BIODIVERSITY BUILDING BLOCKS FOR POLICY

D6.4 Report on the stakeholder driven case study

Optimising species assessment and reporting of the Habitats Directive in Europe

31/07/2026

Authors: Ana Luísa Machado, Heliana Teixeira, Rocìo Cortès Lobos, Rui Pinto, Lina Maria Estupinan-Suarez, Cristina Preda, Nadya Denkova, Andrew Rodrigues, Quentin Groom

Funded by the European Union

Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the EU nor the EC can be held responsible for them.

Prepared under contract from the European Commission
Grant agreement No. 101059592
EU Horizon Europe Research and Innovation Action

Project acronym:	**B3**
Project full title:	**Biodiversity Building Blocks for policy**
Project duration:	01.03.2023 – 31.08.2026 (42 months)
Project coordinator:	Dr. Quentin Groom, Agentschap Plantentuin Meise (APM)
Call:	HORIZON-CL6-2021-GOVERNANCE-01
Deliverable title:	Report on the stakeholder driven case study
Deliverable n°:	D6.4
WP responsible:	WP6
Nature of the deliverable:	Report
Dissemination level:	Public
Licence of use:	CC-BY
Lead partner:	UAVR
Recommended citation:	Machado AL, Teixeira H, Cortès Lobos R, Pinto R, Estupinan-Suarez L, Preda C, Denkova N, Rodrigues A, Groom Q (2006). ***Report on the stakeholder driven case study: Optimising species assessment and reporting of the Habitats Directive in Europe***. B3 project deliverable 6.4
Due date of deliverable:	Month n°41
Actual submission date:	Month n°41

Deliverable status:

Version	Status	Date	Authors
1.0	Draft	17 July 2026	Ana Luísa Machado (UAVR), Heliana Teixeira (UAVR), Rocìo Cortès Lobos (UNIBO), Rui Pinto (UAVR), Lina Estupinan-Suarez (MLU), Cristina Preda (UOC), Nadya Denkova (PEN), Andrew Rodrigues (GBIF), Quentin Groom (APM)
1.1	Internal Review	27 July 2026	Yanina V. Sica, Nikol Stoykova, Toon Van Daele
1.2	Final	29 July 2026	Ana Luísa Machado (UAVR), Heliana Teixeira (UAVR), Rocìo Beatriz Cortès Lobos (UNIBO), Rui Pinto (UAVR), Lina Estupinan-Suarez (MLU), Cristina Preda (UOC), Nadya Denkova (PEN), Andrew Rodrigues (GBIF), Quentin Groom (APM)

Table of contents

Key takeaway messages 5
Executive summary 5
Non-technical summary 6
List of abbreviations 6
1. Introduction 7
2. Stakeholder engagement 7
2.1. Initial stakeholder consultation 7
2.2. Workshop on Habitats Directive Reporting and GBIF Data Integration 9
2.2.1. Workshop Overview 9
2.2.2. The use of GBIF by Member States and European Institutions 10
2.2.3. Workshop discussion and stakeholder feedback 15
2.2.4. Main conclusions from the workshop 17
3. Species level assessment under Habitats Directive 17
4. GBIF occurrence cubes and indicators for Habitats Directive – a reproducible Workflow 20
4.1. Selected datasets 21
4.1.1. Taxonomic dimension 21
4.1.2. Spatial scale 22
4.1.3. Temporal scale 23
4.2. Data ingestion 24
4.2.1. rgbif Data Ingestion – Module 1 24
4.2.2. GBIF SQL API – Data ingestion Module 2 24
4.2.3. Cubit ShinyApp – Data ingestion Module 3 25
4.3. Quality evaluation 26
4.3.1. **Dubicube:** Calculation and Interpretation of Data Cube Indicator Uncertainty 26
4.3.2. Temporal degradation 28
4.4. Data analysis 31
4.4.1. Occurrences trends 31
4.4.2. Sample completeness 32
4.4.3. Species distributions 34
5. Conclusions 37
6. Acknowledgements 38

7. References 39
8. Annex 41

Key takeaway messages

- Stakeholders identified species-level assessment and reporting under Article 17 of the Habitats Directive as a priority policy challenge, highlighting the need for more reproducible, consistent, and efficient reporting workflows.
- Occurrence data available in GBIF can effectively complement monitoring schemes by providing valuable evidence for mapping species distributions and ranges, although biases limit their use for assessing population trends.
- B3 developments demonstrate that open biodiversity data can be integrated into species-level assessments through standardized and reproducible workflows, supporting both national reporting and European-level assessments.
- The developments are timely in the context of the European Commission's ongoing Birds and Habitats Directives Stress Test, demonstrating how the complementary use of open biodiversity data can strengthen species-level assessments under the Habitats Directive, particularly in Member States with less developed monitoring programs.

Executive summary

Deliverable 6.4 "Report on the stakeholder driven case study - Optimising species assessment and reporting of the Habitats Directive in Europe" is a report prepared under Work Package 6 "Implementing use cases", in particular Task 6.4 "Stakeholder driven case study". Coordinated by the University of Aveiro (UAVR) in collaboration with the partners Global Biodiversity Information Facility (GBIF), Martin Luther University of Halle-Wittenberg (MLU), Ovidius University of Constanta (UOC), Pensoft (PENSOFT), Meise Botanic Garden (APM) and University of Bologna (UNIBO), the objective of this deliverable is to demonstrate the applicability of B-Cubed (B3) developments to support reporting on biodiversity policy through a stakeholder-driven case study focused on species-level assessment and reporting under Article 17 of the EU Habitats Directive.

The case study was designed through a co-creation process that took place in T1.5, involving European and national stakeholders responsible for biodiversity monitoring, data management, research, and policy implementation. Their input identified species assessment and reporting under Article 17 of the Habitats Directive as a high-priority policy challenge, particularly regarding data integration, methodological consistency, and the efficient production of national and European assessments.

The case study addresses these challenges by evaluating how B3 developments can improve the use of open biodiversity data, particularly records available through the GBIF, within the Habitats Directive reporting workflow. Although the GBIF provides large volumes of species occurrence data, concerns regarding data quality, sampling bias, and fitness for policy applications have limited its uptake in official reporting. B3 tackles these limitations by providing reproducible workflows for assessing data biases, standardizing data processing, and generating biodiversity indicators that facilitate the integration of open biodiversity data into policy-relevant assessments.

Overall, the results of this case study demonstrate how B3 developments can contribute to species-level assessment by delivering reproducible workflows that use GBIF occurrence data to complement Article 17 reporting and estimate changes in species distribution across successive reporting cycles, thereby supporting both national reporting obligations and the harmonization of species-level assessments at the European level. In doing so, it contributes to increasing confidence in the use of open biodiversity data and promotes more efficient and evidence-based implementation of the Habitats Directive. These developments are particularly timely in the context of the European Commission's ongoing Birds and Habitats Directives Stress Test, which seeks to simplify and digitalise biodiversity assessments while maintaining robust scientific evidence.

Non-technical summary

This report presents a case study developed within the B3 project to explore how open biodiversity data can better support nature conservation policy in Europe. The case study focuses on the EU Habitats Directive, one of the main legal instruments for protecting Europe's most threatened species and habitats.

The case study was developed together with policy-makers, biodiversity experts, and data managers to address practical challenges in species assessment and reporting. Stakeholders identified the need for more efficient and consistent reporting workflows and, while also highlighting concerns about the use of openly available biodiversity data in official policy processes.

B3 demonstrates how standardized workflows can help integrate species occurrence data from the Global Biodiversity Information Facility (GBIF) into reporting under the Habitats Directive. By improving data processing and making analytical workflows reproducible, B3 supports both national species-level assessments under the Habitats Directive and their harmonization at the European level.

Overall, the case study shows how open biodiversity data, when processed through robust and transparent workflows, can strengthen evidence-based decision-making and increase confidence in the use of open biodiversity data for European conservation policy.

List of abbreviations

GBIF	Global Biodiversity Information Facility
EAA	European Environmental Agency
ETC	European Topic Centre
EU	European Union
HD	Habitats Directive
MS	Member States

1. Introduction

Use cases representative of real case scenarios aim to validate the relevance, usability, and impact of developments by the Biodiversity Building Block for policy Horizon Project (B3). Each use case contributes to assessing: (a) the capacity of newly developed B3 indicators to capture key biodiversity aspects relevant to specific policy contexts; (b) the ability of B3 workflows to generate outputs aligned with the spatial, temporal, and thematic needs of stakeholders; and (c) effective approaches for communicating outputs in a policy-relevant and user-friendly manner.

This report demonstrates the application of B3 developments in a pan-European stakeholder-driven case study, defined through a prior stakeholder consultation process (B3 Deliverable D1.5), during which participants were asked to identify key challenges and needs related to the implementation of EU biodiversity legislation. Based on this consultation, the EU Habitats Directive 92/43/EEC species-level assessment was selected as the focal policy reporting context, leading to the definition of the work here presented. This case study aimed to "***Optimise species assessment and reporting of the Habitats Directive in Europe***", both from a top-down perspective, *i.e.*, from the needs of European Institutions and Agencies that receive and integrate national and biogeographic region assessments, as well as, from a bottom-up perspective, *i.e.*, attending to the challenges of countries that need to report cyclically under the Habitats Directive. This policy context is particularly relevant in the light of the European Commission's ongoing Birds and Habitats Directives Stress Test, which is evaluating opportunities to simplify and digitalise the implementation of the Nature Directives while maintaining robust scientific evidence for biodiversity assessments.

To achieve this, we focused on assessing the performance of B3 developments in improving biodiversity reporting under the Habitats Directive through supporting:

- **National reporting**, by enhancing the data coverage through the integration of species occurrences open data, and the reproducibility, consistency, and automation of species-level assessments reported by Member States to the European Environment Agency; and

- **State of Nature overview**, by enabling large-scale evaluation of species distribution and spatial-temporal trends detection, improving the integration of national reports across biogeographic regions, and thereby strengthening coherence, comparability, and compliance of the assessments at EU level.

2. Stakeholder engagement

2.1. Initial stakeholder consultation

The aim of our tailored co-creation process was to illustrate the adaptability and full potential of B3 workflows to meet policy requirements. As such, a co-designed stakeholder-driven case-study was envisaged to respond directly to user needs co-identified through the **initial stakeholder consultation** carried out as part of Task 1.5 of the B3 project (Estupinan-Suarez *et al.*, 2025).

