwegian	Norway	2021	Niva, Norway	Kartlegging av et utvalg marine naturtyper i oslofjorden	https://www.miljodirektoratet.no/sharepoint/downloaditem?id=01FM3LD2XYZDJX7MKVHNG3JHMNCAAHEHSK
55	English	Norway	2002	W. E. Dramstad*, W. J. Fjellstad, G.-H. Strand, H. F. Mathiesen, G. Engan And J. N. Stokland	Development and implementation of the norwegian monitoring programme for agricultural landscapes	https://www.sciencedirect.com/science/article/pii/S0301479701905031
56	Norwegian	Norway	2021	Nina, Norway	Overvåking av effekter av tiltak for prioriterte arter og utvalgte naturtyper	https://brage.nina.no/nina-xmlui/bitstream/handle/11250/2735571/ninarapport1974.pdf?sequence=1&isAllowed=y
57	Norwegian	Norway	2019	Nina, Norway	Test av fagsystemet for økologisk tilstand for terrestriske økosystemer i trøndelag	https://brage.nina.no/nina-xmlui/handle/11250/2599977
58	Norwegian	Norway	2022	Environmental Agency, Norway	Kartleggingsinstruks - kartlegging av terrestriske naturtyper etter nin2	https://www.miljodirektoratet.no/sharepoint/downloaditem?id=01FM3LD2SHXAQSGY6VWNDYTTXQNC34U2IG
59	Norwegian	Norway	2019	Rune Halvorsen Og Harald Bratli	Veileder for beskrivelsessystemet i kartlegging av terrestrisk naturvariasjon etter nin (2.2.0) tilpasset målestokk 1:5 000 og 1:20 000	https://artsdatabanken.no/Files/29631/Veileder_for_beskrivelsessystemet_i_kartlegging_av_terrestrisk_naturvariasjon_-_2.utgave_2019.pdf
60	Norwegian	Norway	2019	Tingstad, L., Evju, M., Sickel, H. Og Töpper, J.	Utvikling av nasjonal arealrepresentativ naturovervåking (ano). Forslag til gjennomføring, protokoller og kostnadsvurderinger med utgangspunkt i erfaringer fra uttesting i trøndelag.	https://www.miljodirektoratet.no/globalassets/publikasjoner/m1294/m1294.pdf
61	Swedish	Sweden	2016	Naturvårdsverket	Metodik för regional miljöövervakning av gräsmarker och våtmarker 2015-2020	https://naturvardsverket.diva-portal.org/smash/get/diva2:1064309/FULLTEXT01.pdf
62	Swedish	Sweden	2016	Jordbruksverket	Ängs- och betesmarksinventeringen metodik för inventering från och med 2016	https://www2.jordbruksverket.se/download/18.48a7452e15c7b4a5a65a3a6b/1496908244029/ra17_9.pdf
63	English	Poland	2015	The Chief Inspector Of Environmental Protection	The state environmental monitoring programme	https://www.gios.gov.pl/images/dokumenty/pms/pms/SEM_Programme_2016-2020_ENG.pdf
64	French	France	2015	*L'Inventaire National Du Patrimoine Naturel (INPN)*	Évaluation de l'état de conservation des habitats agropastoraux guide d'application pour l'évaluation des prairies de fauche	https://inpn.mnhn.fr/docs/N2000_EC/Eval_EC_habitats_agropastoraux_version3_MNHN-SPN_2015.zip
65	French	France	2015	Epicoco C., Viry D	Epicoco c., viry d., 2015 - état de conservation des habitats tourbeux d'intérêt communautaire, méthode d'évaluation à l'échelle du site. Rapport d'étude. Version 1 – mars 2015. Rapport spn 2015-57, service du patrimoine naturel, muséum national d'histoire naturelle / office national de l'eau et des milieux aquatiques, paris, 76 p.	https://inpn.mnhn.fr/docs/N2000_EC/SPN-2015-57-Methodologie_d_evaluation_E_C_tourbieres.pdf
66	English		2015	Gerard Et Al	Gerard, france; acreman, mike; mountford, owen; norton, lisa; pywell, richard; rowland, clare; stratford, charlie; tebbs, emma. 2015 earth observation to produce indices of habitat condition and change. Peterborough, joint nature conservation committee, 86pp. (ceh project no. C05534, jncc ref. C14-0171-0901) (unpublished)	https://nora.nerc.ac.uk/id/eprint/511212/
67	French	France	2016	Maciejewski, L.	Maciejewski, l., 2016. État de conservation des habitats forestiers d'intérêt communautaire, evaluation à l'échelle dusite natura 2000, version 2. Tome 1 : définitions, concepts et éléments d'écologie. Mars 2016. Rapport spn 2016-75,service du patrimoine naturel, muséum national d'histoire naturelle, paris. 82 p.	https://inpn.mnhn.fr/telechargement/documentation/natura2000/evaluation
69						https://www.slu.se/en/Collaborative-Centres-and-Projects/nils/publications/
68	French	France	2022	Hugo Clément, Mathilde Reich, François Botcazou, Baptiste Crouzeix, Margaux Mistarz Et Julie Garcin	Évaluation de l'état de conservation des bas-marais calcaires d'intérêt communautaire cahiers d'évaluation à l'échelle des sites natura 2000 version 3; guide d'évaluation à l'échelle des sites natura 2000: état de conservation des « marais calcaires à cladium mariscus et espèces du caricion davallianae » (ue 7210*) ; des « sources pétrifiantes avec formation de travertins (cratoneurion) » (ue 7220*) ; des « tourbières basses	https://inpn.mnhn.fr/docs-web/docs/download/397190

