

Comparative Analysis of National Biodiversity Monitoring Systems in Ukraine and Czechia using a Developed Evaluation Framework

Alona VARUKHA^{1,2,3} , Jonáš GAIGR⁴ , Yuliia SPINOVA^{1,5} 

¹ NGO Ukrainian Nature Conservation Group, Kyiv, Ukraine;

² Chornobyl Radiation and Ecological Biosphere Reserve, Kyiv, Ukraine;

³ Institute of Geography of the NAS of Ukraine, Kyiv, Ukraine;

⁴ Nature Conservation Agency of the Czech Republic, Praha, Czechia;

⁵ Kyiv Zoological Park of National Importance, Kyiv, Ukraine.

Corresponding author: avarukha@gmail.com

Реферат

Варуха А., Гайгр Й., Спінова Ю. (2026) Порівняльний аналіз національних систем моніторингу біорізноманіття в Україні та Чехії з використанням розробленої структури оцінювання

Ефективне збереження та стале використання біорізноманіття залежать від наявності потужної, адаптивної та скоординованої національної системи моніторингу біорізноманіття (НСМБ). У цій статті представлено розроблену комплексну структуру оцінювання НСМБ, що узагальнює міжнародні рекомендації, найкращі наукові практики та останні зміни в політиці. Ця структура охоплює такі ключові аспекти: правові та інституційні (управлінські); методології збору та управління даними; а також спроможність (фінансування, людські ресурси, інфраструктура та партнерство). Застосовуючи детальні критерії, розроблені в рамках цієї структури, ми проводимо порівняльну оцінку України та Чехії — двох країн, що перебувають на різних етапах розвитку НСМБ та інтеграції з законодавством Європейського Союзу та глобальними стратегіями у сфері біорізноманіття. Аналіз ґрунтується на національних концепціях, законах, урядових звітах та міжнародних рекомендаціях. Оцінка існуючих систем моніторингу біорізноманіття виявила значну різницю в результатах: Україна отримала загальний бал 6 з 50 (12%), тоді як Чехія продемонструвала високий рівень відповідності, набравши 45 балів з 50 (90%). Отримані результати підкреслюють важливість адаптивного управління, узгоджених протоколів, сталого фінансування та залучення зацікавлених сторін для ефективного моніторингу біорізноманіття. Надано рекомендації щодо вдосконалення розробки ефективних систем моніторингу біорізноманіття в Україні, що має ширше значення для країн, які прагнуть привести своє законодавство у відповідність до директив ЄС та Стратегії біорізноманіття до 2030 року.

Ключові слова: система моніторингу біорізноманіття, структура оцінювання, Україна, Чехія.

Abstract

The dataset contains records of vascular plant species occurrences and distribution in 20 vegetation plThe effective conservation and sustainable use of biodiversity depend on a strong, adaptive, and coordinated national biodiversity monitoring system (NBMS). This manuscript presents a developed comprehensive framework for evaluating NBMSs, synthesizing international guidelines, scientific best practices, and

Citation:

Varukha, A., Gaigr, J., & Spinova, Y. (2026) Comparative Analysis of National Biodiversity Monitoring Systems in Ukraine and Czechia using a Developed Evaluation Framework. *Ukrainian Nature Conservation Journal*, 1 (1): 33–56. <https://doi.org/10.67531/uncg-j.2026.1.1.33-56>

recent policy developments. The framework encompasses critical dimensions: legal and institutional (governance) frameworks; data collection methodologies and management; and capacity (funding, human resources, infrastructure, and partnership). Applying the detailed criteria developed under this framework, we conduct a comparative evaluation of Ukraine and Czechia, two countries at different stages of NBMSs maturity and integration with European Union laws and global biodiversity strategies. The analysis draws on national visions, laws, government reports, and international recommendations. Assessment of current biodiversity monitoring systems revealed a significant disparity in performance: Ukraine achieved a total score of 6 out of 50 (12%), whereas Czechia demonstrated high compliance with a score of 45 out of 50 (90%). The findings underscore the importance of adaptive governance, harmonized protocols, sustainable funding, and stakeholder inclusivity for effective biodiversity monitoring. Recommendations are provided to enhance the development of effective NBMS in Ukraine, with broader implications for countries seeking to align with the EU Directives and Biodiversity Strategy for 2030.

Keywords: *biodiversity monitoring system, evaluation framework, Ukraine, Czechia.*

Introduction

Biodiversity loss remains one of the most pressing global environmental challenges, threatening ecosystem services, human well-being, and the resilience of natural and managed systems.

Both Ukraine and Czechia face threats to biodiversity, including habitat destruction, pollution, and the overexploitation of natural resources. In Ukraine, these threats are significantly more pronounced due to the war's impacts.

To reverse Europe's biodiversity decline, EU Member States have committed to the 2030 Biodiversity Strategy alongside the international conservation goals of the Kunming-Montreal Global Framework. Crucially, these parties have emphasized the importance of establishing robust, cooperative national, regional, and global biodiversity monitoring systems to ensure the biodiversity targets are actually met and measured.

Biodiversity data acquired through monitoring are vital for spatial biodiversity assessment and prioritization to inform national policy, planning, decisions, and action (SANBI & UNEP-WCMC, 2024).

According to Juergens (Juergens, 2009), biodiversity monitoring is the systematic observation and recording of biological objects to determine potential changes in biodiversity (genes, taxa, biotopes, etc.). Nowadays, biodiversity monitoring is not just about collecting

data — it's about building the coordinated system needed to turn observations into actionable knowledge. Kissling (Kissling et al., 2026) argues that only by integrating technological innovation and human expertise through harmonised monitoring designs and interoperable data infrastructure it is possible to deliver robust and policy-relevant biodiversity data, information, and knowledge across terrestrial, freshwater, and marine systems.

Currently, 274 biodiversity monitoring programmes are being implemented across European countries and agencies (Moersberger et al., 2024). However, many of these biodiversity monitoring programs are fragmented, with significant gaps in spatial, temporal, and taxonomic coverage. Many have been established to achieve diverse objectives, applying varied methodologies across countries, as well as different sampling mechanisms and monitoring frequencies. In many countries, biodiversity monitoring programs are absent (Morán-Ordóñez et al., 2023).

A key initiative worth highlighting is the European Biodiversity Partnership, Biodiversa+, developed by BiodivERsA in collaboration with the European Commission as part of the EU Biodiversity Strategy for 2030. It unites more than 80 research programmes, sponsors, and stakeholders from 41 European and associated countries (Biodiversa +, 2026).

Biodiversa+ report on mapping of national and sub-national organisations funding and

steering biodiversity monitoring schemes, covering 23 countries, shows that in most countries Ministries of Environment and/or Environmental Protection Agencies are the actors in charge of steering and governing biodiversity monitoring schemes (Biodiversa, 2023).

The approach to implementing monitoring measures of the country varies depending on its unique ecological characteristics, political priorities, available resources, and specific conservation issues. However, the following best practices for biodiversity monitoring in Europe can generally be identified: long-term monitoring programs; standardization of data collection; indicator species monitoring; use of geospatial information (GIS), DNA barcoding and molecular methods; citizen science initiatives; data sharing and integration; adaptive management systems.

These practices help to improve the understanding of biodiversity status in Europe, support conservation strategies based on factual data, and provide valuable information for policymaking processes aimed at ecosystem protection.

Despite the recognized importance of biodiversity monitoring, countries face significant challenges in establishing and sustaining effective National Biodiversity Monitoring Systems (NBMS). These include fragmented legal and institutional arrangements, inconsistent data collection methodologies, limited data accessibility, insufficient stakeholder engagement, and chronic underfunding. The diversity of national contexts, ecological conditions, and policy priorities further complicates harmonization and interoperability, both within and across countries.

The NBMS serves as the backbone for evidence-based conservation, enabling countries to track trends, evaluate policy effectiveness, and fulfill international commitments such as the Convention on Biological Diversity (CBD), the EU Biodiversity Strategy for 2030, Birds

and Habitats Directives. The Kunming-Montreal Global Biodiversity Framework (GBF), adopted in 2022, further underscores the need for robust, harmonized, and adaptive monitoring systems to inform progress towards ambitious biodiversity targets at the national and global level.

Recent years have witnessed a surge in international guidance, technical standards, and collaborative initiatives aimed at strengthening NBMS. The United Nations Economic Commission for Europe (UNECE) and Biodiversa+ have published comprehensive guidelines for developing and evaluating NBMSs, emphasizing the integration of legal, institutional, methodological, and technological dimensions (UNECE, 2022; UNECE, 2023; del Pozo et al., 2023; UNEP-WCMC, 2024). To support EU and global biodiversity goals, there was a call to establish a coordinated, interoperable, and policy-relevant European Biodiversity Observation Network — built around Essential Biodiversity Variables (EBVs) (Vihervaara et al., 2017). The designed Roadmap proposes the creation of a European coordination centre (Kissling et al., 2026).

