Guidelines to develop national Forest Bird Indices for the new EU Nature Restoration Regulation

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Degraded forests in Sweden © Åke Lindström

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Background

The European Bird Census Council (EBCC), BirdLife International, and national partners involved in the Pan-European Common Bird Monitoring Scheme (PECBMS) develop a set of Wild Bird Indices (WBI), including the Farmland Bird Index (FBI) and the Forest Bird Index (FoBI). These indicators have been annually produced at European and EU levels for 20 years. WBI are high quality biodiversity indicators recognised as component indicators within the Kunming Montreal Global Biodiversity Framework (CBD 2022). The current European Common FoBI has been a benchmark indicator to inform on the general state of common forest birds in EU/Europe and many constituent countries. It is a composite, multispecies indicator that measures the rate of change in the relative abundance of 34 bird species that use forests for breeding and/or feeding (PECBMS 2025). Currently, data come from monitoring schemes running in 26 EU Member States (and two European non-EU countries), which are integrated in PECBMS (Voříšek et al. 2019). National FoBIs are also produced in various EU Member States (MS) (Klvaňová 2023).

For quite a long time, the European Common FoBI has been used by the European Environmental Agency to support environmental policy-making (EEA 2025). The Regulation on Nature Restoration, Regulation (EU) 2024/1991 − adopted on 17 June 2024 and also known as the Nature Restoration Law, NRL from now on − is a new component of EU legislation that has important obligations related to forest bird indicators (European Commission 2025). The NRL asks MS to improve forest habitats and establishes a series of indicators to track its implementation, including a FoBI. This indicator will be needed very soon for the National Restoration Plans (NRPs) that the MS are currently preparing to submit to the European Commission (EC) by September 2026. Despite its accepted role as a general indicator of the state of forest bird communities, the European Common FoBI and at least some of the current national FoBIs are likely insufficient to accurately inform about the progress towards the targets of NRPs for forest ecosystems related to the NRL. For example, some forest bird species could not be reliable indicators for the process of forest restoration as expressed in the NRL. In other cases, species could be strong indicators in some countries but cannot be used in others simply because they are not present.

The selection of the data and methods to develop the FoBI for NRPs is a national-level responsibility. EBCC and BirdLife Europe and Central Asia advocate for the collaboration between relevant governmental ministries and agencies, and national ornithological organisations and relevant research institutions to optimise the design of FoBIs for application in relation to NRPs. Knowledge exchange and proper interpretation of the results of the indicators among countries and at the EU level will be particularly important. In this context, harmonising criteria and approaches across countries, while ensuring adaptation to national contexts, are also a desirable and important component of this process.

The NRL recognises that investing in monitoring and surveillance is necessary in order to underpin robust and evidence-based NRPs. This document attempts to assist EBCC partners, national NGOs, researchers, national and EU governmental departments involved in the NRL, and other stakeholders to develop high quality national FoBIs in EU Member States for the NRPs. It includes guidance on what the index should indicate, what data should be used, criteria for species selection, the analytical methods as well as its interpretation and limitations. A series of recommendations and references for further reading are provided at the end of the document.

1. Introduction

1.1. The European Common Forest Bird Index

The European Common Forest Bird Species Index tracks trends in common forest bird populations across Europe using long-term monitoring data, primarily coming from PECBMS. Long-term and large scale bird monitoring schemes contributing to PECBMS use standardised field methodology, including rigorous sampling. Among others, they provide indices of relative population changes between years and long-term population trends. Birds are widely used as biodiversity indicators due to their broad distribution, sensitivity to environmental change, ease of monitoring, and public recognition. By integrating data from multiple countries, the indicator provides a European-scale perspective while supporting national-level assessments.

A key element is the selection of species. Included species are characteristic of forest ecosystems, represent major European forest types (boreal, temperate, Mediterranean), and are monitored with sufficient consistency and precision. Selection combines expert judgement with quantitative approaches such as specialization indices, or resource-use assessments. Some specialized or poorly monitored species remain underrepresented, reflecting limitations in current monitoring coverage.