By means of interviews with 17 participants with relevant backgrounds and complementary roles in biodiversity policy implementation at EU Governmental Office/Agencies, National Agencies, Data Managers, Research Institutes and Academia experts, we gathered opinions on biodiversity data gaps, bottlenecks, data flows, and science-policy interface challenges. The interviews helped to identify the most critical needs related with biodiversity monitoring, assessment and reporting that could be tackled by the B3 planned developments. Suggestions for potential focus spanned from taxon-specific gaps and requirements, drivers of change and different environmental policy instruments (Table 1). The selection of the case study was driven by the policy relevance of the topic, as well as the potential to leverage the use of the GBIF data within a policy context.

Table 1. Approach to select a stakeholder driven case study, from initial consultation: summary of potential scope and development focus.

Case study	Policy relevant	Global	Regional /Local	GBIF data	High quality data	Overlap with other initiatives	Potential focus:
Aquatic case studies (freshwater)	X		X		X		• Benthic communities • Algae blooming
Habitat Directive (Species Asse.)	X		X		X	Partially	Unbalanced information of species distribution between country member. SDMs for missing countries
Pollinators	X		X		X	X	Butterfly index
Soil data analysis	X		X		X		A soil biodiversity atlas for Europe using species distribution models, taxonomic expertise but not data infrastructure https://www.eudaphobase.eu
Zoonotic diseases	X	X		X		Partially	Risk of wild-life diseases transfer

Several stakeholders identified gaps and needs for improving Assessment and Reporting under Article 17 of the Habitats Directive 92/43/EEC, particularly in assessments and reporting by some Member States (MS) and inconsistencies in assessment methods. The core of the Article 17 report is the assessment of conservation status of the habitats and species targeted by the Directive. The assessment is made based on information on status and trends of species populations or habitats and on information on main pressures and threats. For the species level assessment, "*all relevant species of a Member State in accordance […] check-lists in the online Article 17 reference portal*" should be considered, which currently amounts to over 1500 species across all biogeographic regions every reporting cycle.

The monitoring effort that this policy requirement entails, and the conclusion from the latest EEA State of Nature in EU Report (Röschel *et al.,* 2020) that only 27% of non-bird species have a 'good' conservation status, make the case for considering evidence from all available complimentary data sources. Open, standardised data, such as that in GBIF, accelerates science, saves resources, and supports urgent action on conservation (Groom et al., 2026a).

Nevertheless, the stakeholder consultation revealed that data available through GBIF are still rarely considered in Article 17 reporting by many MS (Table 1). This was largely due to concerns regarding their trustworthiness and suitability for policy applications.

Given this context, the Habitats Directive 92/43/EEC (HD) was selected as the main Policy target of this stakeholder driven case study, aiming to facilitate national reporting obligations by MS, while at the same time supporting European institutions and agencies (e.g., EEA, EEA-ETC) evaluating coherence of national reports within biogeographical regions and supporting large scale analysis of, for example, the effectiveness of Natura 2000 sites across Europe.

This case study is expected to increase stakeholders' confidence and literacy regarding the integration of data hosted by the GBIF. Although large volumes of biodiversity data are available, they are often fragmented, inconsistent, and difficult to integrate efficiently, which poses a challenge for policy-makers. B3 developments aim to deliver actionable, reproducible, and scalable insights for policymakers and stakeholders, through leveraging open data through automated, interoperable data pipelines and workflows (Groom et al., 2026b). Ultimately, it will also contribute to enhancing the mobilisation and accessibility of biodiversity data into FAIR compliant formats.

A **second consultation event** (24 March 2025) took place in the project mid-term, already with a focus on the Habitats Directive species level assessment, which invited NGOs, regional and national agencies in Germany, directly monitoring and reporting for biodiversity and the HD, and the European Topic Centre (ETC) colleagues, working on the Natura 2000 data flows and sufficiency assessments. In two break-out group sessions, we discussed current data challenges (*e.g.*, new reporting elements and format, disconnected databases, species check lists update, public versus private data mobilisation, EU institutions access only to MS aggregated data) and the role of standardised data in overcoming such challenges, setting the scene for this case study developments.

2.2. Workshop on Habitats Directive Reporting and GBIF Data Integration

2.2.1. Workshop Overview

As part of the B3 stakeholder-driven case study, a **third consultation event** (23 June 2026) was organised to present and receive feedback on the developments of B3 for the previously co-identified HD challenges. The online workshop had 32 participants from MS representatives, GBIF National Nodes, EU institutions, biodiversity data experts and B3 partners. The workshop was designed to inform the development and validation of reproducible workflows for integrating GBIF data into HD Article 17 reporting processes.

The discussion focused on the role of biodiversity data infrastructures in supporting national reporting obligations and improving the evidence base for policy implementation. Attention was given to barriers and enabling conditions for the operational use of GBIF data within existing

reporting workflows, as well as to opportunities for automating indicator generation and improving the timeliness of biodiversity assessments.

Within the scope of the stakeholder-driven case, the workshop contributed to testing the adaptability of B3 workflows in a real-world policy context. It also served as a platform to demonstrate how automated and reproducible indicator pipelines can support biodiversity assessments, strengthen reporting under HD consistency across MS, and enhance the use of biodiversity data in environmental governance. These elements directly contribute to one of the core objectives of the B3 project: improving the uptake of biodiversity data infrastructures in policy-relevant workflows.

The main objectives of this workshop were to:

- Present B3 tools and biodiversity data cubes workflows for streamlining the integration of data in GBIF into HD species level assessments.
- Assess the current use of data in GBIF and GBIF infrastructure in national Habitats Directive reporting across MS.
- Identify technical, institutional, and legal barriers to integrating biodiversity data in GBIF into national reporting.
- Exchange national experiences and existing reporting approaches.
- Explore the potential of automated and reproducible workflows developed within B3 for reporting.
- Strengthen collaboration between MS, GBIF national nodes, EEA, and relevant research infrastructures.
- Develop recommendations for policy and infrastructure improvements.

2.2.2. The use of data in GBIF by Member States and European Institutions

As part of the preparatory phase of the third (?) stakeholder's workshop, a short **questionnaire** was circulated to participants, prior to the event. The aim was to capture baseline information on the current use of data in GBIF for the HD reporting, as well as to identify perceived barriers, integration practices, and data quality considerations.

Apart from the target audience characterization, namely the participant's Institution or Organization, the role in which the participant is attending the workshop, and the country of their institution. The questionnaire also deepened the knowledge around the current state of the art regarding the reporting process under HD Art. 17 species assessment level. The participants were asked about:

1. Whether their institution considers or integrates data from GBIF into national reporting for the Nature Directives, namely HD species-level assessments;
2. Which are considered the main barriers to using data available in GBIF, in the case where they are not using it;

3. Infrastructure limitations to integrate data in GBIF with national data;
4. The existence of national legal constrains to the use of additional data;
5. The level of awareness of the potential of data in GBIF for the HD species level assessment;
6. The distrust or concerns regarding the quality of data in GBIF;
7. How is data in GBIF integrated with national data for the reporting, for those using it;
8. And, whether they follow a data quality evaluation procedure in which they address biases and uncertainty in relation to data in GBIF during their national reporting and assessment processes, for example, by selecting and filtering data, statistical analysis.

The results (n = 10) provide an overview of the heterogeneity of practices across MS and institutions involved in biodiversity reporting and highlight key constraints and opportunities for the integration of GBIF information into operational reporting frameworks.

In terms of participants' roles, most respondents identified as national representatives involved in HD reporting (n=4), followed by GBIF National Node representatives (n=2), EU institutions or agencies using national reporting data (n=1), and other stakeholder roles (n=3) (Figure 1).



Figure 1. Distribution of participants' roles within their institutions, based on responses to the pre-workshop questionnaire.

Participants were geographically distributed across five countries. Portugal represented the largest share of respondents (n=4), followed by Sweden (n=3), while Belgium, Denmark, and France each had one respondent (n=1) (Figure 2).



Figure 2. Geographic distribution of workshop participants by country.

Regarding the integration of data in GBIF into national reporting workflows, responses were evenly split. Fifty percent of respondents indicated that their institutions already consider or integrate data in GBIF into HD Art. 17 reporting, while the remaining 50% reported no current use of GBIF (Figure 3). This suggests an uneven level of operationalisation across MS and institutional contexts.

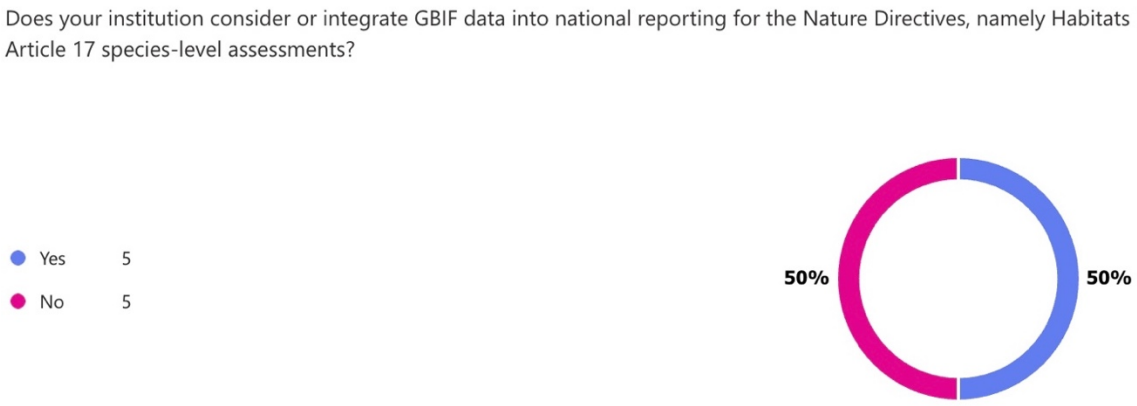


Figure 3. Proportion of respondents indicating whether their institution integrates GBIF data into national reporting under the Habitats Directive (Article 17).

Among respondents (n=5) not using data in GBIF in HD reporting workflows, the main barriers identified (Figure 4) were lack of awareness of the potential of data in GBIF (n=3) and distrust or concerns regarding data quality (n=3). Infrastructure limitations for integrating GBIF and national datasets were less frequently reported (n=1).