Additionally, scientists emphasise (Gonzalez et al, 2026) the need for the Biodiversity Monitoring Standards Framework that offers a structured pathway to address the longstanding challenges of fragmentation and inconsistency in biodiversity monitoring. Such a framework will promote consistent data capture, quality assurance, and validated analytical pathways, thus enabling credible comparison of findings and providing high-confidence biodiversity insights for adaptive conservation management.

Moreover, biodiversity measurement is rapidly changing due to advances in citizen science, image recognition, acoustic monitoring, environmental DNA, genomics, remote sensing, and AI, and thus facing novel complex challenges (Sutherland et al., 2026), and NBMS could serve here as a solid structure

for cooperation of transdisciplinary professionals, stakeholders, etc. that need to address them.

As a result, there is a need to update and partially develop national and transnational biodiversity monitoring initiatives in countries and regions where they are missing. The first step on this way is an evaluation of the current state of affairs with the NBMS.

This manuscript aims to advance the science and practice of NBMS evaluation by:

1. Proposing a structured, multidimensional framework for the evaluation of NBMS based on international guidelines, scientific literature, and best practices.
2. Applying this framework to a comparative evaluation of Ukraine's and Czechia's NBMSs, two countries with distinct practices of biodiversity monitoring and statuses of integration into the EU.
3. Identifying the strengths of and weaknesses of Czechia's NBMS and Ukraine's NBMS, and outlining areas for improvement, with actionable recommendations for policymakers.

By synthesizing lessons from Ukraine and Czechia, this study contributes to the broader discourse on building resilient, adaptive, and harmonized biodiversity

monitoring systems, especially for countries joining the EU, amid accelerating environmental change and evolving policy landscapes.

Materials and methods.

Evaluation of the National Biodiversity Monitoring System requires a comprehensive, holistic approach. Thus, a synthesis of international guidelines, scientific literature, recent policy developments, and Ukrainian and Czech experts guided our development of the NBMS evaluation framework. Key sources included the UNECE Guidelines for Developing National Biodiversity Monitoring Systems, the Biodiversa+ reports on harmonising biodiversity monitoring protocols, peer-reviewed studies on biodiversity monitoring in Europe, etc. (Kostiushyn et al., 2009; Wright et al., 2020; Jungmeier and Yenilmez, 2022; Burns et al., 2018; Genovart et al., 2025; Santana et al., 2025; Gonzalez et al., 2026; FAO, 2017).

The developed framework (Fig. 1) encompasses the four different dimensions, operationalized through specific 10 criteria. We described each criterion used within the framework (Annex 1).

The comparative evaluation, based on criteria developed, drew on a wide range of sources, including: legal documents

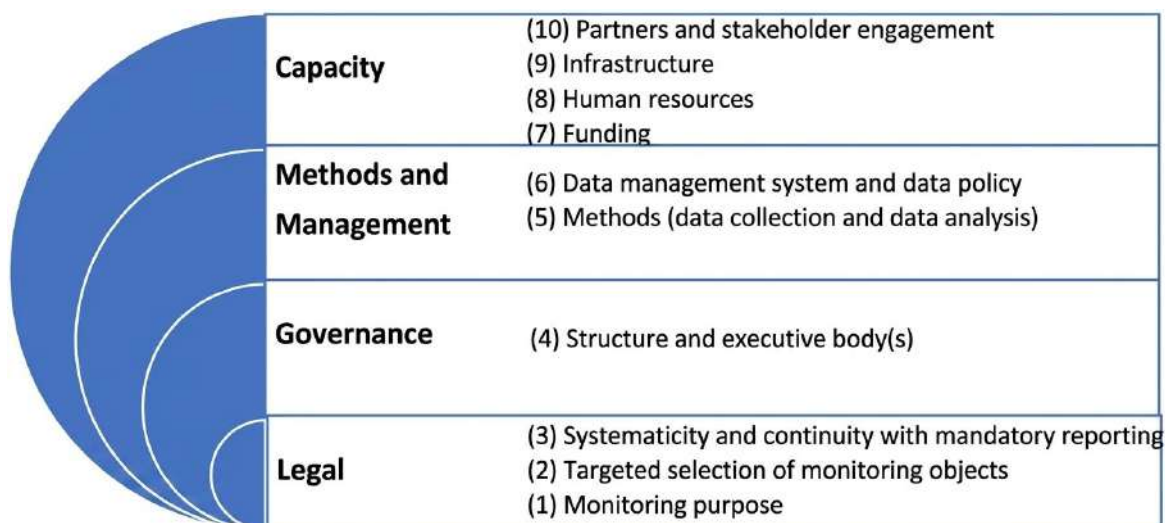


Figure 1. Evaluation Framework for NBMS.

(Directives, laws, resolutions, etc.); national biodiversity strategies and action plans (NBSAPs); reports from national authorities (e.g., Nature Conservation Agency of Czechia, relevant Ministry in Ukraine); peer-reviewed literature and technical guidelines; recent news releases and project reports; and broad deep expertise of authors involved and experts.

For each criterion, Ukraine's and Czechia's NBMSs were described based on the most recent available evidence (as of the end of 2025). The evaluation considered both formal structures (laws, institutions, protocols) and practical implementation (data accessibility, stakeholder engagement, funding stability). Further, each NBMS of the respective countries was assigned a score (from 0 to 5) for each criterion, taking into account the completeness of compliance with the criterion essence.

Results.

Based on the evaluation of existing biodiversity monitoring systems, Ukraine received a total score of 6 out of a possible

50 points or 12%, while Czechia scored 45 points or 90%. A comparative table summarizes Ukraine's and Czechia's performance across all framework criteria, providing a visual synthesis of their strengths and weaknesses (Table 1).

The diagram (Fig.2) provides a holistic visual picture of the impediments to national biodiversity monitoring systems.

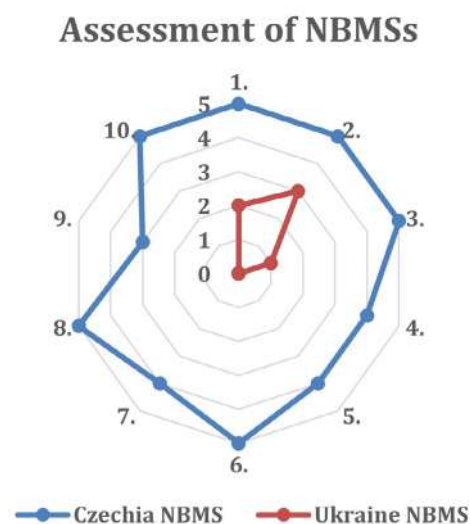


Figure 2. The diagram presents the result score of the assessment of National Biodiversity Monitoring Systems in Czechia (blue) and Ukraine (red) according to 10 criteria.

Table 1. Results NBMSs assessments of Czechia and Ukraine.

№	Criteria	Czechia NBMS	Ukraine NBMS
		points (0-5)	
1.	Certainty with the main purpose of monitoring	5	2
2.	Targeted selection of monitoring objects	5	3
3.	Systematicity and continuity with mandatory reporting	5	1
4.	Structure and executive body(s)	4	0
5.	Methods (data collection and data analysis)	4	0
6.	Data management system and data analysis	5	0
7.	Funding	4	0
8.	Human resources	5	0
9.	Infrastructure	3	0
10.	Partners and stakeholder engagement	5	0
Sum of points (max. 50):		45	6
Percentage (max. 100 %):		90	12

The analysis revealed that the national biodiversity monitoring system in Czechia is generally well-developed, while Ukraine's remains in its infancy. While Czechia's NBMS received «3 points» only for one criterion (infrastructure), it was the lowest assessment Ukraine's NBMS received: «3 points» only for one criterion (targeted selection of monitoring objects) as the highest grade.

Czechia has already made significant progress in establishing a well-coordinated national biodiversity monitoring system. By contrast, Ukraine still needs to take key steps in designing a comprehensive national biodiversity monitoring system across its entire territory. This requires strengthening the institutional NBMS's capacity, developing effective methodological and management approaches, building close cooperation between governmental bodies, research institutions, NGOs, and international partners, with a view to improving overall approaches to biodiversity monitoring and creating a system capable of effectively managing biodiversity data.

Discussion

Further, we elaborate on the details of the evaluation of NBMS in Czechia and Ukraine, describing their current state dimension by dimension using the developed criteria.

1. Evaluation of a Legal Dimension of NBMS of Czechia and Ukraine was conducted using the following three criteria: (1) certainty with the main purpose of monitoring; (2) targeted selection of monitoring objects; (3) systematicity and continuity with mandatory reporting.