The indicator is calculated as the geometric mean of species population indices, aggregated first at national and then at European levels, with weights reflecting population sizes. Calculations follow the Multispecies Indicator (MSI) method (Soldaat et al. 2017), in which species-specific indices are combined into a multispecies indicator. The program TRIM (TRends and Indices for Monitoring data; Pannekoek & van Strien 2005) is often used to generate these species trends, providing the statistical foundation for MSI. Optional smoothing can be applied to reduce annual fluctuations, while confidence intervals are derived from species indices and their standard errors, for example through bootstrapping. Indices are scaled relative to a base year, typically set at 100.

Trends in the indicator reflect long-term changes in forest bird communities. Declines may indicate habitat degradation, unsustainable forest management, or broader environmental pressures, while stable values suggest no major change. Increases may reflect habitat improvement, better forest management, or recovery after disease. Trends should also be interpreted considering large-scale drivers such as climate change.

The indicator offers several strengths: broad geographic coverage, cost-effectiveness through volunteer participation, a well-established methodology, and recognized policy relevance in EU and pan-European biodiversity strategies. It is therefore a flexible tool, supporting national, regional, and European-scale reporting.

Challenges include incomplete species coverage, limited monitoring capacity in some regions (particularly Eastern and Southern Europe), and complexity in interpreting trends, which may reflect factors beyond forest condition alone. Additionally, the index may be biased in the long term, as it is based on a fixed set of (formerly) common species. Rare species and new arrivals, which are not included in this set, may follow different trends, with new arrivals often showing an increase (Inger et al. 2015). Periodical assessment of the representativeness of the species selection is therefore

recommended. Nevertheless, the indicator provides a robust tool for assessing forest biodiversity and supporting conservation and management decisions across Europe. Furthermore, techniques for incorporating newly arriving species or accounting for disappearing ones also exist (see 2.3. Development of multispecies indicators).

1.2. National forest bird indicators

National Forest Bird Indices (FoBI) have been developed to describe the inter-annual changes in bird species populations that depend on forests and respond to environmental drivers. FoBIs are a valuable tool to track whether specific policies and the practices derived thereof help to mitigate negative changes in bird populations and overall forest biodiversity.

National FoBIs were already developed in many EU countries for biodiversity monitoring and reporting before the entry into force of the NRL in August 2024. National bird monitoring scheme coordinators in 17 EU MS produce national FoBI annually (Klvaňová 2023). In three countries (Austria, Germany, and Italy), FoBIs were produced annually for a certain period but were no longer updated. In five countries (Croatia, Cyprus, Lithuania, Romania, and Slovenia), the indicator was being prepared in 2023. In Ireland and Malta, both forest areas and breeding forest birds are so limited, that producing a forest bird indicator was considered as not informative.

The FoBI data source was always a national, long-term, generic bird monitoring scheme typically run by an NGO or an academic institution, often with governmental funding support. The schemes were managed by professional ornithologists responsible for the coordination of fieldwork, database maintenance and data analyses. Countries differed in the number of plots (sites or transects) where they monitor birds (i.e., the coverage), ranging from 210 plots in Luxembourg to 1837 in Germany, usually corresponding to the country's area. The schemes followed well-described, approved field methods for survey design and data collection (Brlík et al. 2016). Point counts (17 schemes) and line transects (11 schemes) were the most used monitoring methods, while territory mapping was used only in the Netherlands. Although monitoring methods differ, they were standardised, which ensured that the collected data were comparable among the countries.

Eleven of the 17 MS producing the FoBI annually published the indicator values online and made them publicly available. Most countries (19 out of 20 MS producing the FoBI regularly or irregularly) agreed to share the values and publish them via the PECBMS website, although four needed approval from their national governments. The main ornithological organisations running in Slovakia and Spain did not make the values publicly available due to the lack of funding from national governments.

The national FoBIs have been used by national policies in 14 EU MS; however, in many cases, the extent to which they have informed practical conservation actions has not always been well documented. FoBI updates have been regularly cited in internal and external publications and reports of national ministries or as an indicator in national biodiversity strategies and/or National Development and Sustainability Plans. Some national authorities have used the indicator in forest management policies (e.g., in Luxembourg).