A substantial proportion of responses (n=4) fell under “Other”, which could be grouped into three main themes: (i) limited availability of capacity and intermediate tools to support data integration; (ii) high methodological and documentation requirements in scientific reporting, including the need for detailed validation; and (iii) institutional and governance constraints, particularly related to data sensitivity, limited resources, and challenges in translating national databases into interoperable standards such as Darwin Core.

Overall, the results indicate that barriers extend beyond technical integration issues and are strongly linked to institutional capacity and reporting requirements.



Figure 4. Main barriers to the use of GBIF data for national reporting.

Among respondents already using data in GBIF, the most common integration approach was the use of selected GBIF records to fill gaps in national datasets (n=3). A similar number (n=3) selected "Other", indicating that integration practices vary across institutions and projects, with workflows often tailored to specific reporting needs. The use of independent reproducible workflows was reported by two (n=2) of respondents, while only one (n=1) indicated that integration is carried out in coordination with the GBIF National Node (Figure 5). None of the respondents reported integrating all available data in GBIF or using independent integration without a specific workflow.

Overall, the results suggest that data in GBIF are primarily used to complement national datasets rather than as a standalone source, with integration approaches remaining heterogeneous across institutions.

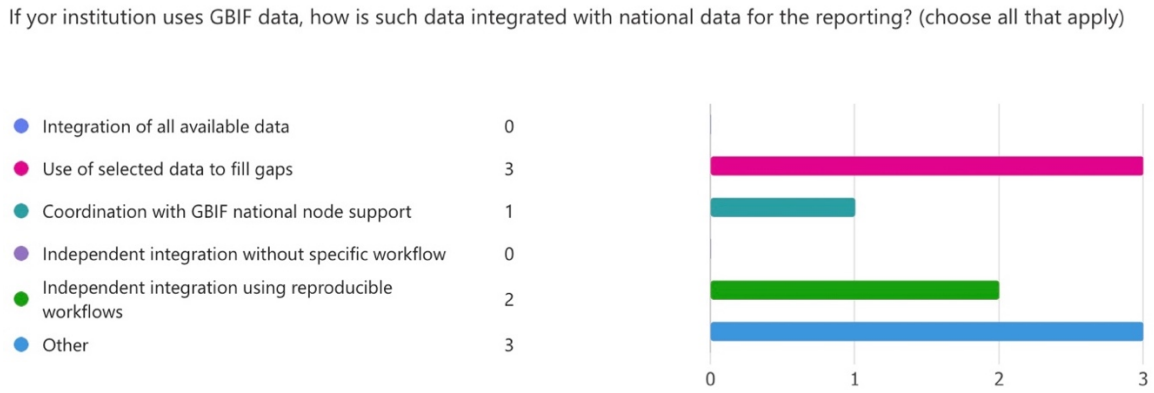


Figure 5. Approaches used by institutions to integrate data in GBIF with national datasets for reporting.

Responses regarding the treatment of bias and uncertainty in data in GBIF showed that four respondents (n=4) reported including a data evaluating step in their reporting and assessment processes, whereas three (n=3) indicated that uncertainty is not currently addressed (Figure 6).

Among those conducting data quality assessment, the approaches described can be grouped into three categories: (i) technical validation of datasets, including verification of data structure (e.g. schema validation); (ii) expert-based validation of records, such as verification at the author and/or coordinate level; and (iii) quality assessment as part of the broader conservation status assessment process. One respondent also noted that source dataset selection is based on expert judgement using non-standardised criteria.

Overall, the responses suggest that data quality assessment practices vary across institutions and rely primarily on institution-specific procedures rather than harmonised methodologies.

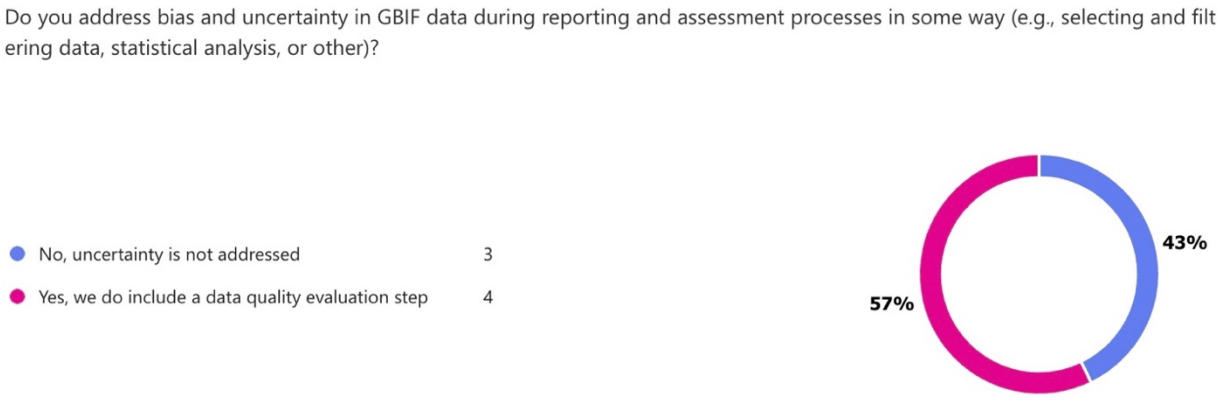


Figure 6. Proportion of respondents indicating whether bias and uncertainty in GBIF data are addressed during reporting and assessment processes.

Overall, the pre-workshop questionnaire provided a baseline overview of current practices, challenges, and opportunities related to the use of data in GBIF in HD Art. 17 reporting. The results highlighted variability in data integration approaches, quality assessment practices, and institutional capacity across participating organisations, while consistently identifying barriers related to awareness, data quality concerns, interoperability, and methodological requirements. These findings informed the workshop discussions and contributed to structuring the key themes addressed during the session.

2.2.3.Workshop discussion and stakeholder feedback

Following the pre-workshop questionnaire, the workshop was organised around two main components: the presentation of the workflows and tools developed within the B3 case study, together with the results of their application, and the exchange of national experiences among MS representatives on current HD reporting practices. These discussions helped place the proposed workflows in the context of existing national approaches and provided insights into their potential relevance for supporting reporting activities.

Three national perspectives were presented and discussed: Sweden, France and Portugal. These examples showed that the use of data in GBIF for HD reporting remains highly dependent on national data infrastructures, institutional confidence in data quality, and the existence of validation workflows.

The Swedish representatives provided a detailed example of the national workflow used for HD reporting. Sweden explained that, for official reporting purposes, it relies on national and trusted data sources rather than directly integrating GBIF-mediated data. The main concerns raised related to data reliability, traceability and the difficulty of verifying whether individual records in GBIF are suitable for formal reporting. Although Sweden uses biodiversity datasets available in GBIF, including data from SLU biodiversity platform (https://www.artportalen.se), the Swedish perspective was that GBIF-mediated data are not currently considered sufficiently reliable or auditable for direct integration into the HD reporting workflow.

The French representatives presented a more positive position towards the possible use of data hosted in GBIF. Their experience suggested that GBIF-mediated data can be useful where appropriate validation and filtering steps are applied, and that such data may help complement national sources when relevant. The French case therefore illustrated a more open approach, in which the data available in GBIF are considered as a potential additional source of evidence, rather than being excluded *a priori*.

The Portuguese experience was also generally unfavourable towards an automated use of GBIF-mediated data for reporting. Although Portugal recognises the advantages of data mobilisation, and the Institute for Nature Conservation and Forests (ICNF) has made a significant effort in recent years to share its own monitoring data through GBIF, the discussion also showed that

there is still considerable distrust regarding the quality and fitness-for-purpose of GBIF-mediated data for official reporting. For example, the officer responsible for bat reporting identified suspicious records in GBIF , including occurrences of a given species outside its known range, and therefore tends to discard these data. In practice, data in GBIF have only been used selectively, mainly for specific taxonomic groups or in cases where gaps exist in national datasets.

Overall, the workshop showed that the main issue is not only whether data in GBIF are available and technically accessible, but whether they can be trusted, validated and documented in a way that makes them acceptable for HD reporting. The discussion highlighted several recurring barriers:

a) uncertainty about the quality and taxonomic reliability of occurrence records;
b) difficulty in tracing the origin and validation status of individual records;
c) lack of clear procedures for assessing whether GBIF-mediated data are fit for reporting;
d) differences between national workflows and open data governance systems;
e) institutional reluctance to use data that have not passed through national validation processes.

At the same time, the workshop also highlighted opportunities. In particular, GBIF may be useful as a complementary source of information, especially for identifying potential data gaps, supporting preliminary assessments, or providing additional evidence for poorly covered species or taxonomic groups and regions. The discussion suggested that future integration will depend on clearer validation procedures, stronger links between GBIF and national biodiversity infrastructures, and better documentation of data provenance and quality.

A short post-workshop questionnaire was circulated to participants to collect feedback on the workshop and to assess whether the discussion had changed participants' views on the use of GBIF-mediated data in the context of HD reporting.

Only three responses were received. Therefore, the results should be interpreted as qualitative feedback rather than as representative evidence of all participants' views.

The limited feedback received suggests that the workshop did not lead to a major immediate change in participants' positions. Responses indicated either no change, uncertainty, or only a partial change in perspective. This is consistent with the discussions during the workshop, where participants recognised the potential value of the data available through GBIF but remained cautious about their direct use in official reporting workflows.

The post-workshop feedback therefore reinforces one of the main conclusions of the session: the integration of GBIF-mediated data into HD reporting is not simply a technical matter. It depends strongly on confidence, institutional acceptance, validation procedures and the ability to demonstrate that data are reliable and fit for purpose. The workshop contributed to clarifying these issues and to identifying the conditions under which biodiversity data in GBIF could be more widely considered in future reporting processes.

2.2.4.Main conclusions from the workshop

The workshop demonstrated that there is no single European approach to the use of GBIF-mediated data in HD reporting and that national practices vary considerably.

Sweden and Portugal represented a cautious approach, where only nationally controlled and validated data sources are used for reporting, showing concerns about the quality and reliability of GBIF-mediated data for official reporting. France represented a more open approach, where data in GBIF may be considered when appropriate checks are possible.