					alcalines » (ue 7230); des « formations pionnières alpines du caricion bicoloris-atrofuscae » (ue 7240*)	
70	French	France	2013	Viry Déborah	État de conservation des habitats humides et aquatiques d'intérêt communautaire, méthode d'évaluation à l'échelle du site. Guide d'application. Version 1 – avril 2013. Rapport spn 2013-13, service du patrimoine naturel, museum national d'histoire naturelle / office national de l'eau et des milieux aquatiques, paris, 33 p.	https://inpn.mnhn.fr/docs/N2000_EC/SPN-2013-13-Etat_de_conservation_des_habitats_humides_et_aquatiques_d_interet_communautaire_Methode_d_evaluation_a_lechelle_du_site_Natura_2000_Guide_d_application_V1.pdf
71	French	France	2011	Léonore GOFFÉ	Goffé l., 2011. Etat de conservation des habitats d'intérêt communautaire des dunes non boisées du littoral atlantique - méthode d'évaluation à l'échelle du site natura 2000 - version 1. Rapport spn 2011-18. Museum national d'histoire naturelle / office national des forêts /conservatoire botanique national de brest, 67 p.	https://inpn.mnhn.fr/docs/N2000_EC/SPN-2011-18-Rapport_Goffe_2011_18.pdf

ANNEX – Table 5A: Questionnaire responses: Q1. To begin, which habitat conditions metrics do you currently use?