1.3. The targets on forest restoration in the NRL

The NRL establishes area-based and indicator-based targets for different ecosystems (European Commission 2025). Here, we summarise some relevant general aspects of this regulation and those specifically associated with forests. The overarching objective of the NRL is the recovery of biodiverse and resilient ecosystems across EU Member States (MS), while contributing to climate change mitigation and climate change adaptation. Some elements in the legal text, particularly important to indicator design are the following:

- ***Restoration*** *is the process of actively or passively* ***assisting the recovery of an ecosystem*** *to improve its* ***structure and functions****, with the aim of conserving or enhancing biodiversity and ecosystem resilience.*
- ***Good condition*** *is a state where the key characteristics of the habitat type, in particular its structure, functions and typical species or typical species composition, reflect the* ***high level of ecological integrity, stability and resilience*** *necessary to ensure its long-term maintenance and thus contribute to reaching or maintaining favourable conservation status for a habitat.*
- *Restoration should improve the area of a habitat type to good condition, reaching* ***satisfactory levels*** *for the indicators referred to in the regulation.*
- *Member States shall put in place* ***measures*** *which shall aim to ensure that* ***areas in which good condition has been reached****, and in which the sufficient quality of the habitats of the species has been reached,* ***do not significantly deteriorate****.*
- ***National Restoration Plans (NRPs)*** *should* ***define the habitats and areas*** *that are not considered in good condition and* ***in which restoration will be focused****.*

The NRL sets out a series of obligations for Member States specifically concerning the restoration of forest ecosystems:

- *Member States (MS) shall put in place the* ***restoration measures*** *necessary to* ***enhance the biodiversity of forest ecosystems****, while considering the risks of forest fires (see NRL Annex VII).*
- *Member States should aim to* ***increase the diversity of native tree species*** *and* ***promote an uneven-aged forest structure****, including old-growth components such as large, old, and dying trees, as well as significant amounts of lying and standing deadwood.*
- *EU Member States should put measures in place to achieve an* ***increasing trend*** *in the* ***Common Forest Bird Index and*** *at least* ***6 out of 7 indicators*** *(e.g., Standing/laying deadwood, Share of forest with uneven age structure/dominated by native tree species, Forest connectivity, Stock of organic carbon, Tree species diversity).*
- ***Satisfactory levels*** *for indicators should be determined by 2030 based on scientific evidence. The Commission could provide guidance on how to define these indicators at national level.*

- *The **monitoring of the Common Forest Bird Index** shall be carried out every year (see NRL Annex VI). MS shall achieve an **increasing trend** at the national level of the Common Forest Bird Index **until satisfactory levels are reached**.*

2. Guidelines for developing national FoBI in the context of the NRL

This document presents guidelines designed to support the preparation and implementation of national FoBIs for National Restoration Plans (NRPs), addressing aspects from field data to species selection and the calculation of multispecies indicators. They are based on the general obligations established by the NRL but also aim to anticipate some situations that might arise in different countries and that could determine the development of the NRPs. It is important to note that although the use of FoBIs is nationally focused, the EU Commission will likely have to evaluate them. A high level of harmonisation among national FoBIs is therefore strongly advised to facilitate the assessment of results at the EU level.

2.1. Data

Data sources

The NRL asks for indicators showing the level of progress towards a target over time. Well-standardised bird surveys, repeated year after year in the same sites and using the same fieldwork protocols, are therefore the most appropriate data for the development of FoBIs. Breeding bird surveys are highly preferred since forest bird communities are usually more diverse, abundant and detectable during the breeding season, as many birds hold breeding territories (singing, calling or displaying). We strongly recommend generic breeding bird monitoring schemes (GBMs) from schemes included in PECBMS, because they have been shown to be reliable datasets in policy and research (PECBMS 2025). It should be mentioned that GBMs are also likely to be used to develop national Farmland Bird Indices (FBIs) for the monitoring of the farmland restoration achievements of the NRL.