The key message emerging from the workshop was that, although GBIF-mediated data have recognised potential, their use in HD reporting remains strongly conditioned by confidence in data quality, provenance, and validation procedures. Participants consistently emphasised the need for robust validation mechanisms, transparent workflows, and stronger links between GBIF and national biodiversity infrastructures before such data could be more widely considered in official reporting processes.

This validates and supports further investment in the development of confidence methods and uncertainty evaluation tools that can support data exploration and filtering as well as communication of uncertainty in transparent and reproducible ways, such as the ones developed in B3 (Langeraert & Van Daele, 2026; Langeraert *et al*., 2026) and implemented in our case study (see next sections).

3.Species level assessment under Habitats Directive

The Reporting under HD Art. 17 is based on six-year periods, and three cycles have been completed: 2001-06; 2007-12 and 2013-18. The fourth cycle 2019-24 has been completed and submitted by MS by 31 July 2025. The public consultation for the Article 17 biogeographical assessments of species conservation status is currently open, until 16 August 2026, and the assessments overviews are expected to be released soon. The reporting format contains five main components:

- ***General report*** *(one overview per country);*
- ***Species reports*** - background information for assessment of the conservation status of a species;
- ***Species evaluation matrix*** - assess the conservation status of a species based on the species report (part B);
- **Habitat type reports** - background information for assessment of the conservation status of a habitat type;
- **Habitat type evaluation matrix** - assess the conservation status of a habitat based on the habitat type report (part D).

The species assessment should be conducted for **all relevant species** of a MS in accordance to check-lists in the online Article 17 reference portal[1] of the European Environment Information and Observation Network (Eionet). These checklists are specific to each MS and biogeographical region and have evolved over successive reporting cycles (see Section 4.1.1).

Knowing the HD requirements and the indicators (Figure 7 and Figure 8), that each MS must assess, is essential to identify how B3 developments may contribute and address current reporting needs. An important component of the Article 17 report is the species distribution map, which is reported using a standardized 10x10km ETRS89 grid for harmonized assessment at the European Level (DG Environment, 2017) (Figure 7).

2 MAPS	
Distribution of the species within the Member State concerned.	
2.1 Sensitive species	*The spatial information provided relates to a species (or subspecies) to be treated as 'sensitive'* ☐ *YES* ☐ *NO*
2.2 Year or period	*Year or period when distribution was last updated*
2.3 Distribution map	*Submit a map together with relevant metadata following the technical specifications in the Explanatory Notes . The standard for species distribution is 10x10km ETRS 89 grid cells, LAEA (EPSG:3035) projection.*
2.4 Distribution map Method used	*Select one of the following methods:* *a) Complete survey or a statistically robust estimate* *b) Based mainly on extrapolation from a limited amount of data* *c) Based mainly on expert opinion with very limited data* *d) Insufficient or no data available*
2.5 Additional maps *Optional*	*MS can submit an additional map, deviating from standard submission map under 2.3 and/or a range map*
2.6 Additional information *Optional*	*Other relevant information, complementary to the data requested under fields 2.1–2.5* *Free text*

Figure 7. Features of the National level reporting (Eionet portal HD art17 guidelines) highlighting those with potential to be informed by data in GBIF.

[1] https://cdr.eionet.europa.eu/help/habitats_art17

5 RANGE		
Range within the biogeographical/marine region concerned.		
5.1 Surface area	*Total surface area of the range within biogeographical/marine region concerned in km²*	
5.2 Change and reason for change in surface area of range	*Is there a change between reporting periods?* *(If yes, more than 1 option b) to f) can be chosen)* *a) no, there is no change* *b) yes, due to genuine change* *c) yes, due to improved knowledge/more accurate data* *d) yes, due to the use of different method* *e) yes, but nature of change is unknown* *f) yes, due to other reasons*	
	The change is mainly due to (select one of the reasons below): *a) genuine change* *b) improved knowledge or more accurate data* *c) the use of a different method* *d) unknown* *e) other reasons*	
5.3 Short-term trend Period	*2013 - 2024 (rolling 12-year time window) or period as close as possible to that. The short-term trend should be used for the assessment of range*	
5.4 Short-term trend Direction	*Select one of the following:* *a) stable* *b) increasing* *c) decreasing* *d) uncertain* *e) unknown*	
5.5 Short-term trend Magnitude *Optional*	*a) Estimated Minimum*	*Percentage change over the period indicated in the field 5.3. If a precise value is known, please provide the same value under both minimum and maximum*
	b) Estimated Maximum	*Percentage change over the period indicated in the field 5.3. If a precise value is known, please provide the same value under both minimum and maximum*
	c) Pre-defined range	*Where a precise value is not known (5.5 a & b) provide a range. The ranges are provided with a positive or negative sign.* ☐ *0 – 12%* ☐ *13-25%* ☐ *26 – 50%* ☐ *51 – 100%* ☐ *>100%*
	d) Unknown	*Indicate if the trend magnitude is unknown*

Figure 8. Features of the Biogeographical / Marine level reporting (Eionet portal HD art17 guidelines) highlighting those with potential to be informed by data in GBIF.

To facilitate the use of open biodiversity data in this context, B3 developed tools such as the R package **b3gbi** – General Biodiversity Indicators for Biodiversity Data Cubes (Dove, 2025; Dove, 2026). The package provides functions to calculate several indicators relevant to Article 17 species-level reporting, including visualizations of species ranges or species occurrences, total occurrences, density of occurrences and data completeness. Most indicators can be visualised directly as publication-ready maps and time-series plots, allowing users to explore spatial and temporal patterns through a simple and reproducible workflow.

Although this package enables the derivation of temporal trends in occurrence records that could support assessments of population trends, also required by HD, these indicators were not used in the present study. Temporal changes in the number of GBIF occurrence records are strongly influenced by increasing data mobilisation and sampling effort and therefore cannot be interpreted as changes in species abundance without accounting for variation in survey effort. Within the B3 project, complementary metrics to quantify sampling effort have been proposed (Langeraert *et*

al., 2026), however, these could not be calculated in the present case study because the data cubes were aggregated at annual resolution, preventing the derivation of sampling-effort metrics based on observation dates.

4. GBIF occurrence cubes and indicators for Habitats Directive – a reproducible Workflow

The workflow developed within the B3 stakeholder driven case study provides a reproducible framework for exploring the use of GBIF-mediated biodiversity occurrence data in support of HD species-level assessments (Figure 9). It recognizes three main stages of data processing:

(i) ***Data ingestion***, where species occurrence data downloaded from GBIF and data from other different sources, for example, other platforms or private repositories, can be harmonised and structured into biodiversity cubes;

(ii) ***Data quality evaluation***, where the fitness of the data is assessed through a series of validation and quality checks; allowing spatial, temporal and other bias exploration and supporting subsequent data filtering and selection based on transparent and reproducible criteria; and

(iii) ***Data analysis***, where the processed data is used to generate biodiversity indicators, assess spatial and temporal patterns and quantify uncertainty in the assessment.

Together, these stages ensure that the analytical process is transparent, reproducible, and adaptable to different data sources and reporting contexts.

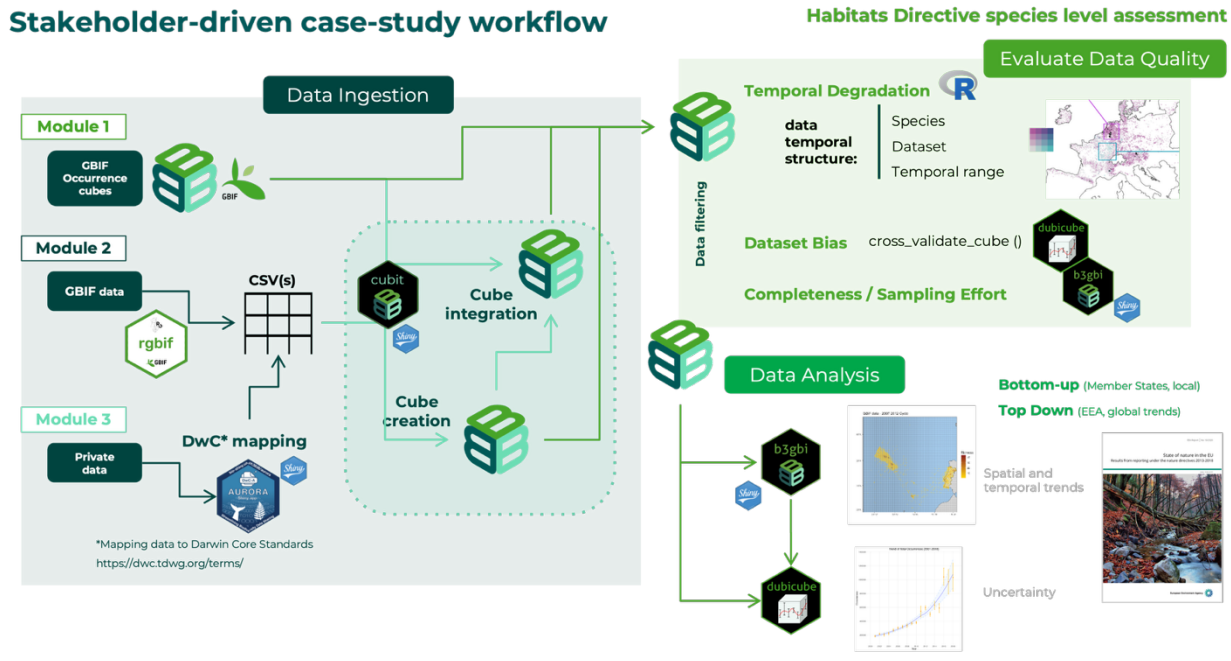


Figure 9. Proposed workflow for integrating GBIF occurrence data into the Habitats Directive Article 17 reporting process.

This workflow tested and implemented several tools developed within B3 project (B-Cubed, 2026; detailed in the next sections). Nonetheless, in the scope of the needs identified within this case study, an additional tool was developed, under this Task 6.4, that can further support data mobilisation and facilitate integration of different types of data into occurrence cubes for analysis - the **Cubit** tool (Figure 9; see details in section 4.2).

