Monitoring in the context of ecosystem restoration

Results of a two-part EU-level expert workshop

Discussion paper

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Key messages

- The EU Biodiversity Strategy for 2030 announced the development of a proposal for legally binding EU nature restoration targets. Monitoring is key in this context: Both on the EU level and the national level (i.e. when developing National Restoration Plans), existing or newly established monitoring schemes should inform the prioritisation of restoration actions. Moreover, both the progress of restoration actions and the subsequent improvement of ecosystem condition will need to be monitored, to allow for adaptive actions and to verify success.
- A wide variety of information, data sources and methodological approaches already exists in EU member states for the assessment of ecosystem condition and restoration needs. Assessments of restoration potentials, including socio-economic barriers, have often also been conducted. Yet data availability and level of detail differ among member states.
- It is crucial that the setting of restoration priorities is informed by science. Policy-makers are called to engage with technical experts to ensure greater integrability of assessment results and to strengthen the scientific base of their decision-making processes.
- Spatially explicit assessments are generally favored for priority-setting, especially when they allow the identification of restoration co-benefits (e.g. ecosystem service provision, including climate change mitigation or adaptation services, or improved connectivity between protected areas). The rarity of targeted ecosystems or key species is frequently used as a prioritization factor.
- It will be important to monitor both progress and success in the implementation of the new EU nature restoration targets. Yet assessing the improvement of ecosystem conditions following restoration measures is a complex task. A range of complementary indicators should be employed, taking into account the particularities of different ecosystems under different initial conditions and the varying temporal scales of their recovery processes (often spanning decades). The full continuum of restoration activities, from improving conditions to recreating ecosystems, should be considered.
- While monitoring of restoration outcomes on a site-level is well established, many common indicators cannot realistically be used at a nation-wide scale without incurring excessive costs and effort. There is still a need for further guidance to identify monitoring approaches and a set of suitable, complementary indicators that can be aggregated well towards the national and EU level.
- There remains a large potential for further exchange of knowledge and experience among European experts from science, policy and practice, in order to accelerate the priority-setting, implementation and monitoring of ecosystem restoration in the EU.

Context and Objectives

The EU Biodiversity Strategy for 2030 aims to bring nature back on the path to recovery by 2030. A central element of the strategy is its EU Nature Restoration Plan, which includes the key commitment by the European Commission (EC) to develop a proposal for legally binding nature restoration targets. The preparation of this new EU law was accompanied by an extensive consultation process with an Open Public Consultation as well as several stakeholder workshops in 2021. In parallel, an impact assessment for various policy options was drafted.

In order to support these processes, the German Federal Agency for Nature Conservation (BfN), in collaboration with the German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU) and the European Commission's Directorate General for the Environment, organised a two-part technical expert workshop on monitoring in the context of ecosystem restoration, held virtually on 28 April and 5 May 2021.

Participants included technical experts from thirteen EU Member States, primarily members of the MAES working group of the Co-ordination Group for Biodiversity and Nature (CGBN), as well as experts from the Commission's Directorate General for the Environment (DG ENV), the Joint Research Center (JRC) and the European Environmental Agency (EEA).

Building on each other, the two workshop parts addressed the following main questions:

- How can data from existing or future monitoring schemes inform the prioritisation of restoration actions?
- How can the progress of restoration actions and/or the subsequent improvement of the condition of the environment be monitored?

The workshop could build on preliminary work on an EU level, as well as to varying degrees by Member States, within the context of Achi Target 15 and its EU counterpart, Target 2 of the previous EU Biodiversity Strategy to 2020 ("*By 2020, […] restoring at least 15% of degraded ecosystems*").

The aim of both workshop parts was to share and examine prior experiences on restoration monitoring and to identify potential knowledge gaps within the context of legally binding EU nature restoration targets. To this end, the workshop included presentations of several national examples (presented below as case studies in separate boxes), discussed a range of specific restoration cases and employed various interactive tools to systematically gather input from all participants.

Starting point of discussions – data availability

A wide range of information about the condition of ecosystems and the environment in general, is already reported to the European Commission and subsequently analysed by the Commissions services. Recent examples of the respective reports are:

- The European environment – state and outlook 2020[1]
- State of nature in the EU – Results from reporting under the nature directives 2013-2018[2]
- Report on the implementation of the Marine Strategic Framework Directive[3]
- European Red List of Habitats – Part 2. Terrestrial and Freshwater Habitats (EU 2016)[4]
- European waters – Assessment of status and pressures 2018 (EEA 2018)[5]

[1] EEA (2020). The European environment – state and outlook 2020. https://www.eea.europa.eu/soer/2020

[2] EEA (2020). State of nature in the EU. https://www.eea.europa.eu/publications/state-of-nature-in-the-eu-2020

[3] EC (2018). Assessing Member State's programmes of measures under the Marine Strategy Framework Directive. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2018:562:FIN&qid=1533034580736