1.1. Legal Dimension of NBMS of Czechia: evaluation

(1) Certainty with the main purpose of monitoring.

In Czechia, the principal legal framework implementing the Habitats Directive (92/43/EEC) and the Birds Directive (2009/147/EC)

is [Act No. 114/1992 Coll., on Nature and Landscape Protection](#) (Zákon č. 114/1992 Sb., 1992). There are multiple provisions establishing the legal grounds for the national biodiversity monitoring schemes.

1. Purpose of the Act (§ 1–2). Sections 1 and 2 explicitly state that the Act aims to maintain and restore natural balance, to protect species and habitats, and to establish and manage the Natura 2000 network in line with EU law.
2. Transposition of the EU Directives (§ 45a–i). As a result of a series of amendments, the Act introduces §§ 45a–i, which transpose key obligations from both directives. In particular, § 45f requires systematic, long-term monitoring of the conservation status of EU-listed species and habitats using a unified national methodology. Section 45f thus constitutes the key legal provision defining the frequency and scope of monitoring.
3. Mandate of the Nature Conservation Agency of the Czech Republic (NCA ČR). Under § 45f, the NCA ČR is charged with collecting data, evaluating trends, and preparing regular reports for the European Commission. This institutional assignment ensures both clarity of responsibility and continuity of effort.
4. Data Management and International Cooperation (§ 72d, § 78 (8)). Section 72d establishes the role of the Nature Conservation Information System and obliges the competent nature conservation authorities to maintain detailed records of all monitoring activities, while § 78 (8) secures the exchange of data and collaboration with all relevant stakeholders listed within the provision.
5. Reporting Obligations. The Act concretely defines the schedule and content of reports on the status of

Natura 2000 sites and on species and habitats of Community interest, fully mirroring the requirements laid down in Articles 17 and 19 of the Habitats Directive and Article 12 of the Birds Directive.

Owing to these provisions, the legal system of Czechia clearly defines the objectives of monitoring, embeds them in national legislation, allocates institutional responsibilities, and ensures alignment with EU reporting cycles.

Considering mentioned above, the score for this criterion is 5.

(2) Targeted selection of monitoring objects.

The Act No. 114/1992 Coll., on Nature and Landscape Protection, defines the selection of monitoring objects in § 45f. The provision contains links to other paragraphs (eg. § 5a Protection of wild birds), ensuring alignment with the relevant Annexes of the Birds Directive and Habitats Directive.

Monitoring of the Annex I habitats is slightly more complex. In the year 2000, the Habitat Mapping of the Czech Republic project was launched. Its main purpose was to create an expert basis for the designation of Sites of Community Importance within the Natura 2000 network for individual types of natural habitats. Mapping and the subsequent resolution of specific issues continued until 2005. The outcome was the fundamental layer of habitat mapping of the Czech Republic, providing the initial nationwide information on the occurrence and condition of natural habitats within the territory of the country. The principal goal of the mapping process was the data preparation for the designation of Natura 2000 sites, largely independent of the existing protected areas. In 2006, the original mapping was followed by the project of updating the habitat mapping layer. Its goal is to maintain the layer in an up-to-date form in twelve-year cycles. Field data collection is carried out according

to the mapping methodology – using the current working version for the season – and the spatial unit of updating is a clearly defined update district.

Nature conservation authorities are responsible for reporting to the Ministry of Environment.

Considering mentioned above, the score for this criterion is 5.

(3) Systematicity and continuity with mandatory reporting.

The systematic nature, continuity, and frequency of biodiversity monitoring are determined by reporting obligations. The NCA ČR plays a coordinating role at the national level as a government body under the authority of the Ministry of Environment, which is responsible for reporting to the EU bodies. The mapping and monitoring frequencies are hence given by the obligations. The execution of monitoring actions is coordinated primarily by the Department of Biodiversity Monitoring at the NCA headquarters.

Each January and February, biodiversity monitoring experts at the NCA headquarters draft a year plan to contribute towards the fulfilment of 1) reporting obligations under the Habitats Directive and Birds Directive; 2) conservation status of species and habitats within the Natura 2000 Network and small-scale protected areas; 3) various local and regional needs. The plan is then shared with the NCA employees at the regional branches, and after revisions, it is confirmed and fulfilled.

The individual employees are mainly zoologists and botanists working at either the NCA (headquarters and regional branches, including staff of protected landscape areas) or the national parks administrations (PA staff). Naturally, when there is a forester, a landscape architect, or even an accountant with relevant expertise, they can join the monitoring efforts if tasked by their supervisor. However, most biodiversity monitoring is conducted by botanists and zoologists. Biodiversity

monitoring is a significant part of their work, but the majority of experts are also involved in writing management plans, administering and managing PAs, and organising public events.

The main actors of the monitoring and reporting systems are hence 1) the NCA headquarters maintaining the databases, data collection forms, coordinating the monitoring, evaluating the data, and reporting the results; and 2) the biodiversity monitoring experts (mainly zoologists and botanists) at the regional branches of the NCA (incl. Protected Landscape Area administrations) and National Parks administrations, who collect and upload the data to the central databases.

The implementation of the annual plan is monitored and evaluated yearly. The results are subsequently reviewed at the annual meetings of the NCA board, and if identified, the inadequate performance of the regional branches failing to achieve the expected outcomes is reported to the managerial level. Hence, there is a clear chain of command and transfer of responsibilities from the top levels (Ministry of Environment tasking the NCA top management) across mid-management (NCA Department of monitoring presenting the monitoring plan to regional branch Heads) to the base-level (individual employees are responsible for the planned monitoring actions and report directly to their supervisors).

Considering mentioned above, the score for this criterion is 5.

1.2. Legal Dimension of NBMS of Ukraine: evaluation

(1) Certainty with the main purpose of monitoring.

In Ukrainian environmental legislation, the definition of the state system of environmental monitoring has been in existence since 1991 ([Law of Ukraine «On Environmental Protection» No. 1264-XII, dated June 25, 1991](#)). However, until 2023, it only referred to ecological

monitoring data (sometimes including chemical, quantitative, biological, hydromorphological, and physicochemical indicators). There was also a separate concept of forest monitoring (Item 6, Article 35 of the [Forest Code of Ukraine](#)).

The concept of biodiversity monitoring was not previously defined at the legislative level. In 2023, the Law of Ukraine «[On Amendments to Certain Legislative Acts of Ukraine Regarding the State System of Environmental Monitoring, Information on the State of the Environment \(Environmental Information\), and Information Support for Environmental Management](#)» No. 2973-IX was adopted. This law introduced many changes to Ukraine's existing environmental protection legislation. Specifically, it defined the concept of biodiversity monitoring as part of the state environmental monitoring system (Clause «r» of Article 22 of the Law of Ukraine «On Environmental Protection»):

«Biodiversity and landscape diversity monitoring is a system of observations of biological and landscape diversity, collecting, processing, and exchanging information on the condition of its components, which is used to assess and forecast changes in their condition and to develop scientifically grounded recommendations for making effective management decisions. Biodiversity and landscape diversity monitoring is a component of the state environmental monitoring system and is carried out in the manner established by the Cabinet of Ministers of Ukraine».

This definition now serves as the foundation for shaping Ukraine's state policy of biodiversity monitoring. In 2023, similar amendments were made to the legislation concerning fauna, flora, and the ecological network, all of which specify that «*monitoring of biological and landscape diversity is a component of the state environmental monitoring system*».

In line with this law, the Cabinet of Ministers of Ukraine approved Resolution

No. 684 on June 13, 2024, [«On the Procedure for the Functioning of the State Environmental Monitoring System and Its Subsystems»](#). This resolution, like the law, enters into force six months after the end of martial law in Ukraine.

The goal of creating the overall state environmental monitoring system, according to Article 22 of the Law of Ukraine «On Environmental Protection», is: *«ensuring the collection, processing, storage, and analysis of information about the state of the environment, forecasting its changes, and developing scientifically grounded recommendations for making effective management decisions in Ukraine»*.

On January 17, 2025, the Government approved the Cabinet of Ministers of Ukraine Resolution №45 [«On Approving the Procedure for Biodiversity and Landscape Diversity Monitoring»](#) (hereinafter - Resolution №45), which became the most specialized regulatory legal act in the field of biodiversity monitoring in Ukraine. The Procedure for Biodiversity and Landscape Diversity Monitoring (hereinafter referred to as the «Procedure») defines the list of subjects (central executive authorities, state enterprises, institutions, organizations, as well as the National Academy of Sciences of Ukraine and the National Academy of Agrarian Sciences of Ukraine) and the objects of biodiversity monitoring in Ukraine.