4.1.Selected datasets

The proposed workflow is based on species occurrence datasets from the species-level assessments reported by MS under the HD, together with the harmonised EU-level dataset provided by the European Environment Agency (EEA). These datasets were publicly available through the EEA data repository (EEA, 2021). Species occurrence records for the same set of species were retrieved from GBIF and aggregated as species occurrences cubes (Desmet *et al.,* 2023) to enable comparison with the official Article 17 datasets. The DOIs of all GBIF datasets used in this case study are provided in **Annex 1**.

4.1.1.Taxonomic dimension

The HD requirements determined the taxonomic scope of the study, defined by the species listed in the Directive's annexes. Sensitive species were excluded from the case study, for comparability's sake, because their distribution data are not publicly disclosed by the EEA or the MS, as making these data available could be detrimental to their conservation. Consequently, it was not possible to compare their distributions with species occurrence data from GBIF.

The remaining species were considered in our study: a total of 1115 species for 2001-2006 cycle, 1273 for 2007-2012 cycle and 1508 for the 2013-2018 cycle. The species list from the most recently completed reporting cycle was also used to download GBIF occurrence records for the subsequent period (2019–2024), as the results of the 2019–2024 Habitats Directive reporting cycle were not yet public available at the time of the analysis. The differences in the number of species listed in the annexes of the Habitats Directive across reporting cycles, reflect taxonomic revisions, changes in the taxonomic resolution of the assessments, as well as the enlargement of the European Union, which brought species characteristic of newly incorporated biogeographical regions and endemic species from countries that more recently joined the EU.

Several hurdles were met during the taxonomic mapping of species in the HD Annexes to the GBIF Backbone Taxonomy:

- differences in taxonomic nomenclature, including the use of outdated names and synonyms;
- differences in taxonomic circumscriptions (e.g. taxa recognised as species in one system but as subspecies in the other);

- species listed with explicit taxonomic exclusions (e.g. *Rupicapra rupicapra*, excluding *R. r. balcanica*, *R. r. ornata* and *R. r. tatrica*), which could not be directly represented in the GBIF Backbone Taxonomy;
- taxa listed in the Habitats Directive with no direct match in the GBIF Backbone Taxonomy.

Species based assessments are central to many biodiversity policies (Estupinan-Suarez *et al*., 2024) and thus facilitating crosswalks between taxon identifiers used across different databases (*e.g*., taxonKey in GBIF Backbone Taxonomy; Taxon ID in Catalogue of Life checklist; taxonID in AlgaeBase; AphiaID WoRMs; ITIS Taxonomic Serial Number) and those used in the most common European Polices and Regulations (*e.g*. Habitats Directive 4-digit Species/Taxon Codes) would substantially improve interoperability, promote data usage and reduce time and error associated with taxonomic harmonization.

Recent developments within GBIF, including the adoption of the Catalogue of Life eXtended Release as its primary taxonomic reference (GBIF, 2026), represent an important step towards greater consistency in taxonomic interpretation across biodiversity information systems. Nevertheless, interoperability with policy-specific taxonomies remains limited. Publishing the taxonomic reference lists underpinning European biodiversity legislation (*e.g.* the HD species lists and associated species codes) as interoperable checklists within biodiversity infrastructures would facilitate taxonomic matching, improve reproducibility and reduce the effort required to integrate policy and biodiversity data.

As a contribution towards this objective, the taxonomic mappings developed in this study have been published as openly accessible datasets on Zenodo (Machado & Teixeira, 2026). The repository contains both the direct output of the automated taxonomic matching against the GBIF Backbone Taxonomy (raw datasets) using `rgbif::name_backbone()` and manually curated versions (curated datasets), which include manually assigned or corrected GBIF taxon keys for taxa that could not be matched automatically or required taxonomic review. The curated datasets were used in the analyses presented in this deliverable and are intended to support future integration of HD species lists with occurrence data in GBIF and other biodiversity information systems.

4.1.2.Spatial scale

The stakeholder-driven case study was conducted at the pan-European scale, covering all countries required to report under the HD in each reporting cycle (Figure 10).

Species distribution data reported under the HD are based on the EEA reference grid with a spatial resolution of 10x10 km. However, the official datasets provided by the MS and harmonised by the EEA are distributed as georeferenced multipolygon layers representing the aggregation of occupied 10x10 km grid cells at the national and biogeographical region levels, rather than as individual grid cells. To enable direct comparison with the B3 workflows and the GBIF occurrence cubes, these multipolygon datasets were converted into individual 10x10 km EEA grid cells,

preserving the original reporting resolution while producing a gridded representation suitable for analysis.

The complementary data from GBIF were downloaded as species occurrence cubes aggregated to the same 10x10 km EEA reference grid, ensuring spatial consistency between both data sources.

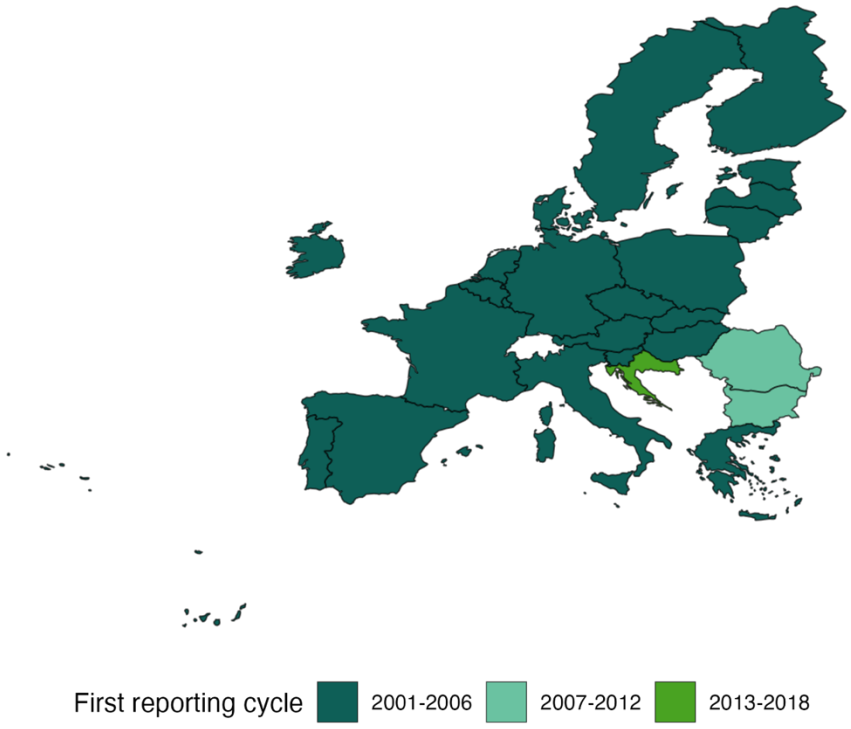


Figure 10. European countries with reporting obligations under the Habitats Directive, showing the reporting cycle in which each country first submitted an Article 17 report.

4.1.3. Temporal scale

The temporal scale used corresponded to HD Art. 17 reporting periods, conducted every six years. The evaluation of temporal trends was carried out over the three cycles reported so far: 2001-2006, 2007-2012 and 2013-2018. Additionally, data for the upcoming reporting cycle (2019-2024) was also downloaded from GBIF.

Some of the analyses presented show also yearly based results highlighting the relevance of data in GBIF for exploring, detecting and reporting trends in a more regular basis, with potential to act as early warning within reporting cycles, anticipating ecological shifts and shortening the time lag between observation and transfer of knowledge and evidence in support of biodiversity conservation and management (Estes *et al*., 2018).

4.2.Data ingestion

4.2.1. rgbif Data Ingestion – Module 1

To support the assessment of species distributions across the three past HD reporting cycles (2001–2006, 2007–2012, 2013–2018) and the upcoming one (2019–2024), a reproducible workflow was developed using **rgbif** package (Chamberlain, 2017) to retrieve, harmonise and spatially aggregate occurrence records from GBIF (Figure 9 Data ingestion Module 2). Given the large number of taxa included in the pan-European Habitats Directive species lists, rgbif enabled the automated generation of download requests directly from input species lists, facilitating the retrieval of occurrence records prior to cube generation. For each reporting cycle, the list of target taxa to be reported under Art. 17 was compiled and matched to their corresponding GBIF taxonomic identifiers. A manual taxonomic reconciliation step was applied to resolve inconsistencies arising from synonyms, deprecated names and recent nomenclatural changes, ensuring that records referring to the same biological entity were grouped under a single accepted identifier. A particular challenge arose from the fact that the HD requires reporting at different taxonomic ranks depending on the taxon, including genera, species and subspecies. Consequently, the workflow had to dynamically adapt the download strategy by using the appropriate GBIF identifier for each rank (*e.g.*, genusKey for genera, speciesKey for species and taxonKey for subspecies), rather than relying on a single taxonomic key throughout (download keys and DOIs on **Annex 1**).

Occurrence downloads were then submitted to GBIF for every combination of taxon, country and reporting cycle, restricted to human and machine observations of present occurrences within the relevant time window. The resulting files were automatically unzipped, and information on country, cycle and rank of origin was added to each file. Records with a coordinate uncertainty greater than 10 km were discarded to guarantee sufficient spatial precision (Langeraert *et al*., 2026) and the cleaned datasets were merged into a single file per reporting cycle.

Finally, all occurrences were projected onto the standard EEA 10 × 10 km reference grid, producing an occurrence "data cube" per cycle in which each row summarises the number of records of a given taxon within a specific grid cell, year and country. To aggregate records, a complementary summary of total occurrences per year/per grid cell was calculated. The final outputs provide a harmonised, spatially explicit and taxonomically consistent basis for downstream biodiversity indicators and reporting.

4.2.2. GBIF SQL API – Data ingestion Module 2

Alternatively, one could have directly created and download data cubes from GBIF[2] (Figure 9 Data ingestion Module 1) using the new GBIF SQL download API[3], where users can easily define cubes by selecting the desired taxonomic, temporal and/or spatial dimension from a simple pre-

[2] https://www.gbif.org/occurrence-cubes
[3] https://techdocs.gbif.org/en/data-use/api-sql-downloads

set list of options. The generated SQL query may be further customized before the download is launched (Desmet *et al*., 2023) offering users greater flexibility on generated cubes.

4.2.3. Cubit ShinyApp – Data ingestion Module 3

Alternatively, acknowledging that many biodiversity data still lays in private repositories we have created a tool - **Cubit**, that allows mobilizing such data to be used on its own as data cubes or to be integrated with open data from GBIF generated species occurrence cubes (Figure 9 Data ingestion Module 3).