[4] EU (2016). European Red List of Habitats, Part 2, Terrestrial and Freshwater Habitats. https://op.europa.eu/en/publication-detail/-/publication/22542b64-c501-11e7-9b01-01aa75ed71a1/language-en,

[5] EEA (2018). European waters – Assessment of status and pressures 2018. https://www.eea.europa.eu/publications/state-of-water

- Mapping and assessment of primary and old-growth forests in Europe[6]
- MAES analytical framework[7]

Similarly, the Streamlined European Biodiversity Indicators (SEBI) initiative provides a list of indicators on various states and pressures and from various sources (e.g. on nitrogen, SEBI 009, 019). This includes "area-focused" data such as protected area coverage (SEBI 007, 008), land management information for forests and agricultural area (SEBI 020), or Corine ecosystem coverage (and changes thereof) (SEBI 004) as well as species-focused or based information (e.g. SEBI 001, 003, 005).

A holistic EU pollinator monitoring scheme as well as a sample-based approach to monitor agricultural landscapes (EMBAL) are currently being developed as well.

Workshop 1 – Identifying priorities for restoration targets

Background

Restoration targets should reflect restoration "*needs*", i.e. the necessity to improve the condition of degraded ecosystems in order to ensure the long-term survival of species and the provision of nature's contributions to people. At the same time, the necessary restoration action may face barriers, such as lack of funding, capacity or acceptance. These barriers stand in the way of realising the full restoration "*potential*". Addressing the different barriers can increase the probability of realising the potential for ecosystem restoration and meeting the respective needs. Various data is available for both needs and potential, including information from existing EU reporting processes and initiatives as well as from national monitoring schemes.

Approaches and methodologies presented by Member State experts

The first part of the workshop explored to what extent **data and information from existing monitoring processes or the analysis thereof** could be or is already being used to identify restoration needs and potential. It was found that assessments of ecological needs commonly focus on the current state of ecosystem condition, threats and conversion rates of ecosystems, as well as on the rarity of key species or ecosystem types. Assessments of rarity can also feed into an analysis of the representation of different ecosystems in the respective national protected area network. Likewise, the completeness of the protected area network can be assessed through a hotspot approach, identifying areas most relevant for the conservation of endangered and rare species. Potential natural vegetation maps or favourable reference values may also be considered. Moreover, several participants pointed out that future climate change scenarios should also be considered when restoration actions are being planned – as also highlighted in the EU Biodiversity Strategy for 2030. Likewise, data on potential natural vegetation can be used as a safeguard to prevent inadequate measures that could be detrimental to climate mitigation efforts (e.g. planting trees on peatland soils or natural carbon-rich grasslands). Here, the increase in soil organic carbon can also be used as a proxy indicator.

[6] Barredo Cano, J.I., Brailescu, C., Teller, A., Sabatini, F.M., Mauri, A. and Janouskova, K. (2021). Mapping and assessment of primary and old-growth forests in Europe, EUR 30661 EN, Publications Office of the European Union, Luxembourg, https://publications.jrc.ec.europa.eu/repository/handle/JRC124671,

[7] Maes J, Teller A, Erhard M, Grizzetti B, Barredo JI, Paracchini ML, Condé S, Somma F, Orgiazzi A, Jones A, Zulian A, Vallecilo S, Petersen JE, Marquardt D, Kovacevic V, Abdul Malak D, Marin AI, Czúcz B, Mauri A, Loffler P, Bastrup-Birk A, Biala K, Christiansen T, Werner B (2018). Mapping and Assessment of Ecosystems and their Services: An analytical framework for ecosystem condition. Publications office of the European Union, Luxembourg. https://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/5th%20MAES%20report.pdf

Barriers impeding restoration activities can be addressed during the planning stage by assessing the cost and effort necessary to restore an ecosystem as well as highlighting the socio-economic co-benefits and nature's contribution to people that the restored nature would provide (e.g. carbon sequestration, flood prevention, water regulation, recreation and mental health, and other ecosystem services). Especially with respect to restoration measures with climate co-benefits, links to the National Energy and Climate Plans (NECPs) under the EU Governance Regulation (EU/2018/1999) can also be made. One option to reduce barriers would be to focus restoration activities on unproductive areas or areas with limited economic use (e.g. obsolete river barriers, forests vulnerable to climate change, agricultural land with low productivity, etc.). The rejection of measures by stakeholders was mentioned by workshops participants as a common obstacle. Stakeholder positions are often linked to the potential costs that restoration measures pose for them by causing changes in economic activities. However, it was highlighted that stakeholder consultations in setting restoration priorities and their active participation in decision-making processes could also increase acceptance and, as a result, restoration potential.