The objective of biodiversity and landscape diversity monitoring, according to paragraph 3 of the Resolution, is to:

«Ensure the organization of permanent or periodic observations of monitoring objects; the collection, processing, storage, generalization, analysis of information on the state of biological and landscape diversity and its components, as well as the exchange of such information; assess and predict changes and develop scientifically grounded plans and programs for the improvement, preservation, and restoration of biological and landscape diversity,

including forests; prevent, limit losses, and ensure the sustainable use of components of biological and landscape diversity according to biodiversity and landscape diversity monitoring programs at the national, regional, local, and site-specific levels».

The Procedure outlines that the biodiversity monitoring system shall operate based on the National Biodiversity and Landscape Diversity Monitoring Program, which the Ministry of Environmental Protection and Natural Resources (hereinafter - the Ministry of Environment, not operating at the moment) must develop within one year of Resolution №45 coming into force. Additionally, monitoring entities are obliged to submit their monitoring results to the Ministry of Environment free of charge, in the format and within the timeframe specified by the National Biodiversity and Landscape Diversity Monitoring Program.

However, the Resolution №45 will take effect simultaneously with the enactment of the Law of Ukraine No. 2973-IX «On Amendments to Certain Legislative Acts of Ukraine Regarding the State System of Environmental Monitoring, Information on the State of the Environment (Environmental Information), and Information Support for Environmental Management» dated March 20, 2023, meaning it will come into force six months after the cancellation or termination of martial law. Moreover, the Ministry of Environment was abolished as an independent Ministry and became part of the Ministry of Economy, Environment, and Agriculture of Ukraine in September 2025.

The broader goal of biodiversity monitoring, specifically «ensuring the achievement of the Sustainable Development Goals,» is stated in paragraph 3 of the Cabinet of Ministers of Ukraine Resolution No. 684 dated June 13, 2024, «On the Procedure for the Functioning of the State Environmental Monitoring System and Its Subsystems».

As all the legal acts related to biodiversity monitoring have yet to come into effect, the score is 2.

(2) Targeted selection of monitoring objects.

The state environment monitoring system includes monitoring of plants and animals as well as of the ecological network.

Article 61 of the Law of Ukraine «On Environmental Protection», indicates that the land and water areas of the objects of the Nature Reserve Fund of Ukraine are for background environmental monitoring. This includes biodiversity monitoring. This is also confirmed by Articles 9 and 17 of the Law of Ukraine «[On the Nature Reserve Fund of Ukraine](#)» 2456-XII dated June 06, 1992.

According to Article 11 of the Law of Ukraine «[On the Red Data Book of Ukraine](#)» No. 3055-III dated February 07, 2002, the monitoring of objects in the Red Data Book of Ukraine is ensured through: «systematic work on identifying the locations of their habitats, conducting constant observation (monitoring) of the status of their populations».

The most complete list of monitoring objects is provided in paragraph 5 of the Resolution №45, which will come into force later.

Since biodiversity monitoring in Ukraine is conducted in a fragmented, short-term manner, only for specifically identified objects, for which programs are created, the score is 3.

(3) Systematicity and continuity with mandatory reporting.

Despite Ukraine having reporting obligations under the Bern Convention towards species and habitats, there are no regulated requirements for clear reporting deadlines in Ukraine (except for certain species during specific periods). As a result, monitoring lacks a systematic, continuous character and is rather episodic and fragmented.

Systematic and continuous monitoring with annual reporting (Chronicle of Nature) is conducted only within PAs with administrations (e.g., nature reserves, biosphere reserves, national parks, regional landscape parks). Regular, comprehensive biodiversity monitoring on forested lands is absent, although certain game species and plant species are monitored to a limited extent. In Ukraine, there is no liability (responsibility) for the lack of monitoring data, and there is no incentive system.

Considering mentioned above, the score for this criterion is 1.

1.3. Summary. Legal Dimension: Integration vs. Fragmentation

The legal framework in Czechia is characterized by high certainty and alignment with European standards. Act No. 114/1992 Coll. serves as a robust «legal anchor,» transposing EU Habitats and Birds Directives into clear national mandates (§ 45f). With a score of 5/5 across all legal criteria, Czechia demonstrates that systematic monitoring is inseparable from mandatory reporting cycles.

In contrast, Ukraine has recently undergone a «legislative revolution,» moving from a purely ecological/pollution-based monitoring focus (established in 1991) to the explicit inclusion of biodiversity in 2023. However, the system faces two primary hurdles:

- **Suspended Enactment:** Most specialized acts, including Resolution №45 (2025), are tied to the termination of martial law, leaving the current system in a state of legal «limbo.»
- **Fragmented Objects:** Monitoring remains limited to the Nature Reserve Fund and Red Data Book species, lacking the landscape-scale systematicity seen in Czechia's habitat mapping updates.

2. Evaluation of a Governance dimension of the NBMS of Czechia

and Ukraine was conducted using the following criteria: **(04) Structure and executive body(s).**

2.1. Governance of the NBMS of Czechia: evaluation

The Nature Conservation Agency of the Czech Republic is the central executive body responsible for biodiversity monitoring and reporting to the EU (on behalf of the Ministry of Environment). This means that it is the institution that centralises all available data and ensures the operation of the necessary data management infrastructure. Despite this responsibility, the NCA has no direct control over the other nature conservation authorities (national park administrations, regional governments, and military training grounds), and thus cannot enforce the methodologies and guidelines. That is the Ministry of Environment's role. Despite this gap, the current system of governance is fully able to achieve its main goal, timely and detailed reporting to EU bodies.

Furthermore, the system lacked transparency beyond the NCA staff so far. This is changing recently with the update of the Nature Conservation Information System, as the annual biodiversity monitoring plan is becoming available to all the other nature conservation authorities. At the first stage, the regional governments, national park administrations, and the Ministry of Defence will be able to view the NCA's planned monitoring activities. At the second stage, they will be allowed to plan their own activities.

Concerning biodiversity data, as the body responsible for governance and maintenance of species and habitats' databases, the Nature Conservation Agency ensures data management and interoperability. This concerns the obligations stemming from both the Habitats and the Birds Directives. Data concerning the reporting on other various environmental directives (e.g. the Water Framework Directive) is managed by multiple different institutions.

The information provided above relates to the Habitats Directive and Birds Directive. The complex nature of the Nature Restoration Regulation and reporting burden regarding the many articles will increase the demand on the Nature Conservation Agency's data management and interoperability capacities.

The integration of biodiversity monitoring results into policy and decision-making functions is effective at multiple levels. At the most basic level, the databases are well-known by the practitioners who access them daily. A more detailed assessment is completed with each update to the management plan for each protected area, or an appropriate assessment using IT tools for integration of multiple databases and resources to help conservation officers make better-informed decisions. Similarly, the summarised data is used to inform policy-makers through strategic documents, including the Czech Strategy for Biodiversity Conservation.

While there are campaigns to engage stakeholders and make state biodiversity monitoring more collaborative, these are irregular and infrequent. The main bulk of such initiatives is carried out by either national NGOs or international platforms. The Czech Ornithological Society (Birdlife partner) has built a large faunistic database on birds, which is constantly growing thanks to the activity of both professionals and amateurs. The Czech Botanical Society is running a successful project on iNaturalist, although mainly focused on its members.

iNaturalist is also used by many NGOs and educational institutions during short-term campaigns like BioBlitz (focused on mapping the occurrence of invasive alien species) and City Nature Challenge. Such activities had played a key role in growing the community in Czechia. Despite its support, the Nature Conservation Agency is still not a major actor in these, but is utilising the citizen science data through its uptake into the Species Occurrence Database.

Considering mentioned above, the score for this criterion is 4.

2.2. Governance of the NBMS of Ukraine: evaluation

Unlike in Czechia, in Ukraine, there is no central level structure or executive body responsible for policy and its implementation (action). The former Ministry of Environment was not able to properly perform its duties at the local level because regional environmental protection divisions were abolished as part of an earlier reform in 2010. The management, monitoring, and supervision system is not functioning properly. The protected areas are being violated on a massive scale, and compliance with international obligations is not being monitored.

Ukrainian NGO emphasise (EPL, 2022) the urgent need to restore the territorial bodies of the former Ministry of Environment, as well as to reform the monitoring, control, and supervision subsystems; a separate Agency for Nature Conservation or a full-fledged Department should be established to implement state policy in the field of development and management of the national protected areas network, the Emerald Network sites, and biodiversity conservation.

As of January 2026, the draft resolution of the Cabinet of Ministers of Ukraine [«On Approval of the Strategy for the Conservation of Biological Diversity in Ukraine for the Period until 2035 and Approval of the Operational Plan of Measures for its Implementation in 2026-2028»](#) is under discussion. Clause 3.2.9. of the Operational plan of measures for implementation in 2026-2028 provides for *«the creation of a central executive body to ensure the implementation of state policy in the areas of organization of protection and use of the natural reserve fund, formation, conservation, and use of the ecological network, conservation, restoration, and sustainable use of biological and landscape diversity»*. Though, the time of the adoption of the corresponding resolution of the

Cabinet of Ministers of Ukraine that will allow the establishment of the mentioned central executive body is «blurred»: «the 2026 — one year after the termination or cancellation of martial law in Ukraine».