Habitat Condition Metric / Responder	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	total
Cover: Extent of Habitat	X		X	X	X	X	X	X			X	X	X	X	X	12
Cover:Fragmentation metrics (stable or increased connectivity, decreased connectivity)				X	X			X							X	4
Cover: Area without technical interventions in 1km vicinity				X												1
Cover: old growth forest				X	X			X								3
Cover: Area without dead or damaged Calluna.				X	X	X										3
Cover: Area with Calluna in at least two life stages.				X		X							X			3
Cover: Water extent				X	X								X		X	4
Composition, Structure, Function: presence of positive indicator species.	X	X		X	X	X	X	X	X		X	X	X	X	X	13
Composition, Structure, Function: species indicating nutrient change - e.g. grassland improvement	X			X	X	X	X	X	X		X	X				9
Composition, Structure, Function: species indicating mowing regime and grazing regime				X	X		X	X	X		X					6
Composition, Structure, Function: presence of problem (negative) species and alien species.	X	X	X	X	X	X	X	X		X	X		X		X	12
Composition, Structure, Function: Presence of all dynamic stages				X	X	X	X	X								5
Composition, Structure, Function: woody cover(%)		X	X	X	X	X	X	X		X	X		X			10
Composition, Structure, Function: Natural reduction in population				X	X											2
Composition, Structure, Function: Graminoid - Forb ratio				X	X								X			3
Light condition/canopy cover - forest		X	X	X	X					X			X			6
Forest gaps/glades			X	X	X											3
Indicator value for nutrient level (Ellenberg N).			X	X	X								X			4
Light condition - herb vegetation (Ellenberg L).			X	X	X											3
Dead Material (litter, wood)				X	X	X	X	X								5
Coarse dead wood >30cm diameter				X	X	X		X			X		X			6
Degradation, Alterations: % burnt area				X		X	X									3
Degradation, Alterations: % bare ground			X	X	X	X	X	X	X							7
Degradation, Alterations: high density of natural grazers (e.g. rabbits)/diggers (e.g. moles)				X			X	X								3

Degradation, Alterations: % dung					X				X							2
Degradation, Alterations: Abrasion, linear features (tracks or areas with low veg due to traffic, digging)			X	X		X	X								X	5
Degradation, Alterations: Human made objects	X					X	X	X								4
Degradation, Alterations: Stream/river regulation				X	X		X	X							X	5
Degradation, Alterations: change in microtopography (e.g. sunken peat, erosion channels)			X	X		X	X									4
Degradation, Alterations, productivity: evidence of grazing (not using indicator species e.g., vegetation height)				X	X		X		X				X			5
Degradation, Alterations: hydrology - evidence of drainage (as alternative for water table level and indicator of drying)				X	X	X	X	X				X	X			7
Function: Water dynamic regime (altered/degraded)	X		X	X	X			X				X				6
Number of large trees				X	X	X		X					X		X	6
Number of hollow broadleaved trees				X	X			X					X		X	5
Wetness (Ellenberg F)			X	X	X		X		X							5
Another habitat condition metrics (not listed)	Water parameters: salinity, temperature, oxygen etc.		Lifeforms spectrum, floristic composition, other Ellenberg value	Vegetation structural types	Habitat specific natural structures		Tree planting, number of woody species, total vegetation cover, silting, water color, high woody cover, low woody cover, dredging, crushing, artificialization	too many			Blowout dynamic (in dunes)			PREI (posidonia oceanica)		

ANNEX – Table 5B: Questionnaire responses: Q2. Please now rank these habitat conditions metrics that you use in terms of their importance, with 1 indicating the most important metric.

Habitat Condition Metric Responder	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	m ed	ad ju	Co
Cover: Extent of Habitat	1		1	1	1	1	1	1			1	5	5	1	3	1	0.08	12
Cover:Fragmentation metrics (stable or increased connectivity, decreased connectivity)				3	2			2							6	2.5	0.63	4
Composition, Structure, Function: presence of positive indicator species.	4	2		6	3	5	6	4	7		2	1	3	2	1	3	0.23	13
Composition, Structure, Function: species indicating nutrient change - e.g. grassland improvement	5			11	4	2	3	13	3		3	2				3	0.33	9
Composition, Structure, Function: presence of problem (negative) species and alien species.	6	3	4	12	7	3	4	3		1	4		4		2	4	0.33	12
Composition, Structure, Function: species indicating mowing regime and grazing regime				7	6		7	19	1		6					6.5	1.08	6
Composition, Structure, Function: woody cover(%)		4	5	8	10	6	5	11		2	7		10			6.5	0.65	10
Number of hollow broadleaved trees				32	27			7					7		4	7	1.40	5
Light condition/canopy cover - forest		1	6	17	15					3			11			8.5	1.42	6
Composition, Structure, Function: Presence of all dynamic stages				13	9	4	17	9								9	1.80	5
Function: Water dynamic regime (altered/degraded)	2		13	5	25			16				3				9	1.50	6
Composition, Structure, Function: Natural reduction in population				14	5											9.5	4.75	2
Degradation, Alterations: Abrasion, linear features (tracks or areas with low veg due to traffic, digging)			11	26		10	9								8	10	2.00	5
Number of large trees				31	26	14		5					6		5	10	1.67	6
Cover: Water extent				4	14								14		7	10.5	2.63	4
Degradation, Alterations: Human made objects	7					11	10	18								10.5	2.63	4
Coarse dead wood >30cm diameter				22	21	15		6			8		8			11.5	1.92	6
Degradation, Alterations: change in microtopography (e.g. sunken peat, erosion channels)			12	28		12	11									12	3.00	4