While GBMs are strongly recommended, they might not always cover some rarer species adequately at the national level in some countries and habitats; this might include, e.g., rare, cryptic and nocturnal birds. Therefore, other complementary data sources of similar quality might have to be considered. For instance, highly structured data from online complete lists located in fixed sites with counted individuals could be a valuable complementary source of data for areas or species where GBMs fall short. Importantly, data from specific forest monitoring schemes could be particularly welcome to obtain abundance indices for some scarce species that are highly indicative of old-growth forests (including gamebirds, raptors, woodpeckers, owls, etc). In some cases, for species that are rare and occur in only a few locations, population estimates that can reasonably be treated as complete censuses may also be used. If this approach is adopted, clear criteria should be established to determine when an estimate can be considered a complete census. Depending on the situation, data from a given species could come from a single structured data source, or from a combination of different types of surveys (e.g., point counts, line transects; Rigal et al. 2023). TRIM can accommodate such heterogeneity in its modeling framework (Pannekoek & van Strien 2005). In all instances, careful inspection of the quality of the data is highly recommended before its integration into multispecies indicators.

Bird monitoring techniques based on passive acoustic monitoring (PAM) have been developed in recent years, along with automatic species identification using machine learning. While PAM appears to be a valuable method to detect the presence of vocal cryptic species, which are often more difficult to detect through GBMs or other schemes, reliably estimating the number of (breeding) individuals using this method has proven to be difficult. Identification errors and species-specific limitations in estimating population size pose additional challenges for the effective use of PAM. Therefore, using PAM as an extra source of data on single cryptic species may be possible, although the issue of reliably estimating population size must be addressed. However, fully replacing generic monitoring schemes with PAM is currently not feasible for the purpose of NRL. Similarly, the use of smartphone applications for bird identification by human observers in the field is not recommended for bird monitoring purposes due to the high proportion of identification errors derived from these tools.

Location of surveys

The NRL explicitly demands an increase in the value of the FoBI at the national level. This means that the aim is to evaluate whether forest restoration (focused mainly on degraded areas but also ensuring the non-deterioration of those in good condition) will influence the overall national trend of forest bird species, which serve as a proxy for forest biodiversity and health. It is therefore important to monitor the best-conserved forest stands in each country, where species indicative of old-growth forests are still thriving. At the other end of the forest quality gradient, tracking progress in the restoration of currently degraded areas also requires monitoring sites within those forests. As a general recommendation, data from all habitats in their present state could be included, since in principle any area may contribute to forest restoration, including some urban parks. A stratified design of field plots is recommended, and trend analyses should incorporate this information to generate robust and representative population trends. If the national FoBI is designed to cover population trends across the whole country (e.g., including urban areas or extensive farmland), a strong species selection (see below) is required to ensure that the indicator reflects forest conservation and restoration rather than other habitats and processes.

Coverage

According to the NRL, FoBI evaluations should start in the 2025 breeding season, as the law specifies that the baseline should be the first value of the indicator measured on or after the date of entry into force. It is therefore very important to have a sufficient number of survey sites for developing a FoBI that can robustly inform on the situation across the whole country. The NRL also points out that indicators should be monitored on a yearly basis. If annual capacity is limited to cover all required survey sites, a ‘jumping-site’ monitoring strategy can be considered, ensuring that all sites are surveyed at least once. Monitoring the objectives of the NRL is compulsory for EU MS, providing a legislative framework that supports and reinforces investment in forest bird monitoring at the national level.

Funding

To ensure the consistent delivery of reliable data on birds in the long term and to support proper NRPs implementation, public funding is essential, including in supporting the existing, robust and long-running bird monitoring schemes. Importantly, a long-term, well-functioning system securing sustainable funding for bird monitoring in the EU is still lacking in several MS and at the EU level.

2.2. Species selection

The NRL aims to reach a 'good condition' of forest habitats with a species composition contributing to a high level of ecological integrity, functionality, stability and resilience. According to the integrity concept, the number of forest species included in the FoBI should be as comprehensive as possible. Consequently, we suggest not removing species by some degree of redundancy (ecological, phylogenetic, etc.) to retain species trend data available for the analyses. The NRL indicates that bird species functions (e.g., seed dispersal, control of prey populations, builders of forest structure, food for others, etc.) should be adequately represented. Non-native forest bird species may have disruptive functions and, therefore, are poor candidates for FoBIs. On the other hand, long-distance migrants should be included, even though they spend part of their life cycle elsewhere. Studies have shown that actions aimed at boosting productivity, i.e., measures implemented at breeding grounds, are important for conservation of such species (Morrison et al. 2021). Importantly, bird species that depend on old-growth forests (specialists) should be also included. Including rare and locally occurring species should be possible, for e.g., by using additional species-specific monitoring data and by considering and altering sample size restrictions imposed on GBM data (but see implications of inclusion of rare species in 2.3. Development of multispecies indicators).