Cubit is an R shiny interactive application[4] than can execute an automated and user-friendly workflow for generating species occurrence cubes from user-provided datasets. The user can upload their biodiversity occurrence data in CSV or TSV format, configure the cube to be generated from this data (Figure 11).

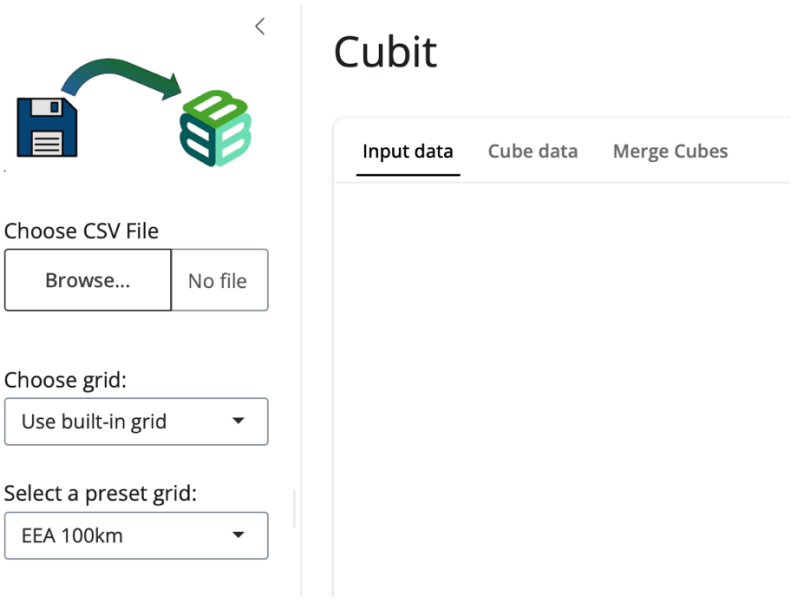


Figure 11. Cubit ShinyApp graphical user interface view of Input data menu. In the sidebar panel, users can upload the data in CSV or TSV format, choose a predefined grid or upload another grid in GeoPackage format.

The user can additionally merge generated cubes with occurrence cubes obtained from GBIF or any other compatible source. This graphical interface accommodates datasets with different formats and structures, reducing the technical expertise required to generate standardized occurrence cubes. In this way, Cubit facilitates the mobilisation of private biodiversity data

[4] Cubit ShinyApp available at https://bio-shiny.ua.pt/Cubit/

alongside publicly available information, enabling more comprehensive biodiversity assessments while promoting transparent and reproducible analytical workflows.

The application is available in two versions: a web-hosted version intended for small- to medium-sized datasets[5], and a locally installable version[6] designed to efficiently process large biodiversity datasets. Although GBIF now provides occurrence cubes as a downloadable product, a substantial amount of biodiversity information remains outside global repositories, including institutional databases, monitoring programmes, environmental assessments, and unpublished datasets. In this way, Cubit complements GBIF services by allowing users to transform data from heterogeneous sources into a common cube structure. The source code of this version and the local version, along with corresponding documentation, is deposited in the **B-Cubed GitHub repositories web-cubit** and **Local-Cubit**.

4.3.Quality evaluation

The increasing availability of open-access biodiversity data creates new opportunities to support species conservation assessments. However, as highlighted by the stakeholder consultation presented earlier in this report, concerns regarding the quality and reliability of these data remain a barrier to their wider use in policy and reporting. To address this challenge, the B3 project developed a set of tools to assess the structural integrity and robustness of biodiversity data cubes. These tools were applied in the present case study to evaluate the quality of the GBIF occurrence cubes before exploring their potential to complement HD Art. 17 reporting. By enabling users to explore, select, and filter data, these tools empower them to address common biases associated with data aggregated from multiple sources in GBIF. Furthermore, by applying transparent and scientifically sound criteria, they facilitate the implementation of reproducible workflows.

4.3.1. **Dubicube:** Calculation and Interpretation of Data Cube Indicator Uncertainty

As an initial quality control step, the occurrence data cubes generated from **rgbif** downloads were assessed using the `diagnose_cube()` function implemented in the **dubicube** package (Langeraert & Van Daele, 2026). This diagnostic evaluates the structural integrity and consistency of the data cubes by identifying potential issues such as missing values, temporal and spatial gaps and inconsistencies in the cube dimensions. As expected for data cubes generated through a fully automated workflow and containing a large number of occurrence records, no major structural issues or data gaps were detected (Figure 12).

[5] Github code supporting development of web-hosted Cubit https://github.com/b-cubed-eu/web-cubit
[6] Github code supporting development of local executable Cubit https://github.com/b-cubed-eu/Local-Cubit

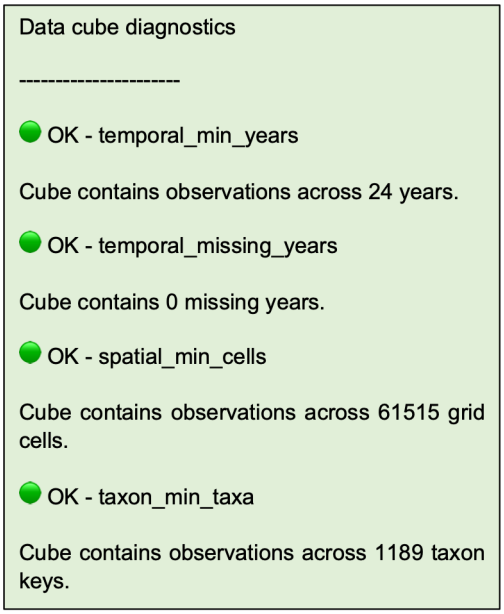


Figure 12. Output of the `diagnose_cube()` function from the b3gbi R package, summarising the structural integrity and quality of the occurrence data cube for Habitats Directive species covering the period 2001–2024.

Group-level sensitivity was assessed using `cross_validation_cube()` function, also from the **dubicube** R package. A leave-one-out cross-validation (LOSO) procedure was applied to the taxonKey dimension, whereby each taxon was iteratively excluded and the indicator recalculated using the remaining taxa. The agreement between the original and recalculated indicator values was then used to assess the influence of individual taxa on the indicator.

The LOSO identified Atlantic salmon (*Salmo salar*) and European bullhead (*Cottus gobio*) as having a disproportionate influence on the occurrence count. Inspection of the corresponding records in GBIF showed that this pattern was largely driven by fish-trapping datasets, which characteristically produce high numbers of occurrence records concentrated in relatively few grid cells, thereby increasing the influence of these species on the calculated metric (Figure 13).



Figure 13. Results of the leave-one-out cross-validation (LOSO) applied to the occurrence count variable using the `cross_validation_cube()` function from the dubicube R package, for the 2001–2006 Article 17 reporting cycle.

4.3.2. Temporal degradation

GBIF provides extensive spatiotemporal biodiversity occurrence data, but its opportunistic nature introduces biases in sampling effort and coverage. In contrast, EU Habitats Directive monitoring provides standardized and reliable information but at discrete reporting intervals. To bridge this gap, we developed a framework to quantify the temporal informativeness of records available in GBIF for species listed under the EU Habitats Directive.

Species occurrences downloaded from GBIF (2001–2024) and aggregated into 10 × 10 km EEA grid cells were used to generate annual presence–absence time series. To ensure sufficient variation for temporal modelling, we retained only cells with at least 3 years of presence and 3 years of absence across the study period (eligible cells). For each species–grid cell combination, a binomial Generalized Linear Model (GLM) was fitted. The model estimates the probability of presence of a given species in a given spatial unit as a function of time, and from each fitted model McFadden's pseudo-R² (1)

$$R^2_{McF} = 1 - \frac{\log L_{model}}{\log L_{null}} \quad (1)$$

was derived, calculated by comparing the fitted model with an intercept-only model. Values close to 0 indicate that time explains little variation in the presence–absence sequence, suggesting weak temporal structure. Higher values indicate that time accounts for a larger portion of the observed variation, reflecting a more coherent temporal pattern.

The framework was applied at both species and dataset levels. Following exploratory inspection of the `datasetName` field, records were assigned to one of five groups using keyword-based matching (citizen science, monitoring programs, national inventories, collections, and other datasets), allowing comparison of temporal signal across data sources. Species contributions to strong temporal signals were quantified, and differences among dataset groups were assessed using Jaccard dissimilarity followed by PERMANOVA.

Records in GBIF were analysed within EU Habitats Directive reporting periods to identify areas where open biodiversity occurrence data from multiple sources can provide robust temporal information, supporting their integration into biodiversity monitoring and conservation assessments.

These approaches to understanding the temporal structure of data in GIBF showed that, at the species level, coverage, expressed as $\frac{eligible\ cells}{total\ occupied\ cells}$, varied considerably among taxa, with most species having between 20% and 60% of their occupied grid cells meeting the modelling criteria. Median McFadden's pseudo-R² values also spanned a broad range, indicating substantial variation in the strength of temporal signal among species. Species represented by a larger number of eligible cells (i.e., a larger number of grid cells in which temporal dynamics can be assessed) generally exhibited lower median McFadden's pseudo-R² values, whereas species with fewer modelled cells showed greater variability in temporal signal strength (Figure 14).

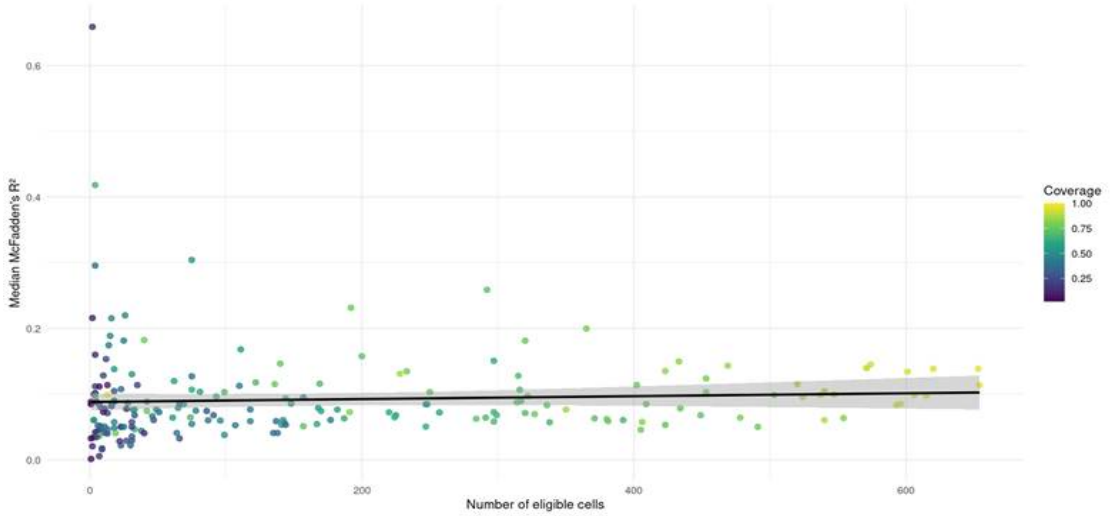


Figure 14. Relationship between number of modelled cells and median McFadden's pseudo-R². Each species represents a point.