Degradation, Alterations, productivity: evidence of grazing (not using indicator species e.g. vegetation height)				29	8		13		2				12			12	2.40	5
Dead Material (litter, wood)				21	23	7	12	8								12	2.40	5
Degradation, Alterations: hydrology - evidence of drainage (as alternative for water table level and indicator of drying)				30	12	13	8	15				4	1			12	1.71	7
Cover: Area with Calluna in at least two life stages.				10		16							13			13	4.33	3
Degradation, Alterations: Stream/river regulation				27	13		2	14							9	13	2.60	5
Degradation, Alterations: % burnt area				23		8	14									14	4.67	3
Indicator value for nutrient level (Ellenberg N).			9	19	19								2			14	3.50	4
Composition, Structure, Function: Graminoid - Forb ratio				15	17								9			15	5.00	3
Degradation, Alterations: % bare ground			10	24	24	9	15	17	5							15	2.14	7
Light condition - herb vegetation (Ellenberg L).			7	20	16											16	5.33	3
Cover: old growth forest				16	20			10								16	5.33	3
Degradation, Alterations: high density of natural grazers (e.g. rabbits)/diggers (e.g. moles)				25			16	12								16	5.33	3
Cover: Area without dead or damaged Calluna.				9	22	17										17	5.67	3
Degradation, Alterations: % dung					29				6							17.5	8.75	2
Forest gaps/glades			8	18	18											18	6.00	3
Wetness (Ellenberg F)			3	33	28		18		4							18	3.60	5
Cover: Area without technical interventions in 1km vicinity				34												34	34.00	1

ANNEX – Table 5C: Questionnaire responses: Q3. Please now rank the habitat conditions metrics you use according to their ease of implementation, with 1 indicating the easiest metric to use.