While the NRL sets some general aims, NRPs may clearly differ among EU Member States to reflect the national characteristics and differences of forests across Europe. For instance, in some countries, coniferous forests cannot be considered a target of restoration since they are a result of purely commercial forestry (everywhere or in part of the country). In these cases, bird species characteristic of pine and spruce forests should not be included in FoBIs (from all sites within a country, or just from a subset, in case of possible subnational differences in targeted forests to restore). Other situations may be promoted in NRPs, such as the enhancement of mixed forests, the opening of dense forest stands or the increase of structural diversity. Minimising the risks of forest fires will definitely be a critical issue, especially in southern Europe. Consequently, special attention should be taken in that regard when developing national criteria for species selection, and consider the development of complementary indicators when necessary (see below). National perspectives, however, should not contradict the general aims of the NRL, and harmonising forest species selection at the national level is desirable.

Forest biodiversity is changing rapidly. Given ongoing global environmental changes, the set of species included in the indicator may need to be updated in the future. For example, newly arriving species could be added once they have gone through the initial phase of establishment (which by definition concerns an increase) and reach a defined threshold. Periodically updating the species set in this way can help maintain the long-term robustness and representativeness of the indicator. However, caution is necessary and exploratory tests should be conducted to assess the impact of these changes on the indicator.

Quantitative methods

Scientists have developed quantitative methods to identify and quantify species-habitat associations, thereby supporting objective selection of species for multispecies indicators (see subsection 1.1. The European Common Forest Bird Index). Many of these methods combine appropriate bird and environmental data at a fine spatial resolution, with abundance data often preferred over mere occurrence. Caution is needed with coarse-resolution analyses (e.g., 10×10 km grids over long time periods), which may fail to capture fine-scale relationships between bird abundance and habitat, especially in mosaic or dynamic landscapes. Other approaches rely on ecological knowledge of species-forest relationships without spatially explicit data. Regardless of

the method, national borders rarely match species' ecological distributions, and data availability may be limited; in such cases, international collaboration can strengthen analyses. Metrics that quantify species' habitat preferences and use can provide standardized, quantitative insights to guide species selection and the interpretation of multispecies indicators (e.g., Jiguet et al. 2012, Julliard et al. 2006, O'Reilly et al. 2022).

Expert assessment

Selection of habitat-characteristic species can also be based on expert judgement, but this approach is recommended only when quantitative methods are not feasible. Expert-based selection is inherently subjective and may be influenced by individual perspectives. If this method is used, forming a committee of experts to collectively define criteria and select species for FoBI is recommended. International exchange of expertise can also be valuable, and EBCC/PECBMS is available to provide guidance and support where possible.

Regardless of the method applied to select the set of species included in the indicator, we strongly recommend expert validation of the results from any quantitative or qualitative approach to ensure that the outcomes are meaningful and consistent with ecological knowledge.

2.3. Development of multispecies indicators

The NRL provides a general perspective on what forest indicators, including the FoBI, should indicate in terms of restoration. Despite the regulation containing few ecological details, we can assume that these indicators are selected to measure key elements of ecosystem health or functioning. Consequently, they include birds as a proxy of ecosystem condition, because the available data is relatively strong and accumulated research shows its indicative power, although birds are not necessarily the 'perfect' indicator species.

Multispecies bird indices (MSI) have usually been developed to inform on the changes in the general state of the ecosystem by means of integrating species population trends. Numerous indicator approaches have been used to describe changes in biodiversity, some better than others (van Strien et al. 2012). The geometric mean of relative abundance indices has been extensively used for its favourable mathematical properties (van Strien et al. 2012). Ideally, the indicator should be able to cope with the situations when species disappear from the indicator set (species becomes locally or nationally rarer or extinct) or when a species appears as a new component in the indicator (typically species recovering in numbers and recolonising areas). The geometric mean can be highly influenced by these extreme cases, failing when species become extinct or new species appear. Alternatives to the geometric mean have been explored to minimise the influence of random variation in the abundance of rare species, and to include newly arriving or disappearing species, which could be very relevant over longer time periods (Korner-Nievergelt et al. 2022).