Both **restoration needs and potential** can be assessed in a spatially non-explicit or explicit way. The latter usually provides additional information and was therefore strongly favoured by the participants. For instance, a restored area might be of greater ecological importance if it connects existing natural areas and completes an ecological corridor. The assessment of ecosystem services also benefits from spatially explicit approaches, e.g. to identify suitable areas for river restoration relevant to reducing flood risks in nearby cities.

In general, the first part of this workshop showcased that EU Member States can build on a multitude of **existing information and data** as well as **different methodological approaches** for assessing ecosystem conditions and restoration needs. Information on socio-economic benefits and barriers to restoration measures can be used as a basis for assessing restoration potential. Still, data availability and level of detail differ among Member States. Moreover, data accessibility could be improved through better sharing of existing data (e.g. data from different ministries and between policy areas, such as forestry or agriculture).

Weighing needs against potential

Building on the overview of available information, the discussion then focused on the **approaches and methodologies** used to combine and assess this data in order to identify priorities for the restoration of ecosystems and respective policies. Connectivity was mentioned as one crucial aspect for the prioritisation of restoration activities. Such a focus on green infrastructure and the creation of a larger network of natural areas would also contribute to other commitments of the EU Biodiversity Strategy.

Regarding the aspect of **rarity (of species or ecosystems)**, participants raised the question of to what extent the restoration of an ecosystem should be a priority when it is common on a national level, but rare on an EU level, or the other way around.

The **costs of restoration** activities were also discussed. Some habitats may require costly initial active restoration measures or continuous management, which results in ongoing costs for nature conservation authorities. At the same time, the socio-economic benefits such an ecosystem provides and/or acceptance levels by stakeholders can be comparatively low. However, participants highlighted that if these ecosystems are rare or a priority for other ecological reasons, they should not be excluded or neglected.

Last but not least, it was highlighted that the **setting of restoration priorities** should always be a data-driven process, and that policy-makers need to engage more with technical experts. This would ensure greater integrability of assessments more targeted to the policy-makers' information needs and therefore strengthen the scientific base of subsequent decision-making processes, which ultimately would be based on considerations of restoration needs and potential.

National case study 1 – National green infrastructure development in Hungary

The Hungarian approach to the assessment and development of green infrastructure used ecological state, connectivity as well as ecosystem services as a basis for the prioritisation of areas and measures for the restoration of ecosystems.

Ecological state was assessed using existing data such as forest quality and species composition, Corine land cover for grasslands (to identify two types, given the lack of a national database) and data collected under the Water Framework Directive. Expert judgement was needed to aggregate data in a composite map. A result is the Green Infrastructure map of ecosystem states, which allows the identification of areas to protect (5 %), and areas for potential improvement (88 %). Of these areas, only 13.4 % qualify for improvement of state, the rest is assigned to potential restoration of the ecosystem, which means a land use or ecosystem type change. By considering further limitations, like avoiding areas of high agricultural potential, etc., the delimitation of potential restoration target areas becomes more and more specified. In order to devise habitat type targets for the restoration of ecosystems, Multiple Potential Natural Vegetation (MPNV) models have been used.

To create additional benefits, restoration measures can be targeted towards arable land facing high water levels or lying in water protection areas. Likewise, arable land sensitive to erosion and deflation could benefit from restoration efforts. Additionally, least cost path modelling between good ecological state patches has then been used to identify priority areas for the restoration and creation of ecological corridors. The identified areas could be used, for instance, for the prioritisation of CAP subsidies.