Habitat Condition Metric Responder	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Me	Ad	C
Cover: Extent of Habitat	7		13	1	6	9	18	1			1	2	2	1	4	2	0.17	12
Composition, Structure, Function: presence of positive indicator species.	6	3		6	29	8	10	5	1		4	1	4	2	6	4.5	0.35	13
Composition, Structure, Function: woody cover (%)		2	1	10	8	5	7	4		2	7		5			5	0.50	10
Composition, Structure, Function: presence of problem (negative) species and alien species.	4	4	6	8	11	5	13	9		1	6		3		7	6	0.50	12
Composition, Structure, Function: species indicating nutrient change - e.g. grassland improvement	5			14	28	4	11	6	2		5	5				5	0.56	9
Light condition/canopy cover - forest		1	3	17	5					3			11			4	0.67	6
Cover: Water extent				3	3								8		3	3	0.75	4
Degradation, Alterations: hydrology - evidence of drainage (as alternative for water table level and indicator of drying)				30	4	1	6	8				3	14			6	0.86	7
Degradation, Alterations: % bare ground			2	24	14	11	8	3	4							8	1.14	7
Composition, Structure, Function: species indicating mowing regime and grazing regime				7	22		12	7	7		8					7.5	1.25	6
Cover: Area without dead or damaged Calluna.				4	2	17										4	1.33	3
Degradation, Alterations: Abrasion, linear features (tracks or areas with low veg due to traffic, digging)			4	26		12	1								8	8	1.60	5
Cover: Area with Calluna in at least two life stages.				5		16							1			5	1.67	3
Degradation, Alterations, productivity: evidence of grazing (not using indicator species e.g. vegetation height)				29	15		5		6				9			9	1.80	5
Degradation, Alterations: Human made objects	1					13	2	14								7.5	1.88	4
Composition, Structure, Function: Presence of all dynamic stages				9	24	3	16	10								10	2.00	5
Number of large trees				32	7	14		2					12		1	12	2.00	6
Coarse dead wood >30cm diameter				22	25	15		12			2		10			13.5	2.25	6
Function: Water dynamic regime (altered/degraded)	2		12	31	18			16				4				14	2.33	6
Degradation, Alterations: change in microtopography (e.g. sunken peat, erosion channels)			5	28		2	15									10	2.50	4
Degradation, Alterations: Stream/river regulation				27	12		3	15							5	13.5	2.70	5
Cover:Fragmentation metrics (stable or increased connectivity, decreased connectivity)				11	10			19							9	11	2.75	4
Dead Material (litter, wood)				21	20	7	14	11								14	2.80	5
Indicator value for nutrient level (Ellenberg N).			9	19	16								6			12.5	3.13	4
Degradation, Alterations: % burnt area				23		10	9									10	3.33	3
Wetness (Ellenberg F)			11	34	27		17		3							17	3.40	5

Cover: old growth forest				12	1			17								12	4.00	3
Number of hollow broadleaved trees				33	23			18					13		2	20.5	4.10	5
Light condition - herb vegetation (Ellenberg L).			10	20	13											13	4.33	3
Degradation, Alterations: high density of natural grazers (e.g. rabbits)/diggers (e.g. moles)				25			4	13								13	4.33	3
Composition, Structure, Function: Graminoid - Forb ratio				16	21								7			16	5.33	3
Forest gaps/glades			8	18	17											17	5.67	3
Degradation, Alterations: % dung					19				5							12	6.00	2
Composition, Structure, Function: Natural reduction in population				13	26											19.5	9.75	2
Cover: Area without technical interventions in 1km vicinity				15												15	15.0 0	1
Another habitat condition metrics (not listed)	3 - Other: Water parameters: salinity, temperature, oxygen etc.		7 - Lifeforms spectrum, floristic composition, other Ellenberg value	2- Vegetation structural types	9 - Habitat specific natural structures		19 - Tree planting, number of woody species, total vegetation cover, silting, water color, high woody cover, low woody cover, dredging,	20 - too many			3 - Blowout dynamic (in dunes)			3 - PREI (posidonia oceanica)				

ANNEX – Table 5D: Questionnaire responses: Q4. Which other habitat conditions metrics (not listed would you use given the opportunity (i.e. if you had more resources, better tools etc.)?

Responder	Response
1	NA
2	NA
3	Seed bank viability, future environmental conditions models, sociological perception of the habitat
4	Vegetation structural types of grasslands.
5	Abundance, cover and population size of characteristic and rare species.
6	NA
7	chemical quality of soils and water, fragmentation
8	NA
9	Metric for disturbance level
10	I would like to create a new set of habitat conditions metrics on a smaller scale if I had more resources.
11	For wet habitats groundwater info (level and quality)
12	Interlinked metrics maybe using models and tools such as machine learning.
13	NA
14	NA
15	NA

ANNEX – Table 5E: Questionnaire responses: Q5. Now thinking about remote sensing, for which habitat conditions metrics do you use remote sensing?