Considering mentioned above, the score for this criterion is 0.

2.3. Governance: Institutional Stability and the «Executive Void»

A critical divergence appears in the governance dimension. Czechia (Score: 4/5) benefits from the Nature Conservation Agency (NCA ČR), which acts as a centralized methodological leader and data clearinghouse. While Czechia still struggles with enforcing methodologies across actors, the «chain of command» from the Ministry ensures accountability.

Ukraine (Score: 0/5) currently faces an institutional vacuum. The abolition of the independent Ministry of Environmental Protection in September 2025 and its merger into the Ministry of Economy has severed traditional lines of authority. The proposed creation of a specialized Agency for Nature Conservation remains a «blurred» future objective. Without a central executive body, the «Chronicle of Nature» remains the only consistent (yet isolated) monitoring output, confined strictly to protected areas.

3. Evaluation of the Methods and Management dimension of the NBMS of Czechia and Ukraine was conducted using the following two criteria: (5) methods (data collection and data analysis) and (6) data management system and data policy.

3.1. Methods and Management of the NBMS in Czechia: evaluation

(5) Methods (data collection and data analysis)

Uniformity is currently ensured by providing relevant actors with methodologies for data collection and data storage. The Nature Conservation Agency is the methodological leader

in biodiversity monitoring, species inventories, mapping, and monitoring of target taxa. However, these are often not followed in practice, and individual nature conservation authorities and NGOs may use their databases or repositories. These are rarely compatible with the central system. There is currently an effort to provide clearer methodological guidance (especially to regional governments) and to provide nature conservation actors with a more robust environment for biodiversity monitoring, planning, and data sharing.

Nowadays, traditional biodiversity methods are used almost exclusively to collect data on the occurrence of species and habitats with respect to the Habitats and Birds Directives. Some nature conservation authorities are actively using UAVs in their work (especially the regional administration of the South Bohemian region); however, a unified methodology and a systematic approach to their large-scale application are lacking. A similar situation applies to molecular methods, which currently remain limited to individual studies and are applied in an isolated manner. However, a strategy for protecting genetic diversity is currently under development, and this may potentially lead to systemic changes in the use of molecular methods.

GIS software is commonly used for analysis. ESRI in the institutions of the central government. Regional governments rely mainly on either ESRI technologies or QGIS.

Analytical tasks are undertaken by various bodies. Routine analysis is mainly conducted on a daily basis by each nature conservation authority. Complex tasks are often outsourced to universities and academic institutions.

Biodiversa+ supports Czechia in harmonizing biodiversity monitoring by providing European guidance, tools, and collaborative frameworks developed together with the other Biodiversa+ partner organizations. It issues reports and

guides on aligning monitoring protocols and ensuring data interoperability, helping Czech institutions integrate with the EU standards, including Darwin Core standards concerning the Species Occurrence Database. Through expert workshops, it connects Czech stakeholders with European peers working on Essential Biodiversity Variables and harmonized methods. The Nature Conservation Agency of the Czech Republic engages in Biodiversa+ initiatives testing innovative approaches such as automated monitoring traps and remote sensing. Such novel methods are not yet widely used in Czechia, and Biodiversa+ provides an opportunity to fund and pilot their deployment at several sites. Transnational research calls further enable Czech organizations to access funding and partnerships, strengthening consistent, modernized biodiversity monitoring across Europe.

Considering mentioned above, the score for this criterion is 4.

(6) Data management system and data policy

The Species Occurrence Database (AOPK ČR, 2026) is an application for entering and editing data on the occurrence of plant and animal species. It is a long-term project of the Nature Conservation Agency of the Czech Republic (NCA ČR), in use since 2008. According to defined rules, data can be entered, edited, and viewed not only by NCA staff but also by a wide network of expert collaborators.

Use of the database: The Species Occurrence Database supports nature conservation activities at the national, regional, and local levels. It is used by public authorities (e.g., the Ministry of Environment, regional and municipal authorities) as well as universities, research institutes, and museums. The data are applied to species and site protection (e.g., granting legal exemptions, planning measures), to procedures for environmental impact assessments (SEA, EIA, Natura 2000 evaluations), by investors to consider

conservation interests during project planning, and for EU reporting obligations on species populations. Data are also provided under research agreements, including theses and dissertations.

System structure: The Species Occurrence Database consists of two applications:

- Data entry tool — allows users to record individual observations by placing points or polygons on a map, including observer details and notes (e.g., behavior, habitat, taxonomy). Data can be entered individually or imported in bulk from scientific projects (e.g., habitat mapping updates).
- Data viewing tool – enables users to search and filter records by species, registration date, location, observer, source, region, or cadastral unit, with flexible combinations of criteria.

To maintain data quality and its applicability in conservation practice, a two-step data validation process is established:

Validation: Species occurrence is reviewed by the state nature conservation authority at the regional level. This is usually done by the biodiversity experts at the regional branches and administrations of protected areas and national parks. External experts also have the right to validate the findings. For verified users (employees of the NCA, national parks, and selected experts), the data enters the Species Occurrence database marked as reliable and therefore are automatically validated.

Verification: Data are reviewed by the biodiversity monitoring experts at the Department of Biodiversity Monitoring at the NCA headquarters. The validity of the data is checked in the second step, especially regarding the author if less known, and the likelihood of occurrence given the season of the year.

The Habitat Mapping Database stores data on the occurrence and quality of natural, semi-natural, and anthropogenic habitats. The NCA coordinates the data collection, while mainly external contractors participate in it. A validation process similar to the one on species is in place. The experts at the NCA regional branches validate the data sent by the external contractors, and based on this step, the contractors are then paid.

Both databases are open to the public except for selected species (e.g., some birds of prey, critically endangered plants and fungi species threatened by collectors). Each data point is georeferenced (possesses a GIS component).

While the species occurrence database is relatively easy to use, understanding and working with the habitat data requires good knowledge of the methodology available (Chytrý et al, 2001; Chytrý et al, 2010; Härtel et al, 2009). Neither database automatically provides an interpretation of the data apart from basic summaries (e.g., number of species' occurrences at the given time and place).

Overall, this criterion is implemented at a high level in Czechia due to the operation of centralised databases on the distribution of species and habitats.

Considering mentioned above, the score for this criterion is 5.

3.2. Methods and Management of the NBMS in Ukraine: evaluation

(5) Methods (data collection and data analysis)

There are no approved methodologies and methods. Practitioners and scientists use standard scientific methods to collect data on biodiversity. The Order of the Ministry, «[Program of the chronicle of nature for reserves and national natural parks](#)», set out methods to be used by PAs (biosphere reserves, national parks, etc). Some PAs use some of them. There are no control or verification procedures.

There are several methods for habitat mapping developed by the Ukrainian academics and the Frankfurt Zoological Society. There are some methods used by different actors. For example, the State Fishery Agency is responsible for the monitoring (accounting) of fish species and population, and the state forestry agency is responsible for game species monitoring (accounting).

Tech use is limited due to a lack of equipment and skills. Some are valid for advanced scientific methods and data analysis.

Considering mentioned above, the score for this criterion is 0.

(6) Data management system and data policy

A national biodiversity data management system, as well as a clear policy are absent.

Considering mentioned above, the score for this criterion is 0.

3.3. Methods and Management: Digital Maturity and Risks of Oblivion

The technical evaluation reveals a significant disparity between a centralized, data-driven system that is transitioning toward modernization in Czechia and a highly fragmented, expert-reliant approach in Ukraine.

Czechia's high scores reflect a system capable of meeting EU reporting burdens through institutionalized data flows.

In contrast, Ukraine lacks officially approved national methodologies. Ukraine currently possesses no centralized national biodiversity data management system or formal data policy. Systematicity is hampered by a lack of liability for missing data, which often lacks the cross-taxa uniformity seen in the Czech model, and the absence of a unified national database. Information remains decentralized within the records of individual protected areas or research institutes, making large-scale biodiversity trend analysis or international reporting nearly impossible in the current administrative climate.

Ukraine's scores underscore an urgent need for a national data strategy and the approval of unified monitoring protocols once administrative stability is restored.

4. Evaluation of the Capacity of the NBMS of Czechia and Ukraine was conducted using the following four criteria: (7) funding, (8) human resources, (9) infrastructure, and (10) partners.