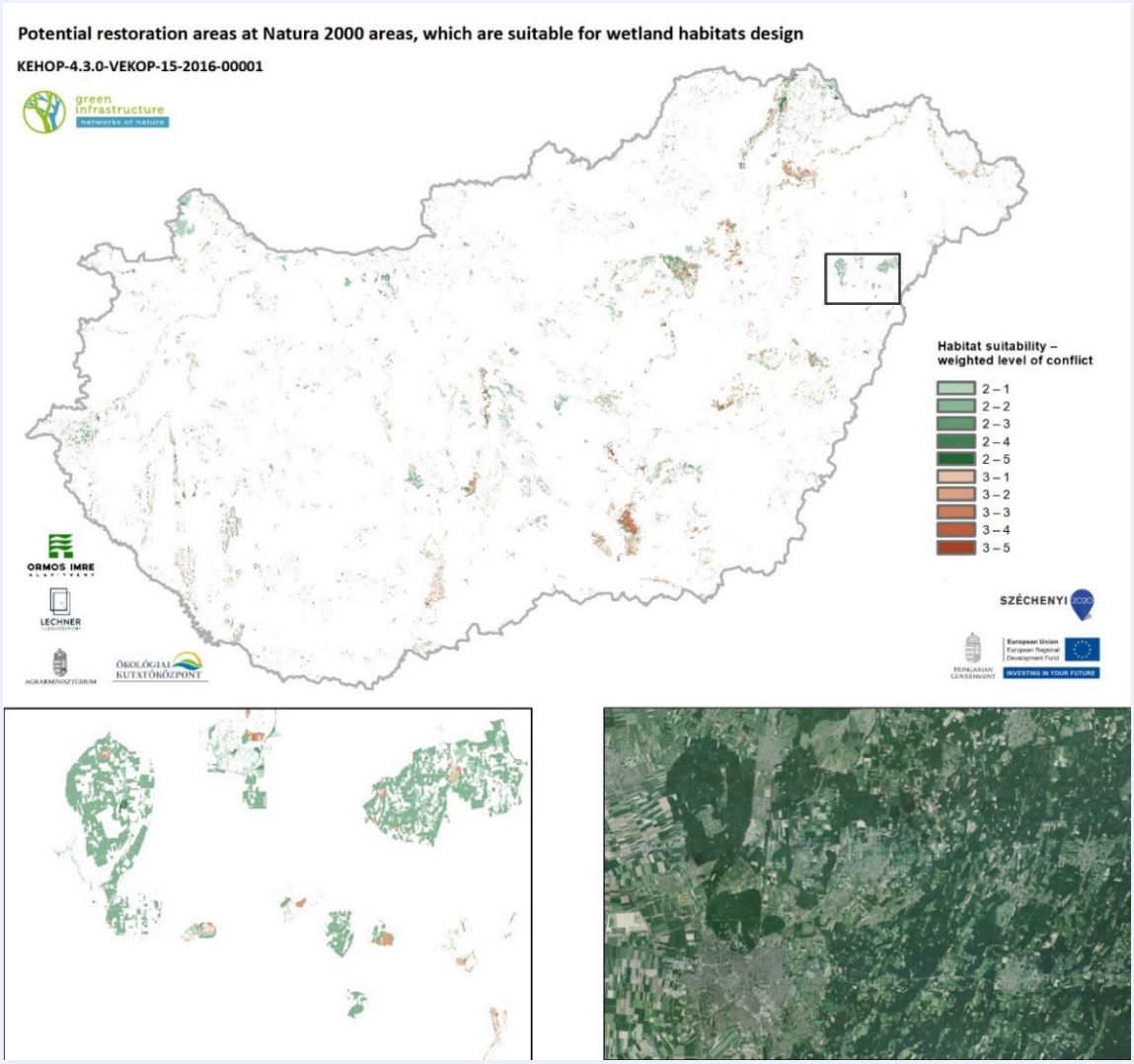

Figure 1: Map of the potential wetland restoration areas based on the green infrastructure state, environmental conflicts of present land use and the Multiple Potential Natural Vegetation model.

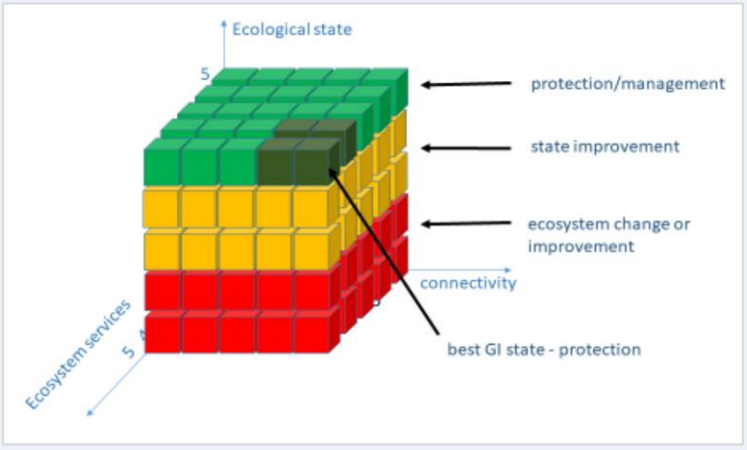

Figure 2: The conceptual diagram of the identification of green infrastructure state. The three dimensions of green infrastructure (ecological state, connectivity and ecosystem services) can have a state at a 5 level scale, and their combinations identify the need for intervention types. Note that ecological state has a primary value, therefore it defines the suggested management. The values are assigned to all pixels in the base map, this provides the basis for the national green infrastructure map.

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National case study 2 – Status of floodplains in Germany

In order to track changes in floodplain status, a nationwide assessment of all rivers with a catchment area of at least 1000 km² takes place every ten years in Germany. After the first report in 2010[8], the second report[9], using an improved methodology[10], was published in 2021.

The GIS-based assessment builds on data reported under the habitat and floods directive as well as national datasets (e.g. on river morphology). In a first step, the difference between active and former floodplains is calculated and mapped for 1km river segments. By adding data about land use, river structure, or share of protected habitats, the status (quality) of the active (remaining) floodplain can be assessed.