Habitat Condition Metric Responder	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Count
Cover: Extent of Habitat	X	X	X	X	X		X		X		X	X		X	X	11
Cover:Fragmentation metrics (stable or increased connectivity, decreased connectivity)				X	X		X		X					X		5
Cover: Area without technical interventions in 1km vicinity				X	X									X		3
Cover: old growth forest				X	X				X							3
Cover: Area without dead or damaged Calluna.				X	X											2
Cover: Area with Calluna in at least two life stages.				X												1
Cover: Water extent		X		X	X							X			X	5
Composition, Structure, Function: presence of positive indicator species.		X														1
Composition, Structure, Function: species indicating nutrient change - e.g. grassland improvement		X														1
Composition, Structure, Function: species indicating mowing regime or grazing regime																0
Composition, Structure, Function: presence of problem (negative) species and alien species.		X			X											2
Composition, Structure, Function: Presence of all dynamic stages																0
Composition, Structure, Function: woody cover(%)		X		X	X						X					4
Composition, Structure, Function: Natural reduction in population																0
Composition, Structure, Function: Graminoid - Forb ratio																0
Light condition/canopy cover - forest		X		X	X											3
Forest gaps/glades				X												1
Indicator value for nutrient level (Ellenberg N).																0
Light condition - herb vegetation (Ellenberg L). `																0
Dead Material (litter, wood)																0
Coarse dead wood >30cm diameter																0
Degradation, Alterations: % burnt area				X	X											2
Degradation, Alterations: % bare ground				X	X											2
Degradation, Alterations: high density of natural grazers (e.g. rabbits)/diggers (e.g. moles)																0
Degradation, Alterations: % dung																0
Degradation, Alterations: Abrasion, linear features (tracks or areas with low veg due to traffic, digging)				X	X										X	3
Degradation, Alterations: Human made objects				X	X							X				3

Degradation, Alterations: Stream/river regulation				X	X											2
Degradation, Alterations: change in microtopography (e.g. sunken peat, erosion channels)				X												1
Degradation, Alterations, productivity: evidence of grazing (not using indicator species e.g. vegetation height)																0
Degradation, Alterations: hydrology - evidence of drainage (as alternative for water table level and indicator of drying)					X											1
Function: Water dynamic regime (altered/degraded)																0
Number of large trees		X			X										X	3
Number of hollow broadleaved trees		X														1
Wetness (Ellenberg F)																0
Another habitat condition metrics (not listed)				Vegetation structural types							Blowouts in dunes					

ANNEX – Table 5F: Questionnaire responses: Q6. Which habitat conditions metrics do you think remote sensing could deliver?

Habitat Condition Metric Responder	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Count
Cover: Extent of Habitat	X	X	X					X		X			X			6
Cover:Fragmentation metrics (stable or increased connectivity, decreased connectivity)	X	X	X					X		X	X	X	X			8
Cover: Area without technical interventions in 1km vicinity	X	X	X							X	X		X			6
Cover: old growth forest	X	X														2
Cover: Area without dead or damaged Calluna.	X	X	X						X					X		5
Cover: Area with Calluna in at least two life stages.	X		X				X		X					X		5
Cover: Water extent	X	X	X					X	X		X		X			7
Composition, Structure, Function: presence of positive indicator species.		X								X		X				3
Composition, Structure, Function: species indicating nutrient change - e.g. grassland improvement										X		X				2
Composition, Structure, Function: species indicating mowing regime or grazing regime																0
Composition, Structure, Function: presence of problem (negative) species and alien species.			X							X		X	X			4
Composition, Structure, Function: Presence of all dynamic stages		X					X			X						3
Composition, Structure, Function: woody cover(%)	X		X			X	X	X		X			X			7
Composition, Structure, Function: Natural reduction in population	X									X		X				3
Composition, Structure, Function: Graminoid - Forb ratio	X			X												2
Light condition/canopy cover - forest	X		X						X	X	X		X			6
Forest gaps/glades										X						1
Indicator value for nutrient level (Ellenberg N).										X						1
Light condition - herb vegetation (Ellenberg L).										X				X		2
Dead Material (litter, wood)				X						X						2
Coarse dead wood >30cm diameter				X												1
Degradation, Alterations: % burnt area	X	X	X						X		X					5
Degradation, Alterations: % bare ground	X	X	X							X	X					5
Degradation, Alterations: high density of natural grazers (e.g. rabbits)/diggers (e.g. moles)		X			X											2
Degradation, Alterations: % dung		X														1
Degradation, Alterations: Abrasion, linear features (tracks or areas with low veg due to traffic, digging)	X	X	X							X	X		X			6
Degradation, Alterations: Human made objects			X						X	X	X		X			5
Degradation, Alterations: Stream/river regulation									X	X		X	X			4
Degradation, Alterations: change in microtopography (e.g. sunken peat, erosion channels)					X					X						2