As an example, temporal dynamics are mapped for the species *Rana temporaria* (Figure 15).

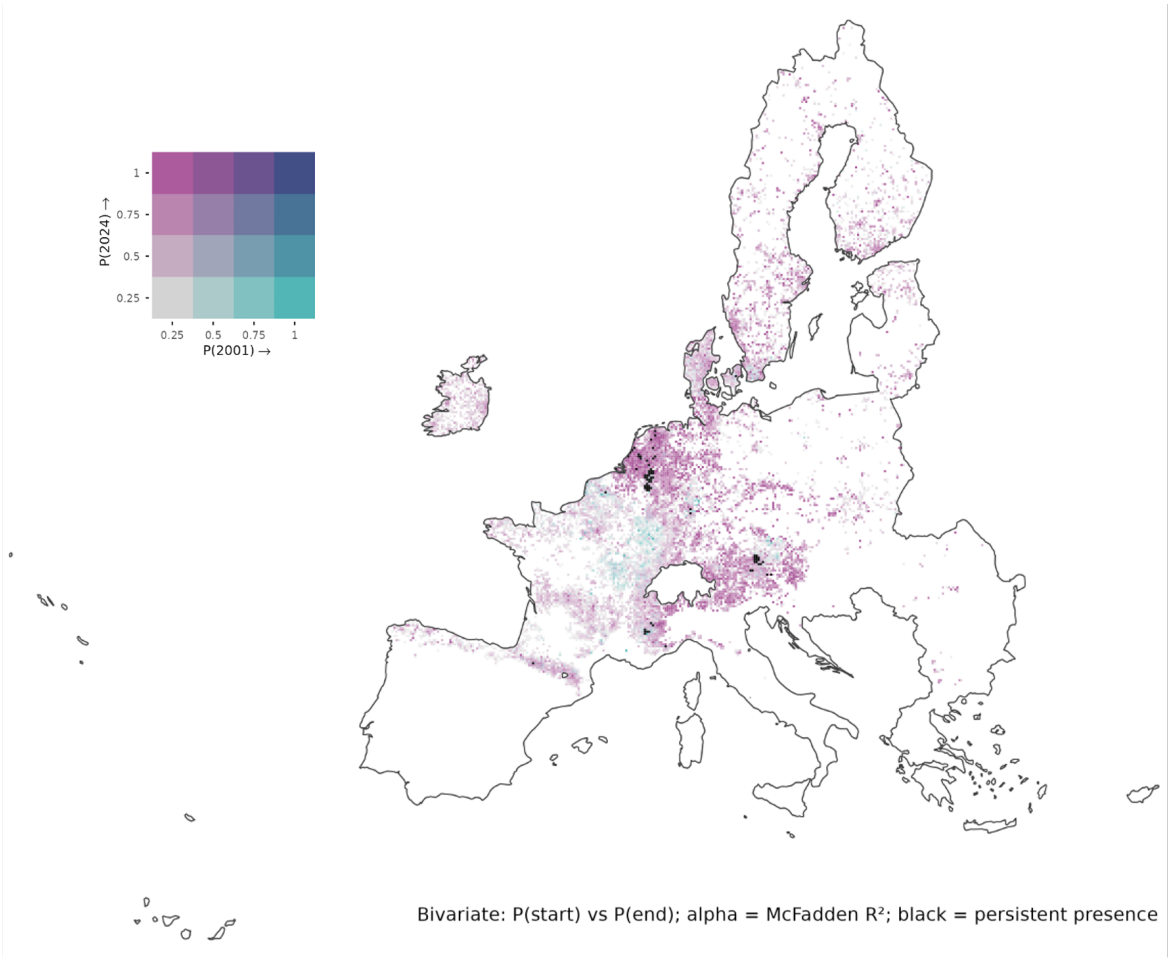


Figure 15. Reporting dynamics of species in GBIF. Example of occurrences of *Rana temporaria* from 2001 to 2024, highlighting the strength of the temporal signal to inform biodiversity trends across Europe. Each grid cell is colored according to the estimated probability of presence at the beginning and end of the time series, showing the direction of change. Cell opacity represents the strength of the temporal signal, measured by McFadden's R^2. Black cells indicate areas where the species is present in almost all years, from 2001 to 2024.

At the dataset level, dataset groups differed significantly in the set of species exhibiting substantial temporal signal (PERMANOVA, $R^2 \approx 0.71$, $p < 0.001$). Figure 16 shows that substantial temporal signals occurred across all dataset groups, with citizen science datasets representing a comparatively large proportion of cells with strong temporal signal. Nevertheless, the identity of the species contributing to these signals differed among observation systems, indicating that the different data sources provide complementary temporal information.

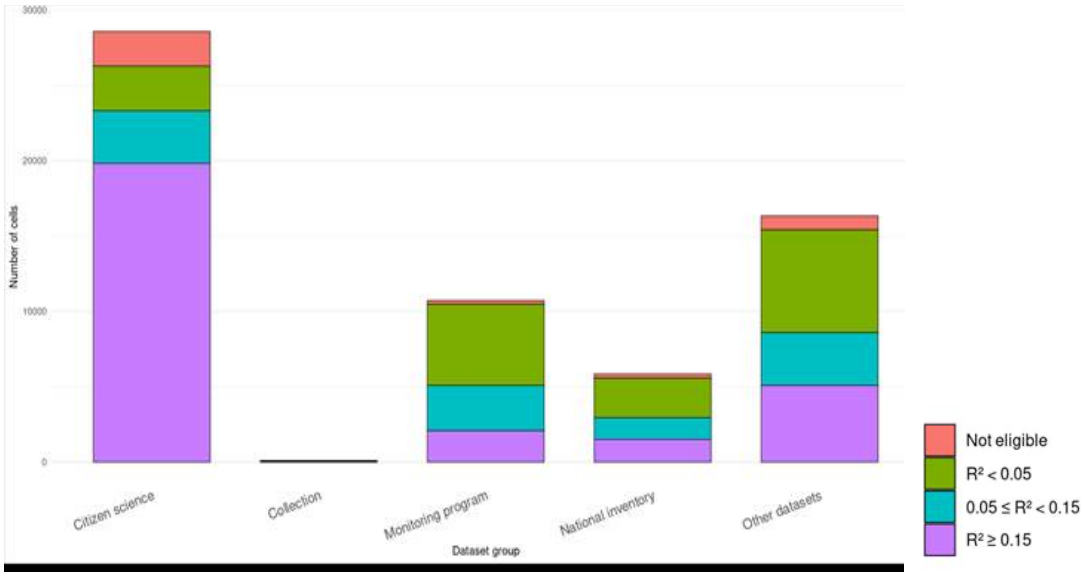


Figure 16. Distribution of cells across dataset groups, classified by their temporal signal class (McFadden R^2: < 0.05; [0.05-0.15]; >= 0.15).

Results show that data in GBIF should not be treated simply as noisy or unreliable by default. Although information in GBIF does not represent a standardized sampling process, its temporal dimension contains substantial information that can be identified and evaluated explicitly. By modelling temporal structure at fine spatial scales, the proposed framework makes it possible to distinguish areas where records in GBIF are dominated by stochastic variation from areas where they show coherent temporal patterns.

These findings suggest that GBIF can play an important complementary role alongside official monitoring schemes. Rather than replacing structured surveys, data in GBIF should be integrated selectively into biodiversity reporting and conservation assessments. The proposed framework identifies the areas where GBIF records provide sufficiently strong temporal information, improving temporal resolution between reporting cycles and extending coverage to underrepresented species.

Based on the strength of the temporal signal criteria that can be incorporated in reproducible workflows, the method presented leverages the added value of integrating data from multiple sources to achieve robust temporal structures that support identification of biodiversity trends with higher confidence.

4.4.Data analysis

4.4.1.Occurrences trends

Following the compilation of the occurrence data cubes, temporal trends in GBIF occurrence records were assessed by calculating the annual mean number of occurrences between 2001

and 2024 together with their 95% confidence intervals, using the **b3gbi** R package (Dove, 2016). The temporal trend in occurrence records from GBIF showed a marked increase between 2001 and approximately 2018–2020, reflecting the growing availability of biodiversity data through GBIF. A slight decline was observed in the most recent years, although occurrence numbers remained considerably higher than those recorded during the first reporting cycle (Figure 17).

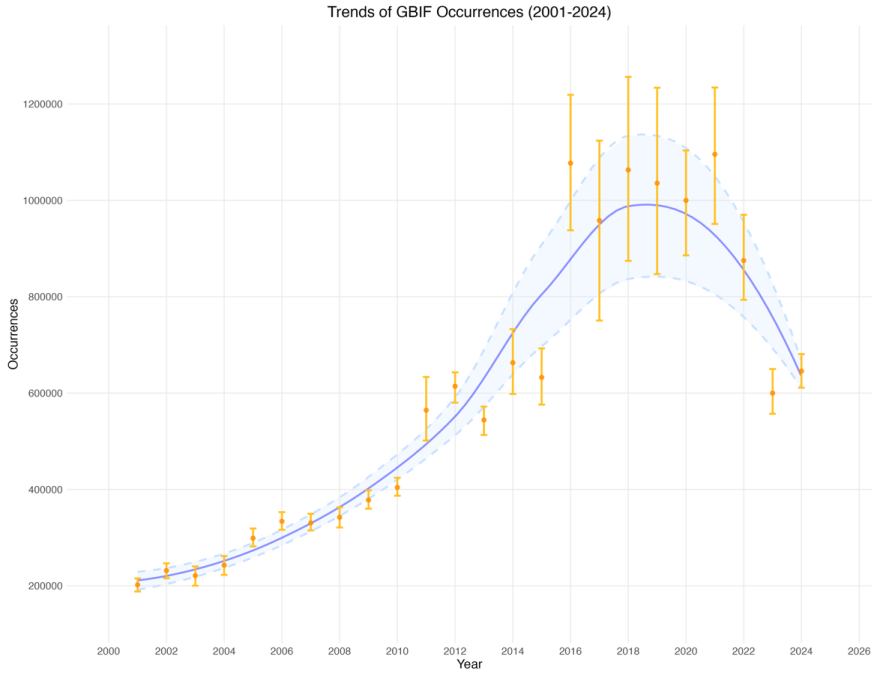


Figure 17. Temporal trend in the number of GBIF occurrence records for species listed under the Habitats Directive between 2001 and 2024.