4.1. Capacity of the NBMS in Czechia: evaluation

(7) Funding

Fulfilled in Czechia to the extent of obligations set by the Habitats Directive and Birds Directive. Mainly covered by the state budget, but significant funds are also coming from the EU funding since the real budget is gradually decreasing, due to inflation, which is not being taken into account when allocating budget for many schemes (i.e., habitat mapping). Moreover, current funding is insufficient in the face of the new obligations set by the Nature Restoration regulation (Regulation — EU — 2024/1991 — EN — EUR-LEX, n.d.).

One Nature project has been an important source for monitoring the condition of the Natura 2000 Network in Czechia. It is a 5-year project with approximately €1.2M available for monitoring over the 5 years, making it €250k/year or so to cover all the target feature species within the Natura 2000 Network. However, this is based on the Czech interpretation of the target feature concept, when only selected occurrences of the Habitats Directive Annex II species are reported as the target features. Accepting the interpretation of every species' occurrence, establishing grounds for a target feature listing would either significantly increase the costs of Natura 2000 monitoring (about 2-3 times) or cause a decrease in frequency and/or detail of monitoring.

The habitat mapping scheme is allocated approximately €250,000 annually from the state budget. A similar budget is available

for species monitoring. The amount is stable in absolute terms, hence it has gradually decreased due to inflation.

The operation programme Environment is a long-term source of funding. It combines funding from the Cohesion Fund and the EU Fund. The programme has been used successfully for decades for both conservation action and biodiversity monitoring. Two major projects are currently being funded by the programme, focusing on mapping the distribution of invasive alien species and monitoring the biodiversity within protected areas.

Iceland-Lichtenstein-Norway Grants had also been historically utilised.

Thus, the funding criteria is fulfilled in Czechia. Funding can be potentially threatened by budget cuts. Moreover, the real budget is gradually decreasing, due to inflation, which is not being taken into account when allocating budget for many schemes (i.e., habitat mapping) and needs to be thus covered by various projects. Annual variation and volatility of sources cause instability of the system.

Considering mentioned above, the score for this criterion is 4.

(8) Human resources

About 110 NCA staff out of almost 900 are primarily tasked with biodiversity monitoring, although they often fulfil other ad hoc tasks. With 14 regional branches and given that 25 of those employees are based at the headquarters, coordinating the monitoring efforts and evaluating the results, the average manpower per regional branch is 6 people. This differs between the branches due to differences in the number of SSPAs, PLAs, and area. A general rule is that each regional branch aims to employ at least one zoologist and one botanist, plus the same duo for each protected landscape area it administers. Naturally, large protected landscape areas like the Beskydy PLA require more staff to cover.

Methodology regarding the time required to survey/monitor the individual

sites of occurrence is species- or group-specific. For example, the monitoring of target amphibian species within the Natura 2000 Network requires 2-5 visits during the vegetation period. The price depends on the size of the protected area, ranging from €200 paid for the smallest sites to more than €3000 for large-scale Natura 2000 sites. A similar concept is applied to most vertebrate species. The Habitats Directive Annex II insect species monitoring follows a different scheme, focusing on the 5x5 km mapping fields. The monitoring experts are required to visit primarily the Natura 2000 sites established for the target species in each field, and at least 3 sites of occurrence or probable occurrence need to be monitored. Each mapping field is worth €100.

The possibility of attracting experts is mainly focused on financial incentives, although the pay available often requires enthusiasm. Voluntary schemes such as the effective use of citizen science are still underutilised compared to many European countries, although these exist in Czechia too. One of these is the Butterfly Monitoring Scheme (Czechia BMS|European Butterfly Monitoring, n.d.), based on monitoring transects by volunteers. The initiative is coordinated by academic institutions, and the NCA supports the coordination financially.

Habitat mapping is largely dependent on the capacities of external contractors due to historical (the scheme was designed in such a way from the very beginning in 2000) and practical (strictly seasonal character of the task) reasons. Furthermore, most of the contractors prefer to work externally since it is easier for them to combine habitat mapping with other jobs. Last but not least, it is also more profitable for many experts to be contracted rather than permanently hired due to the tax system in Czechia. Trends in the number of experts.»

In general, the criteria is fulfilled in Czechia. However, the future for many groups is uncertain regarding their capacities despite fairly close collaboration

with academia, but this presents a global problem. The need for mobilisation and stable demand for expert capacity is dependent on funding.

Considering mentioned above, the score for this criterion is 5.

(9) Infrastructure

No nature conservation authority (concerning territorial protection) has a laboratory available.

Cars - number dependent on the number of employees within the regional branch or protected landscape administration. Typically, 3-4 per unit (branch/administration). About 17 cars are at the NCA headquarters, including those used by the top management.

Monitoring gear - binoculars, umbrella traps, kick nets, electrofishing gear. Drones are becoming more popular, but there is no central systemic support. Moreover, the legislation is preventing an effective use of drones since the nature conservation authority needs to provide its own official statement before reaching out to the Civil Aviation Authority to receive a permit.

GIS: ESRI ecosystems used for the GIS at the NCA. This provides an integrated environment and simplifies a number of tasks; however, it is a costly solution. Many regional governments, therefore, prefer to use open-source and free-to-use QGIS.

Considering mentioned above, the score for this criterion is 3.

(10) Partners and stakeholder engagement

There is regular cooperation between the Ministry of Environment, government agencies, universities, the Academy of Sciences, and NGOs. Much of the cooperation is codified in various memoranda and depends on good relations between the individual actors at the same time.

Considering mentioned above, the score for this criterion is 5.

4.2. Capacity of the NBMS in Ukraine: evaluation

(7) Funding

Currently, there is no NBMS in operation, and consequently, unlike in Chechia, no funds are allocated directly for this purpose. PAs with administrations (like national parks) perform monitoring within their designated territories, staying within their allocated operational budget. It is usually a salary, and additional funds to conduct the research and monitoring.

Procedure for monitoring biological and landscape diversity under the Resolution №45 states that «*Monitoring of biological and landscape diversity is financed from state and local budgets, as well as from other sources not prohibited by law*». Financing of these measures from the state budget is carried out within the limits of expenditures provided for in the Law on the State Budget of Ukraine for the relevant year. Some institutions identified in the Resolution as responsible for monitoring, such as the Ministry of Environment, have been abolished. And, as was mentioned above, the Resolution will come into force later.

Considering mentioned above, the score for this criterion is 0.

(8) Human resources

No centralized system or Agency responsible for biodiversity monitoring exists, so no employees are working on it at the central and regional levels.

It is impossible to evaluate objectively in the absence of objective data how many people are doing the biodiversity monitoring/observation. There are biodiversity monitoring professionals, mainly working in academia, who occasionally do practical work on species, forestry, fisheries, and some experts working in PA. No centralized authority is responsible for species and habitat monitoring.

Considering mentioned above, the score for this criterion is 0.

(9) Infrastructure

Absent on the central level. A couple of laboratories in the PAs with administrations. There are also some cars used for scientific research. Lack of scientific devices (monitoring gear), as well as knowledge of GIS utilisation. Not aimed at monitoring currently. Could be used in the future.

Substantial help in this regard has been provided to some PAs by NGO (international, national, and mixed).

Considering mentioned above, the score for this criterion is 0.

(10) Partners and stakeholder engagement

There is some occasional cooperation between NGOs, Universities, Academia, and PAs. But there is no central entity responsible for BM and the system, no feedback.

Considering mentioned above, the score for this criterion is 0.

4.3. Capacity: Institutional Maturity vs. Systemic Absence

The fourth dimension of the framework evaluates the «engine» of the monitoring system — the funding, personnel, and physical infrastructure required to translate legal mandates into field data. This section highlights the precarious stability of a functioning EU system (Czechia) against a backdrop of complete systemic absence in Ukraine.

Czechia demonstrates a diverse but inflation-sensitive funding model. While the absolute budget remains stable, real-term funding is decreasing due to inflation, forcing a reliance on ad-hoc projects that introduce annual volatility.

Ukraine lacks any dedicated funding for a National Biodiversity Monitoring System. While Resolution №45 outlines potential state and local budget sources, these provisions are currently inactive. Monitoring is currently reduced to a

«salary-only» activity within protected areas (PAs), with virtually zero budget for active research outside PAs or transboundary monitoring.

The management of human resources reveals two different challenges. In Czechia, a special «gig biomonitoring economy» emerged where experts prefer contract work over permanent employment due to tax advantages and seasonal flexibility. While effective, this creates a long-term risk regarding the stability of expert availability for less «popular» taxonomic groups. In Ukraine, on the contrary, we observe the absence of such a phenomenon. There is no centralized authority or designated workforce for biodiversity monitoring. While significant expertise exists within the National Academy of Sciences and PA administrations, their work is academic or site-specific. There is no mechanism to mobilize these experts into a national monitoring network.

Both nations show a surprising gap in high-tech infrastructure, albeit for different reasons. Additionally, in Ukraine, there is a critical shortage of monitoring gear and a widespread lack of GIS proficiency among state employees.