Degradation, Alterations, productivity: evidence of grazing (not using indicator species e.g. vegetation height)		X		X	X								X			4
Degradation, Alterations: hydrology - evidence of drainage (as alternative for water table level and indicator of drying)	X						X			X		X		X		5
Function: Water dynamic regime (altered/degraded)	X				X					X			X			4
Number of large trees				X						X	X		X	X		5
Number of hollow broadleaved trees				X												1
Wetness (Ellenberg F)													X			1
Another habitat condition metrics (not listed)																

ANNEX – Table 5G: Questionnaire responses: Q7. Considering the habitat conditions metrics you do use, please indicate how preciser do their estimates need to be (indicators)?

Habitat Condition Metric / Responder	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Cover: Extent of Habitat	5% extent of cover	40% extent of cover	1% extent or change in cover	5% extent or change in cover, and number of indicator species		1% extent or change in cover	Depends on the habitat				5% Extent of cover, 5% change in cover, presence/absence of indicator species =10	5% Extent cover, 5% change in Cover, Presence/absence of indicator species =10		5% extent, 10% change in cover, presence/absence of indicator species =10	
Cover:Fragmentation metrics (stable or increased connectivity, decreased connectivity)				5% extent or change in cover, and number of indicator species											
Cover: Area without technical interventions in 1km vicinity				5% extent or change in cover, and area covered											

Cover: old growth forest				5% extent or change in cover, and number of indicator species											
Cover: Area without dead or damaged Calluna.				5% extent or change in cover		5% extent or change in cover									
Cover: Area with Calluna in at least two life stages.				5% extent or change in cover		5% extent or change in cover									
Cover: Water extent				5% extent or change in cover											
Composition, Structure, Function: presence of positive indicator species.	1 species			5% extent or change in cover		Presence/absence in all indicator species	Depends on the habitat		Presence/absence of indicator species		2% extent, 2% change in cover, presence/absence of indicator species = 100	10% Extent cover, 10% change in Cover, Presence/absence of indicator species =10		5% extent, 5% change in cover, presence/absence of indicator species =10	

Composition, Structure, Function: species indicating nutrient change - e.g. grassland improvement	1 species			5% extent or change in cover		Presence/absence in all indicator species	Depends on the habitat		Change in % cover		10% extent, 10% change in cover, presence/absence of indicator species = 100	5% Extent cover, 5% change in Cover, Presence/absence of indicator species =5			
Composition, Structure, Function: species indicating mowing regime or grazing regime				5% extent or change in cover		Presence/absence in all indicator species	Depends on the habitat		Change in % cover		25% extent, 10% change in cover, presence/absence of indicator species =25				
Composition, Structure, Function: presence of problem (negative) species and alien species.	1 species		Presence/absence of species	5% extent or change in cover		5% extent or change in cover	Depends on the habitat				1% extent, 1% change in cover, presence/absence of indicator species =100				
Composition, Structure, Function: Presence of all dynamic stages				5% extent or change in cover		5% extent or change in cover	Depends on the habitat								