In many cases, the choice of mathematical approach will have little effect on national MSIs. Given its wide application, we strongly recommend the use of the geometric mean and the MSI method, standardized through the MSI-tool developed by Statistics Netherlands (Soldaat et al., 2017). This tool ensures consistency in MSI creation and includes built-in rules to reduce the influence of highly variable species trends. When very rare species with limited data are included, particular attention should be given to their effect on the indicator results and their potential to introduce bias. In such cases, alternative approaches, such as those described by Korner-Nievergelt et al. (2022), may be more appropriate.

Since the regulation entered into force in August 2024, the NRL requires the FoBI to be generated from the 2025 breeding season onwards, which will likely be set to the reference value (e.g., 100). Therefore, exploratory analyses using data accumulated prior to this starting year are highly recommended. Evaluating the influence of individual species on the aggregated indicator is one useful way to gain insight into indicator robustness.

Satisfactory values

Forest bird indicators can serve as traffic lights for ecosystem condition, with higher values reflecting better condition. A key feature of these biodiversity indices is their role as an 'early warning system', quickly signaling when conditions substantially deteriorate, therefore allowing timely management responses. However, setting specific targets (satisfactory values) can be particularly difficult in FoBIs. Just for comparison, setting targets in Farmland Bird Indices (FBI) could be more straightforward, because the depletion of farmland bird populations has happened in recent decades, and a past reference for good, or at least 'better' condition, can be more or less quantified (see specific index values targeted for FBI in the NRL). For forest ecosystems, ups and downs often occur over a longer time scale. Finding appropriate past references can be challenging and are prone to be subjective. Therefore, it must be acknowledged that setting satisfactory levels of FoBI is difficult, as there is little or no quantitative information on bird populations from periods when forests in Europe were in good condition. Given that satisfactory values should be established by 2030, further research is definitely needed in the forthcoming years to try to determine methodologies for satisfactory levels of FoBI. This may include, for example, modeling past forest bird abundances or projecting future trends under different scenarios in line with the IPBES Nature Futures Framework, as well as compiling data from remaining pristine or intact forests (or other targeted habitats) to derive recommendations at the national level. These may contribute to further EC guidelines on this subject which are anticipated to be developed.

Complementary indicators

We recommend establishing a main FoBI for the NRL per country for its importance in the evaluation of the overall regulation achievements (policy impact) and for the importance in dissemination (public awareness). However, developing a set of complementary indicators could be appropriate to better understand changes experienced during the implementation of the regulation and to place changes in the context of wider environmental change. Here, we describe a few situations for which complementary indicators could be potentially useful.

- **Diverse forests or multiple aims of forest restoration.** NRPs will definitely vary among EU countries for forest ecosystems despite the common umbrella of the NRL. Within a country, restoration plans could also differ depending on the forest type, and the targeted bird communities can consequently differ. In some cases, broadleaved (but not coniferous) forests could be promoted. In other cases, different aims could be set for primeval and production forests, for which the NRL establishes that the proportion of uneven-aged structure should be increasing (see Annex VI of the NRL). In addition, fire regimes could impose different strategies, with open woodland promoted in the areas of higher risk and canopy-closed forests in others. Decisions taken in NRPs cannot be anticipated in this document, but such differences will likely occur and the indicators should accommodate the evaluation of the NRPs. Developing several complementary indicators could therefore be a promising approach within the expected complexity.

- **Coexistence with the current forest bird indicators.** As shown in 1.2. National forest bird indicators, many organisations have developed their own forest bird indicators before the approval of the NRL. This has likely influenced the inclusion of a Forest Bird Index in this regulation. Previously developed indices may not necessarily be consistent with the objectives of NRPs and, accordingly, their results may not be directly applicable in this specific context. Therefore, it is very important to clearly communicate what are the aims of the different forest bird indicators and how they complement each other. In these cases, we recommend reporting them with different names and acronyms. Adapting the production of previous forest bird indicators to strengthen the role of FoBI under the NRL could also be considered.