Comparing the two assessments from 2009 and 2021 revealed the local success of restoration measures and an increase of the active floodplain by 1.5%; however, the status of floodplains hardly changed and more effort is needed. Building on these results, the potential to improve floodplains has also been estimated.

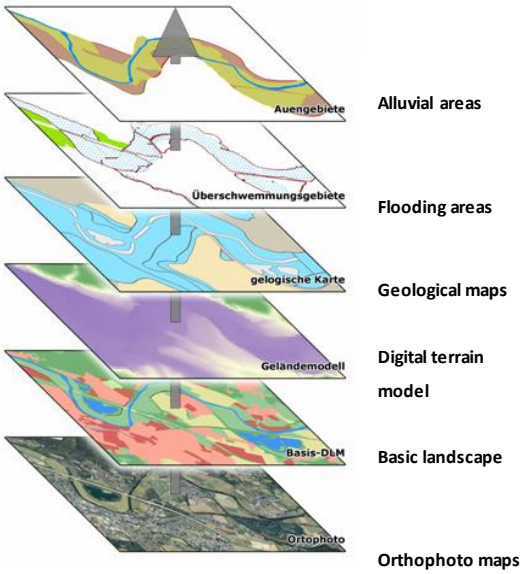

Figure 1: Layers of information used for the assessement of the status of floodplains (BfN 2021)

Considering restrictions such as shipping intensity as well as dams and other structures that cannot be removed, it was found that it may be possible to increase the area of the active floodplain by 40%. Moreover, 64% of the active floodplains have a high to moderate potential to be improved by changes in land use. In the "German Blue Belt" programme this data was used to set measurable strategic aims, such as an improvement of 20% of the floodplain areas by at least one status class until 2035. However, their achievement depends on several further local aspects such as good cooperation with the relevant local actors.

Contact: Ms Stephanie RITZ (stephanie.ritz@bfn.de) and Mr Thomas EHLERT (thomas.ehlert@bfn.de)

[8] English summary : Follner, K., Ehlert, T., Neukirchen, B., (2010). The Status Report on German Foodplains.

[9] BfN (2021). Status Report on Floodplains 2021. https://www.bfn.de/en/publications/leaflet/status-report-floodplains-2021-floodplains-germany-0

[10] Günther-Diringer, D., Berner, K., Koenzen, U., Kurth, A., Modrak, P., Ackermann, W., ... & Heyden, J. (2021). Methodische Grundlagen zum Auenzustandsbericht 2021: Erfassung, Bilanzierung und Bewertung von Flussauen. Bundesamt für Naturschutz. https://www.bfn.de/publikationen/bfn-schriften/bfn-schriften-591-methodische-grundlagen-zum-auenzustandsbericht-2021

National case study 3 – National scale prioritisation and spatial planning in Finland

The work to prioritise restoration efforts in Finland aimed to evaluate how resources can be assessed cost efficiently in order to reach the 15% restoration target (Aichi Target).

To this end, 100 participants in the ecosystem improvement expert working group (working in ecosystem sub-groups) systematically defined the current states for ecosystems, degraded ecosystem elements, measures to best reverse the degradation (cost efficient methods) for each ecosystem type. Subsequently, they calculated resource allocation scenarios within ecosystem groups and across all ecosystems. As a result, it was possible to estimate the habitat specific improvement per hectare and their costs, and to compare trade-offs within and between scenarios. [11]

As a next step, a spatial prioritisation (using the free conservation planning software "Zonation" [12]) was carried out identifying those areas in the PA network that, when restored or managed, will most cost-effectively increase the ecological value of the whole PA network (fill in the biodiversity gaps), considering data for multiple habitats (the condition and its improvement) and species and connectivity. [13] Two main objectives in that process were comparing trade-offs and avoiding opportunism.

The identified restoration measures were then implemented through different programmes, such as the Helmi habitats programme [14], the Forest Biodiversity Programme for Southern Finland (METSO) [15] as well as the SOTKA project [16], where local implementation challenges can also be investigated case by case.

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Figure 2: The four phases (coloured columns) and 10 steps in the prioritization of restoration. Steps 1–5 quantify the degree of degradation in the current ecosystem condition, 6-8 the reduction in ecosystem degradation due to restoration, 9 is prioritization of restoration measures and 10 prioritization among ecosystem types. [17]

[11] Kotiaho, J.S., Kuusela. S., Nieminen, E., Päivinen, J. & Moilanen, A.. (2016). Framework for assessing and reversing ecosystem degradation – Report of the Finnish restoration prioritization working group on the options and costs of meeting the Aichi biodiversity target of restoring at least 15 percent of degraded ecosystems in Finland. https://julkaisut.valtioneuvosto.fi/handle/10024/74862

[12] Finnish Environment Institute. (2018). https://www.syke.fi/en-US/Research__Development/Nature/Specialist_work/Zonation_in_Finland/Zonation_software