Composition, Structure, Function: woody cover(%)			5% extent, 5% change in cover	5% extent or change in cover		5% extent or change in cover	Depends on the habitat				35% extent, 5% change in cover, presence/absence of indicator species =35				
Composition, Structure, Function: Natural reduction in population				5% extent or change in cover											
Composition, Structure, Function: Graminoid - Forb ratio				5% extent or change in cover											
Light condition/canopy cover - forest			5% extent or change in cover	5% extent or change in cover											
Forest gaps/glades			Presence/absence of indicator species	5% extent or change in cover											
Indicator value for nutrient level (Ellenberg N).			Presence/absence of indicator species	5% extent or change in cover											

Light condition - herb vegetation (Ellenberg L). `			Presence/absence of indicator species	5% extent or change in cover											
Dead Material (litter, wood)				5% extent or change in cover		5% extent or change in cover	Depends on the habitat								
Coarse dead wood >30cm diameter				5% extent or change in cover		5% extent or change in cover					5% extent, 5% change in cover, presence/absence of indicator species =100				
Degradation, Alterations: % burnt area				5% extent or change in cover		5% extent or change in cover	Depends on the habitat								
Degradation, Alterations: % bare ground			5% extent/change in cover	5% extent or change in cover		5% extent or change in cover	Depends on the habitat		Extent % cover						
Degradation, Alterations: high density of natural grazers (e.g. rabbits)/diggers (e.g. moles)				5% extent or change in cover			Depends on the habitat								

Degradation, Alterations: % dung									Change in % cover						
Degradation, Alterations: Abrasion, linear features (tracks or areas with low veg due to traffic, digging)			Presence/absence indicator species	5% extent or change in cover		5% extent or change in cover	Depends on the habitat								
Degradation, Alterations: Human made objects	No thresholds. Only presence/absence					5% extent or change in cover	Depends on the habitat								
Degradation, Alterations: Stream/river regulation				5% extent or change in cover			Depends on the habitat								
Degradation, Alterations: change in microtopography (e.g. sunken peat, erosion channels)			Presence/absence indicator species	5% extent or change in cover		5% extent or change in cover	Depends on the habitat								
Degradation, Alterations, productivity: evidence of grazing (not using indicator species e.g. vegetation height)				5% extent or change in cover			Depends on the habitat		Change in % cover						

Degradation, Alterations: hydrology - evidence of drainage (as alternative for water table level and indicator of drying)				5% extent or change in cover		1% extent or change in cover	Depends on the habitat					20% Extent cover, 20% change in Cover, Presence/absence of indicator species =20			
Function: Water dynamic regime (altered/degraded)	5%		Presence/absence indicator species	5% extent or change in cover								20% Extent cover, 20% change in Cover, Presence/absence of indicator species =20			
Number of large trees				5% extent or change in cover		5% extent or change in cover									
Number of hollow broadleaved trees				5% extent or change in cover											
Wetness (Ellenberg F)			Presence/absence indicator species	5% extent or change in cover			Depends on the habitat		X						

Another habitat condition metrics (not listed)	5%- Other: Water parameters: salinity, temperature, oxygen etc.		Presence/absence indicator species	5% extent or change in cover - Vegetation structural types			Tree planting, number of woody species, total vegetation cover, silting, water color, high woody cover, low woody cover, dredging, crushing, artificialization				Blowout dynamic (in dunes) = 2% extent, 2% change in cover, presence/absence of indicator species =100			PREI (posidonia oceanica) = 5% extent, 5% change in cover, presence/absence of indicator species =10	

ANNEX – Table 5H: Questionnaire responses: Q8. What countries/regions does your habitat conditions monitoring cover?

Responder	Response
1	France - Mediterranean coast
2	Netherlands, European Countries.
3	South eastern France
4	unknown
5	unknown
6	Occitanie, France - but could extend over the range of each habitat of community interest
7	unknown
8	unknown
9	France
10	Msida, Malta
11	unknown
12	England
13	Denmark
14	unknown
15	Denmark