- **Favourable Conservation Status.** One potential criticism of indicators based on the geometric mean of population indices, or similar approaches, is the difficulty of defining satisfactory target values. An alternative, complementary indicator could focus on the proportion of species whose populations are in a satisfactory conservation condition. Since the NRL aims for species listed under the Habitats and Birds Directives to achieve Favourable Conservation Status (FCS), the Favourable Reference Value (FRV) developed at the national level for birds, similarly than for other taxa in the framework of Article 17 reporting under the Habitat Directive, could be useful. The logic is straightforward: if a species is above its FRV, it is considered to have FCS (green status: index 100); if it exceeds that value, there is no further need for population increase from a conservation perspective, so the maximum can be set at 100. A composite indicator in which 100 represents all species in FCS could thus reflect the achievement of the goal of favourable status for all species. This approach, which focuses on the status of bird populations rather than on overall ecosystem condition, it is currently under development in the Netherlands (Bijlsma et al., 2019). However, this complementary indicator implies that a FRV for each forest bird species should be calculated first at the national level.

2.4. Documentation

The different decisions and steps taken for the selection of FoBI at the national level should be carefully documented for a proper interpretation of the results at the national level and for comparability at the EU level. Transparent documentation also facilitates future updates of the indicator and increases its credibility in policy contexts. In particular, we strongly recommend documenting:

Species selection process
The criteria and procedure used to select species for the indicator, including any thresholds applied (e.g., minimum data availability, habitat specificity) and, if applicable, the quantitative methods used to prioritise or exclude species.

Indicator construction
The methods used to build the MSI (or any other indicator), including data handling, standardisation, and aggregation. Clear documentation of these choices is essential to ensure reproducibility.

Complementary indicators
Whether additional forest-related indices are generated (e.g., for habitat types or different aims of the NRPs), how they are calculated, and how these relate to or differ from the FoBI.

Data coverage and quality considerations
Information on spatial and temporal coverage of the data, as well as known biases or limitations (e.g., underrepresentation of certain habitats or regions). This provides important context for interpreting national trends.

Updates and revisions
A description of how the indicator will be updated (e.g., adding habitats or species, refining methods) and how these revisions will be communicated over time.

3. How to interpret the indicator

The forest bird indicator is a valuable tool for tracking biodiversity trends and guiding national restoration planning. However, it should be interpreted with caution, taking into account several important limitations:

1. Species coverage is incomplete
Monitoring schemes typically provide the most reliable data for widespread and common species. However, rare, cryptic, nocturnal, or habitat-specialist birds are often under-represented. In some cases, data on such species can be obtained through targeted species-specific monitoring, allowing their inclusion in complementary indicators (e.g., as extensions of the current FoBI). If this is not possible, their absence from the FoBI means that the indicator should not be considered a comprehensive representation of all national forest avifauna.

2. Uneven geographical and habitat representation
Some areas and habitats are better covered than others. For example, dense forests in remote regions are often more difficult to survey. This may result in trends being more representative of accessible or well-monitored areas, rather than the entire national territory.

3. Variation in data quality
Differences in survey methods, observer effort, and monitoring capacity between MS can affect the consistency of the indicator. Harmonisation procedures reduce but do not eliminate these issues, and results should always be viewed in light of potential data heterogeneity.

4. Temporal consistency matters
Long-term monitoring is a key strength, yet data series may include interruptions or methodological changes. These can generate artificial fluctuations that should not be misinterpreted as ecological signals. The application of appropriate statistical methods to account for such methodological changes is key for accurate index calculation. Combining data from different monitoring schemes is often possible, but may not be straighforward. It is advisable to consult the PECBMS coordination team, who already have experience with such data integrations .

5. Indicator reflects relative, not absolute, abundance
The indicator shows relative changes over time rather than variation in total population sizes. A stable trend in the index does not necessarily imply that all populations are secure; local declines may still be occurring, and some species may mask the trajectories of others.