[13] Moilanen, A., Hokkanen, M., Kareksela, S., Mikkonen, N. (2019). Ecological decision analysis in support of societal decision making : Final report of the MetZo-II project. http://urn.fi/URN:ISBN:978-952-361-022-4

[14] Finnish Ministry of the Environment. https://ym.fi/en/helmi-habitats-programme

[15] Ministry of Agriculture and Forestry of Finland, https://mmm.fi/en/forests/biodiversity-and-protection/metso-programme

[16] Ministry of Agriculture and Forestry of Finland, https://mmm.fi/en/sotka-project

[17] Hagen, Dagmar & Kotiaho, Janne & Kareksela, Santtu & Lindhagen, Anna & Isaksson, Daniel & Päivinen, Jussi & Svavarsdóttir, Kristín & Tennokene, Margit & Hansen, Kjell. (2016). Restoration priorities and strategies. http://norden.diva-portal.org/smash/record.jsf?pid=diva2%3A1033385&dswid=-5073

Workshop 2 – Monitoring restoration progress and success

Background

The improvements of ecosystem condition caused by restoration activities follow different trajectories, depending on the ecosystem type, its initial degree of degradation and the restoration measures used. The second workshop used concrete cases to elaborate how such restoration trajectories (e.g. different timescales and baselines) influence the monitoring process. Regarding timescales, the effectiveness and feasibility of using selected indicator categories to monitor the restoration of grassland vs. forest ecosystems was explored. The influence of various site-specific starting conditions (e.g. improvement of existing habitat types vs. full recreation) was discussed using wetlands as an example. In each case, a key question was whether the proposed indicator types and monitoring approaches would be suitable for the aggregation of data to the national and EU level.

Considering the full range of the restoration continuum

Participants stressed the importance of considering the **full range of restoration activities**: habitats can be recreated, the condition of existing habitats can be improved or their effective protection status can be increased. For instance, rewetting a drained and degraded peatland can have different objectives, either targeting a "partial" restoration that still allows extensive land use (e.g. paludiculture), or the "full" recreation of a natural mire ecosystem. This also needs to be reflected in the monitoring system applied, which must be able to consider the different nuances of the recovery process.

However, it was also highlighted that restoration becomes more difficult towards the end of the scale, i.e. with increasing naturalness of the target ecosystem. For instance, bringing back the most rare and sensitive species or the full range and degree of ecosystem functions can be increasingly complicated. Nevertheless, this should also be an objective of parts of the restoration activities and be monitored accordingly.

Further discussion topics included the **applicability of different types of indicators and data sources on different spatial scales**, different time scales and for specific ecosystem types. For example, remote sensing applications might be very suitable for monitoring large-scale land use changes, but completely useless when it comes to monitoring the ecological condition of cave ecosystems. Using the example of forest restoration, it was pointed out that the recovery of nature can take time and different kinds of indicators may become relevant during different temporal stages of the recovery process. In general, it would be beneficial to have different types of indicators that complement each other. For example, in the case of peatland restoration, the water level (a proxy indicator for wetland health) will rise immediately or rather fast after rewetting measures have been carried out, while it might take a long time for the natural vegetation to return if, for example, nutrient levels remain too high, indicating the necessity for additional interventions. Finally, it was highlighted that the monitoring system should be applicable to all restoration measures, regardless of whether they take place within or without protected areas.

From site-level to EU-level

Throughout the workshop, participants stressed that restoration monitoring needs to be **tailored to the respective level and approach** for which it is intended. At the level of individual restoration sites, the presence/absence or abundance of individual species was frequently mentioned as a suitable indicator of restoration success. These species could be selected based on their importance as keystone species or their indicator value for the ecological condition of their respective habitat. Additionally, the recovery wheel[18], as developed by the Society for Ecological Restoration (SER), was suggested as a useful tool using a broader range of indicators. It was pointed out that site-level monitoring should enable adaptive management or the necessary adjustments of restoration measures. In general, various site-level monitoring methods are already well established in EU Member States. However, the workshop participants also noted that existing indicators are applied differently in different countries, which reduces comparability.

If, instead of the site-level, a **nation-wide monitoring system** intended to provide an overall picture of improvements in ecosystem conditions is considered, data will need to be aggregated. Many indicators suitable for site-level monitoring cannot realistically be used at a nation-wide scale without incurring excessive costs and effort. For example, instead of using individual species, an inventory of desirable species could be put in place as a composite indicator, or readily available proxy indicators could be used, such as the amount of dead wood in a forest or the water level in a peatland. In any case, different indicators should complement each other, even on a more aggregated or proxy level. Another approach would be to conduct an ecosystem monitoring on a landscape scale, using randomised sample sites (see case study 4 below). If the relative amount of sample sites is high enough, this would also be able to detect the improvements brought by restoration activities and national programs.