The capacity of the Czech NBMS is «fulfilled but fragile», leaning heavily on external contractors and EU project cycles to compensate for a shrinking real-term state budget. For Ukraine, the challenge is not merely a lack of money, but the absence of an institutional vessel (an Agency or Department) to receive and distribute funds, employ experts, and manage infrastructure. Without the «Structure» identified in the Governance section, any allocated capacity will likely remain fragmented and ineffective.

Conclusions

The development and evaluation of national systems of biodiversity monitoring are critical for achieving national, European and global biodiversity

targets, informing policy, and safeguarding ecosystem services. This manuscript has presented a comprehensive, multidimensional framework for assessing NBMS effectiveness, drawing on international guidelines, scientific best practices, and recent policy developments.

The comparative analysis of Ukraine and Czechia illustrates the diversity of national contexts, trajectories, and challenges in NBMS development. Ukraine has made significant strides in legal reform, but faces ongoing challenges in methodological harmonization, data accessibility, funding sustainability, stakeholder engagement, and, most importantly, institutional capacity. Czechia offers a model of mature, integrated, and participatory biodiversity monitoring, with robust data management, stakeholder engagement, and international alignment, but must address funding constraints and human resource challenges to sustain its achievements.

For Ukraine to bridge the gap toward the EU standards demonstrated by Czechia, it must prioritize the restoration of a central environmental authority and move beyond «fragmented» monitoring toward a unified, technologically integrated data policy.

Key recommendations for strengthening Ukraine's NBMS include:

- **Institutional Strengthening:** clarify institutional responsibilities, and establish centralized coordination mechanisms by taking into account, for example, Czechia's experience, establishing the State Nature Conservation Agency responsible for biodiversity monitoring.
- **Sustainable Funding:** embed monitoring costs in policy frameworks, diversify funding sources, and secure long-term commitments.
- **Methodological Harmonization:** standardize protocols, integrate EBVs, and align with EU practices to ensure consistency and

comparability, especially considering the EU accession requirements.

- **Data Accessibility and Interoperability:** implement FAIR principles, open data standards, and interoperable IT infrastructure to facilitate data sharing and policy integration.
- **Stakeholder Engagement:** foster inclusive, participatory governance, expand citizen science, and build capacity across sectors and regions.

By embracing these principles, Ukraine can build resilient, adaptive, and EU-harmonized biodiversity monitoring systems that support evidence-based conservation, sustainable development, and the achievement of biodiversity conservation goals.

Acknowledgements

This research has been carried out within the project «Conservation of Natural Heritage for Life in Ukraine» (101148569 - LIFE23-PRE-CZ-ConNaturLIFEUkraine - LIFE-2023-PLP).

We thank Anastasia Drapaliuk, Anna Kuzemko, Oleksii Vasyliuk, and the entire Ukraine's project team for their comments, recommendations, and support, and Olena Kryvyk for proofreading the English version of the project's initial report.

Additional Information:

ORCID:

Alona Varukha

<https://orcid.org/0000-0002-5905-1107>

Jonáš Gaigr

<https://orcid.org/0009-0004-0267-1382>

Yuliia Spinova

<https://orcid.org/0000-0002-3051-8893>

References

- AOPK ČR (2026). Poskytování dat AOPK ČR. <https://data.nature.cz/>
- Biodiversa + (2026). <https://www.biodiversa.eu/>
- Biodiversa (2023). *Report on the Mapping of national and sub-national organisations that fund and steer biodiversity monitoring schemes*. URL: <https://www.biodiversa.eu/2023/03/29/new-publication-mapping-organisations-funding-and-steering-biodiversity-monitoring/>
- Burns, E.L., Tennant, P., Dickman, C.R., Gillespie, G., Green, P.T., Hoffmann, A., Keith, D.A., Lindenmayer, D.B., Metcalfe, D.J., Morgan, J.W., Russell-Smith, J., & Wardle, G.M. (2018). Making monitoring work: insights and lessons from Australia's Long Term Ecological Research Network. *Australian Zoologist*, 39(4), 755–768. <https://doi.org/10.7882/az.2018.030>
- Chytrý, M., Kučera, T., Kočí, M. (eds.) (2001). *Katalog biotopů České republiky: Interpretací příručka k evropským programům Natura 2000 a Smaragd*. Vyd. 1. Praha: Agentura ochrany přírody a krajiny ČR. 307 s. ISBN 80-86064-55-7.
- Chytrý, M., Kučera, T., Kočí, M. (eds.) et al. (2010). *Katalog biotopů České republiky*. 2.upr. a rozš. vyd. Praha: Agentura ochrany přírody a krajiny ČR. 445 s. ISBN 978-80-87457-03-0.
- Czechia BMS | European Butterfly Monitoring. (n.d.). <https://butterfly-monitoring.net/czechia-bms>
- EPL (2022). *Compliance of the state policy of Ukraine in the area of biodiversity conservation with priorities and targets of the European Green Deal*. URL: <https://epl.org.ua/en/eco-analytics/vidpovidnist-derzhavnoyi-polityky-ukrayiny-u-sferi-zberezhennya-bioriznomanittya-priorytetam-ta-tsilyam-yevropejskogo-zelenogo-kursu/>
- FAO (2017). *Voluntary guidelines on national forest monitoring*. Rome. <https://doi.org/10.4060/i6767en>
- Genovart, M., Salguero-Gomez, R., Colchero, F., Guil, F., Rabassa-Juveny, J., Uriach-Dasca, J., Conde, D.A., Gaillard, J.M., & Coulson, T. (2025). Call for new criteria for monitoring and registering Natura 2000 species data. *Conservation Biology*, e70064. <https://doi.org/10.1111/cobi.70064>
- Gonzalez, A., August, T., Bailey, S., Bobiwash, K., Boersch-Supan, P.H., Burgess, N.D., Daru, B.H., Elphick, C.S., Freckleton, R.P., Frick, W.F., Hughes, A.C., Isaac, N.J.B., Jones, J.P.G., Lambertini, M., Mac Aodha, O., Madhavapeddy, A., Milner-Gulland, E.J., Purvis, A., Salafsky, N., ... Williams, D.R. (2026). From data to decisions: Toward a Biodiversity Monitoring Standards Framework. *Proceedings of the National Academy of Sciences*, 123(10). <https://doi.org/10.1073/pnas.2519347123>
- Härtel, H.; Lončáková, J.; Hošek, M. (eds.) (2009). *Mapování biotopů v České republice: Východiska, výsledky, perspektivy*. 1. vydání. Praha: Agentura ochrany přírody a krajiny ČR. 196 s., tabulky, mapy, CD-ROM. ISBN 978-80-87051-36-8.
- Juergens, N. (2009). *Monitoring of biodiversity*. Biodiversity: Structure and Function-Volume I, 1, 229.
- Jungmeier, M. and Yenilmez Arpa, N. (2022). *Guidelines for biodiversity monitoring*. Ankara, FAO and MAF. <https://doi.org/10.4060/cb8370en>
- Kissling, W.D., Lumbierres, M., Lyche Solheim, A., Liqueste, C., Breeze, T.D., Bonn, A., McCallum, I., Maes, J., Hirsch, T., van Grunsven, R.H.A., Beja, P., Smets, B., Capinha, C., Ceia-Hasse, A., Fernández, N., Santana, J., Moreira, F., Junker, J., Leese, F., ... Pereira, H. M. (2026). Building the backbone for Europe's biodiversity monitoring. *Nature Reviews Biodiversity*. <https://doi.org/10.1038/s44358-026-00140-6>
- Kostiushyn, V.A., Gubar, S.I., Domashlinets, V.G. (2009). *Strategy for developing the monitoring of biodiversity in Ukraine*. Kyiv, 60 pp.
- Michelle Silva del Pozo, Guillaume Body, Gaby Rerig, Mathieu Basille (2023). *Guide on harmonising biodiversity monitoring protocols across scales*. Biodiversa+ report. 60 pp. URL: https://www.biodiversa.eu/wp-content/uploads/2023/10/Biodiversa_Harmonising-monitoring-protocols.pdf
- Moersberger, H., Valdez, J., Martin, J.C., Junker, J., Georgieva, I., Bauer, S., Beja, P., Breeze, T., Fernandez, M., Fernández, N.,