6. Birds are proxies, not the whole picture
While birds are effective indicators of wider biodiversity and ecosystem health, they cannot capture all ecological dimensions. For robust restoration planning, the bird indicator should be considered alongside complementary non-bird indicators, as indicated in the NRL.

Take-home message: The indicator is most powerful when interpreted as a broad measure of ecosystem condition and biodiversity trend. Member States should use it to identify general priorities and evaluate progress, while recognising its limits and complementing it with additional evidence (e.g., habitat assessments, other taxa, local monitoring). Communicating these caveats transparently will ensure the indicator supports effective, credible, and scientifically grounded restoration planning.

The following section provides a summary of the recommendations reported in this document for applying the indicator in national restoration plans.

4. Summary of recommendations

Member States are encouraged to develop national forest bird indicators (such as the FoBI) in line with the requirements of the NRL. FoBI should be indicative of the level of achievement of the NRPs at the national level, not only in forests under restoration. In countries with very limited forest cover and low opportunities to be restored, producing a meaningful FoBI may not be feasible. Knowledge on how to develop these indicators is mostly available at national level, and further assistance from the EBCC and BirdLife International is developed in these guidelines.

The production of FoBI requires proper monitoring data. We strongly recommend using data from generic monitoring schemes (GMS), complemented where necessary with data from other protocols to cover bird species indicative of the process of forest restoration that are not well covered by GMS. Adequate spatial and habitat coverage of the data are key elements for a robust assessment of the achievements of the aims of the NRL. All forest types should be monitored. The non-degradation is an important component of the regulation and thus all forest types should be consistently monitored, with special attention to remaining well-conserved forests.

The process of selecting bird species characteristic of forest types targeted in NRPs is particularly important. Forest restoration aims may differ among countries, and careful attention should be paid to the targeted forests when selecting the set of species indicative of restoration progress. Bird species selection could be preferably done using well-established methods that quantify species' habitat preferences. Results from species selection, regardless of the method used, should always be validated by experts to ensure they are meaningful and consistent with ecological knowledge. To meet NRL obligations, NRPs may need to increase the number of species included in current FoBIs, which may require rethinking certain aspects of the indicators. It should also be noted that the NRL requires bird indicators to be generated from 2025 onwards; therefore, exploratory analyses using data accumulated before this starting year are highly recommended.

Member States should ideally follow the established Wild Bird Index (WBI) methods that have been developed, tested and published, and which have been adopted as official indicators at both national and international levels, including by the Convention on Biological Diversity (CBD). Using these standardized methods ensures comparability,

robustness, and credibility of the indicators. We recommend the use of the geometric mean and the MSI-tool approach, using confidence intervals to support robust trend assessment. However, caution should be taken to determine the potential impact of the inclusion of forest rare species, which in some cases could be very good candidates to be included in the indicator. Careful exploration of available data is highly recommended before the delivery of FoBI for NRL. Decisions and steps taken at the national level should be well documented.

Considerable insight can be gained by evaluating the contributions and trends of individual species within the indicator. This allows a more nuanced interpretation of overall trends, helps identify species-specific responses to management or environmental changes, and can guide targeted conservation actions. Furthermore, where data allow, presenting FoBIs separately for different forest habitats can provide additional understanding of habitat-specific trends and the effectiveness of management actions.

FoBI is most powerful when interpreted as a broad measure of ecosystem condition and biodiversity trend. Member States should use it to identify general priorities and evaluate progress, while recognising its limits and complementing it with additional evidence (e.g., habitat assessments, other taxa, local monitoring). Transparent communication of these caveats will ensure the indicator supports effective, credible, and scientifically grounded restoration planning.

We recommend developing a main FoBI to inform on the achievements of the NRPs based on the indicative power of bird species. However, complementary indicators could be important to inform on diverse forest habitats or multiple aims of forest restoration. The establishment of satisfactory values of the indicator will be requested by the EU Commission by 2030. This has proven to be difficult and further research will be needed on this regard.

Aligning national indicators with a European framework could support a robust EU reporting and proper evaluation of national restoration and conservation efforts. Therefore, harmonising FoBI among Member States is highly recommended for evidence-based policy decisions at EU level.

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