In the context of the new EU Nature Restoration Law, it will be important to monitor both the improvements in condition of ecosystems (restoration success) as well as the efforts taken by Member States (restoration progress). EU guidance could help to identify selectable indicators for restoration success that can be **aggregated towards the EU level** and allow comparisons across countries and regions. Moreover, it was suggested that a classification of common restoration measures for different ecosystems in different initial conditions should be prepared by the EU Commission to guide Member State actions and ensure sufficient ambition levels. Such a classification would ease the monitoring of progress towards the new legally-binding targets. Finally, there is still a lot of potential for further exchange of knowledge and experience among Member States to accelerate the implementation and monitoring of the upcoming EU ecosystem restoration targets.

[18] Society of Ecological Restoration (2016). International Standards for the Practice of Ecological Restoration. https://cdn.ymaws.com/sites/www.ser.org/resource/resmgr/docs/SER_International_Standards.pdf

National case study 4 – Ecosystem monitoring in Germany

To fill a gap in nationwide information on status and development of biodiversity in the overall landscape, the German Agency for Nature Conservation (BfN) started to develop a sample-based, repeated and systematic monitoring system on a landscape level in 2015. The scheme can rely on 1000 representatively distributed sample plots of one square kilometre each, which had already been established for the common breeding bird monitoring[19] (since 2004) and the high nature value (HNV) farmland monitoring[20] (since 2009). An insect monitoring scheme is currently being tested, using the same sample plots.

The ecosystem monitoring consists of biotope mapping based on the German red list of biotope types as well as the habitat types of the EU Habitat Directive. Qualitative, biotope-specific characteristics such as eutrophication (indicator plants), dryness (indicator plants), structural diversity, degree of sealing, plot size, proportion of linear elements, invasive alien species, proportion of dead wood, shrub encroachment as well as species inventories along transects are also recorded.

Through repeated assessments and analysis, the ecosystem monitoring shows quantitative and qualitative changes of biotopes and landscape over time.

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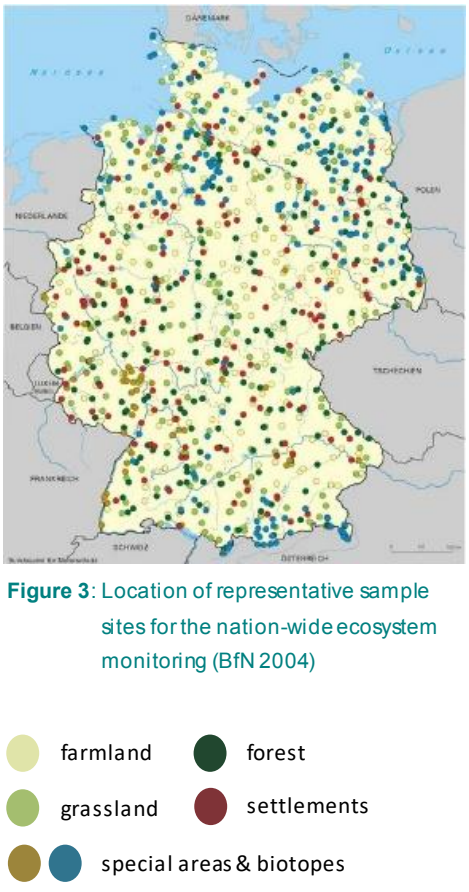

Figure 3: Location of representative sample sites for the nation-wide ecosystem monitoring (BfN 2004)

[19] BfN, Breeding bird monitoring. https://www.bfn.de/vogelmonitoring
[20] BfN, High Nature Value Farmland monitoring. https://www.bfn.de/monitoring-von-landwirtschaftsflaechen-mit-hohem-naturwert

Conclusions

The first workshop showcased that numerous EU member states can build on a multitude of information and data as well as different methodological approaches for assessing ecosystem conditions and subsequently for prioritizing restoration needs. Often, information on socio-economic benefits and barriers of restoration measures also exists, as a basis for assessing restoration potentials. Still, data availability and level of detail differ among member states. The workshop discussions revealed that in general, spatially explicit assessments are favored. These would allow, for example, to identify and prioritize areas where green infrastructure development can increase ecological connectivity and support the creation of a larger network of high nature value areas. Another finding referred to using the rarity of key species or ecosystem types as a potential prioritization factor. In this regard, prioritization should consider that representation will vary between scales (e.g. national and EU-level). It was highlighted that the setting of restoration priorities should always be a data-driven process, and that policy-makers need to engage with technical experts to ensure greater integrability of assessment results and to strengthen the scientific base of subsequent decision-making processes.