- Brotons, L., Jandt, U., Bruelheide, H., Kissling, W.D., Langer, C., Lique, C., Lumbierres, M., Solheim, A.L., Maes, J., Morán-Ordóñez, A., Moreira, F., Pe'er, G., Santana, J., Shamoun-Baranes, J., Smets, B., Capinha, C., McCallum, I., Pereira, H., Bonn, A. (2024). Biodiversity monitoring in Europe: User and policy needs. *Conservation Letters* 17 (5). <https://doi.org/10.1111/conl.13038>
- Morán-Ordóñez A, Beja P, Fraixedas S, Herrando S, Junker J, Kissling WD, Lumbierres M, Lyche Solheim A, Miret G, Moe J, Moreira F, Pereira H, Santana J, Villero D, Brotons L. (2023). *D3.3 Identification of current monitoring workflows and bottlenecks*. ARPHA Preprints. <https://doi.org/10.3897/arphapreprints.e103765>
- Regulation - EU - 2024/1991 - EN - EUR-LEX. (n.d.). <https://eur-lex.europa.eu/eli/reg/2024/1991/oj>
- SANBI & UNEP-WCMC (2024). *Mapping biodiversity priorities: A practical approach to spatial biodiversity assessment and prioritisation to inform national policy, planning, decisions and action*. Second edition. South African National Biodiversity Institute, Pretoria.
- Santana, J., Porto, M., Morán-Ordóñez, A., Brotons, L., Junker, J., Kissling, W.D., Lumbierres, M., Moe, S.J., Solheim, A.L., Villero, D., Breeze, T.D., Carvalho, L., Fernández, N., Herrando, S., López-Baucells, A., Shamoun-Baranes, J., Silero, N., Pereira, H. M., Moreira, F., & Beja, P. (2025). Large Biodiversity Monitoring Gaps Remain Across Europe. *Conservation Letters*, 18(5). <https://doi.org/10.1111/conl.13134>
- Sutherland, W.J., Burgess, N.D., Edwards, S.V., Jones, J.P.G., Soltis, P.S., Tilman, D., Allen, J.M., Andrianandrasana, H.T., Armour, C.J., August, T., Bawa, K.S., Bailey, S., Birch, T., Boersch-Supan, P.H., Cavender-Bares, J., Blaxter, M., Chaplin-Kramer, R., Daru, B.H., De Palma, A., ... Robinson, G.E. (2026). Nine changes needed to deliver a radical transformation in biodiversity measurement. *Proceedings of the National Academy of Sciences*, 123(10). <https://doi.org/10.1073/pnas.2519345123>
- UNECE (2022). Guidelines for developing national biodiversity monitoring systems as an environmental policy tool for countries of Eastern Europe, the Caucasus and Central Asia, as well as interested South-Eastern European countries. URL: https://unece.org/sites/default/files/2022-02/BIODIVERSITY%20guidelines%20revision%20EN_final.pdf
- UNECE (2023). Guidelines for developing national biodiversity monitoring of a ring systems. URL: <https://unece.org/environment-policy/publications/guidelines-developing-national-biodiversity-monitoring-systems>
- UNEP-WCMC (2024). *Guidance for developing plans for national monitoring systems in support of the Kunming-Montreal Global Biodiversity Framework*. 26pp. Cambridge, UK. <https://www.learningfornature.org/wp-content/uploads/2024/10/Guidance-for-plans-for-national-monitoring-systems-Final-Sept24-ENGLISH.pdf>
- Vihervaara, P., Auvinen, A.-P., Mononen, L., Törmä, M., Ahlroth, P., Anttila, S., Böttcher, K., Forsius, M., Heino, J., Heliölä, J., Koskelainen, M., Kuussaari, M., Meissner, K., Ojala, O., Tuominen, S., Viitasalo, M., & Virkkala, R. (2017). How Essential Biodiversity Variables and remote sensing can help national biodiversity monitoring. *Global Ecology and Conservation* 10: 43-59
- Wright, E.F., Bellingham, P.J., Richardson, S.J., McKay, M., MacLeod, C.J., & McGlone, M.S. (2020). *How to get a national biodiversity monitoring programme off the ground: lessons from New Zealand*. PARKS, 26.2, 67–78. <https://doi.org/10.2305/iucn.ch.2020.parks-26-2efw.en>
- Zákon č. 114/1992 Sb., o ochraně přírody a krajiny. (1992). Zákony pro lidi. <https://www.zakonyprolidi.cz/cs/1992-114>

Annex 1. A description of a criteria within the framework developed for countries' NBMS characterization

Dimension	Criteria	Description
Legal	(1) Monitoring purpose	The monitoring system's aim and scope are defined, as well as SMART goals for the monitoring, aligned with national and international policy objectives. Clarity of legal mandates for biodiversity monitoring is set.
	(2) Targeted selection of monitoring objects	Including the species and habitats of the international (Appendix I, II HD, Appendix I BD, Resolutions 4 and 6 of the Bern Convention) and national (Red Data Book of Ukraine, RDBU) level, as well as deviations (Article 16 HD) Monitoring priorities should be established and accepted, with the obligations set by the EU membership given the highest priority.
	(3) Systematicity and continuity with mandatory reporting	Long-term biodiversity monitoring programs that support national biodiversity strategy and action plans (NBSAPs) and fulfil the obligations of the Habitats and Birds Directives. Official Guidelines developed and used for unified monitoring (intervals between monitoring activities periods and intervals, minimum required amount of data, responsibility, etc. are defined)
Governance	(4) Structure and executive body(s)	Governance structures established and Institutional coordination ensured. There is a central executive body (and regional) responsible for biodiversity monitoring and reporting to the EU. It develops the relevant policy in the country and ensures: • Data Management and Interoperability (Standardization of protocols and data; Data interoperability; Data accessibility and sharing). • Resource Allocation and Sustainability (Funding stability and adequacy; Resource allocation across realms). • Utilization of Monitoring Results (Integration into policy and decision-making). • Stakeholder engagement and feedback mechanisms. It is multi-level, transparent, collaborative, independent, science-intensive, sustainable, and adaptable.
Methods and Management	(5) Methods (data collection and data analysis)	Uniformity (using unified, internationally compatible methodologies/protocols (appropriate for different taxa) for data collecting and analysis to ensure their compatibility and comparability (e.g., from different regions and time periods), which are approved at the state level and updated in accordance with the current level of scientific development). Technological (GIS, UAVs, etc.) that allow to increase precision and efficiency. Use of advanced scientific methods (e.g., molecular methods like barcoding) that ensures a deeper level of taxonomic accuracy and biological insight than traditional observation alone. Robust Data analysis methods: rigorous analytical frameworks to process data, ensuring that findings are statistically significant and capable of being integrated into broader scientific databases.

Dimension	Criteria	Description
Methods and Management	(6) Data management system and data policy	Existence of sound data policy, reliable and adaptable database management system (DBMS) and a single platform (core repository) for biodiversity data that align with following requirements. Verification Protocols in place. The system must include a robust mechanism for data verification to ensure accuracy and scientific validity. Centralized Infrastructure. DBMS and core repository infrastructure must be centralized and governed accordingly. Integrity and Interoperability: The system must support cross-platform data exchange and be fully compatible with major international databases such as GBIF, iNaturalist, sPlot, and EVA, allowing for integration into the European database(s). Geospatial Capabilities. A built-in GIS (Geoinformation System) component is required to manage and visualize spatial data. Data analysis capacity in place. The system should provide automated analytical tools capable of identifying (species population) trends, calculating biodiversity indices, generating semi-automatic reports and data visualizations, etc. Transparent terms-of-use. Conditions for data use must be clearly defined and transparent for both contributors (authors) and end-users. Easy to use. The platform must be user-friendly.
Capacity	(7) Funding	Stability: availability of an annual budget (allocated from the State budget) to ensure monitoring. Sufficiency: the yearly budget can cover primary monitoring needs. Fair budget distribution (geographical and institutional). Quality of budget planning and financial management by institutions. legal possibility of spending funds on attracting external experts and carrying out monitoring work. Diversification of funding sources with basic needs covered by state funding, but the possibility of attracting other sources (grants, carbon credits, etc.).
	(8) Human resources	Availability and sufficiency of trained personnel and technical expertise (e.g., field teams, maintenance staff, data analysis, etc.). Sufficiency of personnel's expertise (Botany, Zoology, Geography, Ecology, GIS, remote sensing, data management, and analysis). Capacity-building programs and knowledge transfer mechanisms are in place. The system can attract external experts (expertise).
	(9) Infrastructure	Laboratory, cars, technical devices, monitoring equipment, GIS-environment, etc.

Dimension	Criteria	Description
Capacity	(10) Partners and stakeholder engagement	Inclusion and Cooperation between Government agencies, Universities, Science, NGOs, citizens, volunteers, companies, etc., are ensured. Transparent mechanisms of cooperation, participatory monitoring, and knowledge co-production are defined. Opportunity of multilevel cooperation exists (i.e., the possibility of both cooperating on the development of a monitoring system, methods, or data analysis, etc., and the possibility of cooperation only at the level of data collection) Strategies for managing stakeholder conflict and ensuring legitimacy. Communication strategy in place.