In the context of new EU nature restoration targets, it will be important to monitor both the progress of restoration measures undertaken by member states as well as the resulting improvements in ecosystem condition. The second workshop underlined the complexity of this field. Discussion topics included the applicability of different types of indicators and data sources on different spatial scales (from site-specific to EU-level), the particularities of specific ecosystems, as well as the different time scales of recovery processes. Participants stressed the importance of considering the full continuum of restoration activities (from improving conditions to recreating ecosystems). Monitoring of restoration activities on a site-level is already well established, however EU guidance could help to identify selectable indicators that can be aggregated towards the EU level and allow comparisons across countries and regions as well. At the same time, further EU guidance on suitable restoration approaches for different ecosystems in different initial conditions would foster a common understanding and ease the monitoring of progress towards the targets. To conclude, there remains a large potential for further exchange of knowledge and experience among member states to accelerate the implementation and monitoring of ecosystem restoration.

Annex 1: Detailed Agenda Workshop 1 (28 April 2021)

8:30-09:00	**Check-in**
09:00	**Introduction and welcome**
09:00	**Welcome and introductory remarks** • **Bettina Hedden-Dunkhorst,** Head of Unit, Federal Agency for Nature Conservation (BfN), Unit for International Nature Conservation • **Anne Teller**, Policy Officer European Commission, Directorate General for the Environment Biodiversity Unit
09:10	**Background and objectives of the workshops,** Stephan Piskol (organisation team)
09:15	**Brief introduction of participants (tour de table)**
09:35	**Part I – Restoration needs and potential**
	Thematic input • **"National green infrastructure development – model for measuring restoration success"** **Katalin Török, PhD**, team leader, senior research fellow Hungarian Centre for Ecological Restoration (CER), Institute of Ecology and Botany (IEB); Hungary Restoration Ecology Research Group • **"Status of floodplains in Germany"** **Dr. Stephanie Ritz**, Officer, Federal Agency for Nature Conservation (BfN), Unit for Water ecosystems, water balance, Blue Belt
10:00	**Collective brainstorming** - Which national data sets are used to assess ecosystem condition and restoration needs in your Member States? - Which additional factors determine restoration potential?
10:20	**Plenary discussion** - Which approaches and methodologies are used to assess restoration needs and potential in your Member States? - In your experience, which are the main advantages and greatest challenges in the application of these methods?
10:45	**15 min break**
11:00	**Part II – Prioritising restoration – from data to action**
11:00	**Brief recap and introduction to part II,** Stephan Piskol
11:05	**Thematic Input** • **"National scale prioritisation and spatial planning – Finnish case for cost-effective ecosystem restoration and management"** **Santtu Kareksela, PhD,** Prioritization Specialist, Parks & Wildlife Finland, Metsähallitus
11:15	**Discussion** • What are the main approaches to prioritisation developed and/or used by Member States? • How have socio-economic aspects been integrated? • What are the advantages (and disadvantages) of different approaches? • What are the enabling factors that ensure that data driven processes and assessments feed well into political decision-making processes? (integrability)
11:50	**Workshop synthesis and outlook to second Workshop**
12:00	**End of Workshop 1**

Annex 2: Detailed Agenda Workshop 2 (5 May 2021)

8:30-09:00	**Check-In**
09:00	**Introduction and welcome**
9:00	**Recap of Workshop 1,** Simone Wulf, BfN
9:05	**Background and objectives of Workshop 2** Stephan Piskol (organisation team)
9:10	**Thematic input - Types of indicators** Stephan Piskol (organisation team)
09:20	**How to monitor ecosystem restoration?**
9:20	**Thematic input - "Ecosystem monitoring"** **Dr. Stefanie Stenzel**, Officer, Unit for Biotope protection and management, protected areas; German Federal Agency for Nature Conservation (BfN)
9:35	**Discussion I – Time scales of restoration (cases: comparing forests and grasslands)** The improvements brought by restoration measures follow different trajectories depending on the ecosystem and restoration measures used. This session aims to elaborate how these differences affect the selection of indicators and respective monitoring processes, based on two distinct examples (restoration of forests and of grasslands). Questions for the discussion: • How do the different recovery processes affect the selection of suitable indicators? • How is the monitoring process affected? • Are interim target values required?
10:30	**15 min break**
10:45	**Introduction to Part II,** Axel Paulsch, ibn
10:55	**Discussion II – Ecosystem recreation vs. improvement (cases: wetland example)** The current level of degradation of an ecosystem does not just influence the necessary restoration measures, but also the methodology with which improvements can be detected. In this session, the range restoration activities are discussed at the example of wetlands, e.g. the full recreation of a wetland at an agricultural site vs. the improvement of ecosystem condition in an existing wetland. Questions for the discussion: • How predefined does the final state have to be when we aim for the recreation of ecos ystems? • Is the article 17 monitoring suitable for the initial stages during ecosystem re-creation as well? • Do we need combinations of methods, e.g. proxies (water level) and indicator species in the beginning and Art. 17. Monitoring later on?
11:50	**Workshop synthesis and closing remarks**
12:00	**End of Workshop II**