4.4.2.Sample completeness

Spatial data completeness was assessed calculating the sample coverage metric using the `completeness_map()` function implemented in the **b3gbi** R package. Sample coverage estimates the proportion of individuals in the community that belong to species already detected in the sample, providing a standardized measure of sampling completeness (Chao *et al*., 2020). Here it is used to assess the frequency of rare species in the occurrence cube—specifically singletons (species that appear only once in a grid cell) and doubletons (species that appear exactly twice). If a grid cell contains many singletons, it implies that further sampling will likely reveal even more undiscovered species, hence low completeness. Completeness was calculated for each EEA 10 × 10 km grid cell and for each HD reporting cycle (2001–2006, 2007–2012, 2013–2018 and 2019–2024) and for each EU MS.

Substantial differences in data completeness were observed among MS. Countries with well-established biodiversity data infrastructures and extensive data mobilisation efforts, such as France (Figure 18) exhibited a high proportion of grid cells with high sampling coverage, indicating

that data on GBIF can support the calculation of biodiversity metrics over large parts of their territory. In contrast, countries such as Romania (Figure 19) showed markedly lower spatial coverage, with relatively few grid cells achieving sufficient completeness.

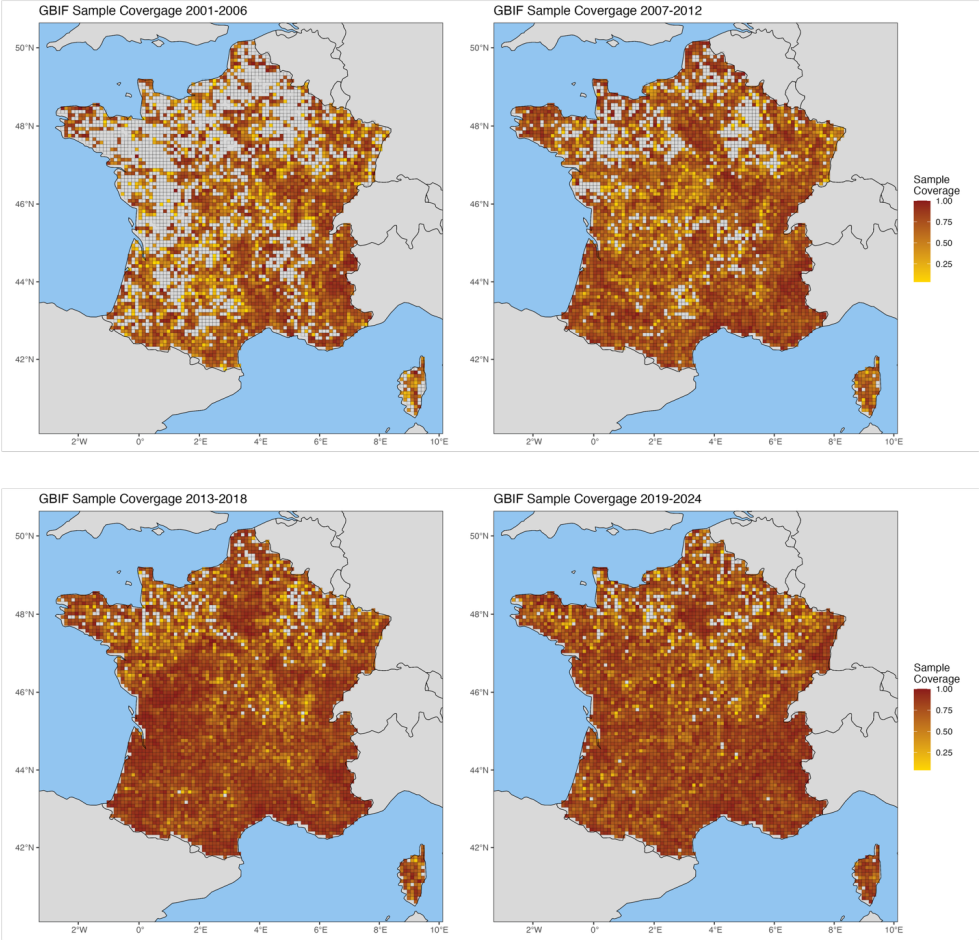


Figure 18. Spatial distribution of sample coverage (completeness) of GBIF occurrence data for France across the four Habitats Directive Article 17 reporting cycles (2001–2006, 2007–2012, 2013–2018 and 2019–2024). Sample coverage was estimated for each EEA 10 × 10 km grid cell using the b3gbi R package.

These differences are consistent with variation among MS in biodiversity data mobilisation, implementation of biodiversity infrastructure, participation in GBIF, and the maturity of citizen science programmes contributing occurrence records. Countries with lower completeness are therefore more likely to reflect limitations in the publication and accessibility of biodiversity data. Romania, for example, has only recently become a GBIF participant, and continued data mobilisation and publication are expected to improve the completeness and representativeness of its occurrence data in future reporting cycles.

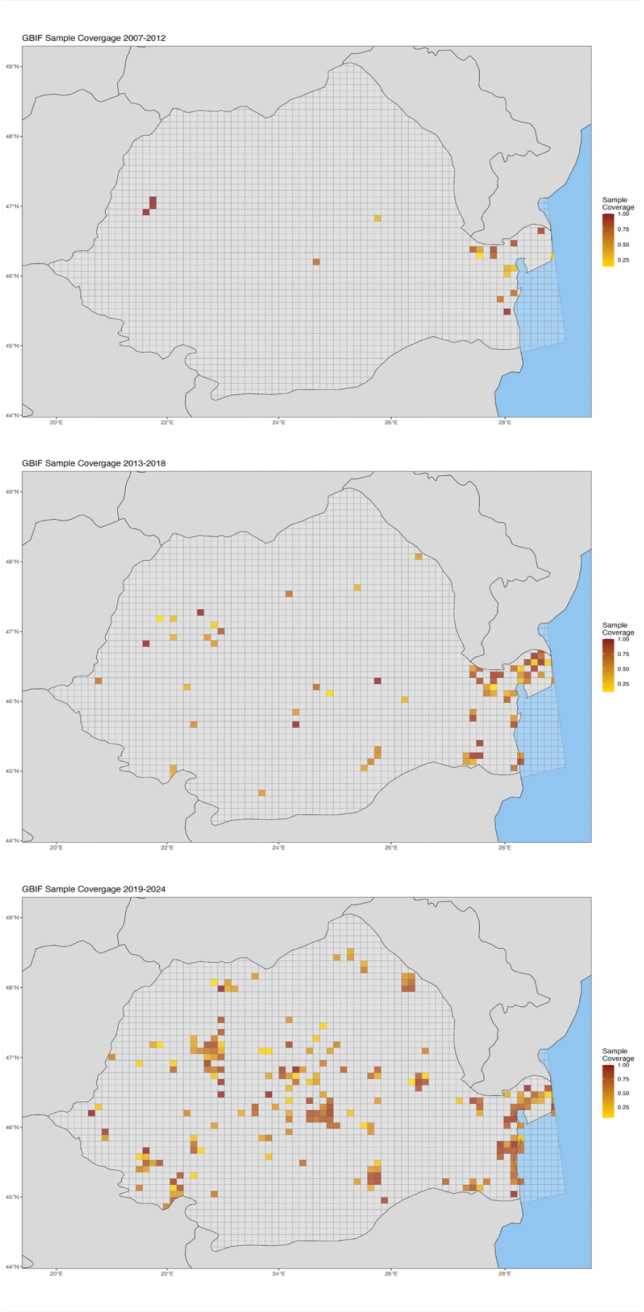


Figure 19. Spatial distribution of sample coverage (completeness) of GBIF occurrence data for Romania during the 2007–2012, 2013–2018 and 2019–2024 Habitats Directive Article 17 reporting cycles. Sample coverage was estimated for each EEA 10 × 10 km grid cell using the b3gbi R package. Romania became subject to Article 17 reporting in 2007.

4.4.3.Species distributions

According to the *State of Nature in the EU* report (Röschel *et al.,* 2020), assessing the conservation status of marine mammals under the HD remains particularly challenging. Compared with many terrestrial species, marine mammals are highly mobile, occupy extensive ranges, and spend much of their lives offshore, where systematic monitoring is logistically complex, costly, and often spatially limited. Consequently, the occurrence data available for Article 17 reporting are frequently uneven in both spatial and temporal coverage.

In this context, species occurrence records available through GBIF provide a valuable complementary source of information on species distributions. To evaluate their potential contribution to Article 17 assessments, the official distribution maps published by the European Environment Agency were compared with GBIF occurrence records.

The Atlantic spotted dolphin (*Stenella frontalis*) provides a representative example. The species has consistently been reported as Data Deficient in Article 17 assessments for both Portugal and Spain, the MS responsible for reporting in the Marine Macaronesian biogeographical region (EEA, 2026). Although the species is known to occur in the region, its range and abundance remain insufficiently documented to support a robust conservation assessment. Consequently, the official distribution maps are based largely on expert knowledge rather than comprehensive observation data.

Figure 20 compares the official Article 17 distribution maps with occurrence records from GBIF for the three reporting periods. While the overall distribution pattern is broadly consistent between the two datasets, the records in GBIF provide georeferenced observations that complement the expert-derived distribution maps. Although data in GBIF are subject to spatial sampling biases, they provide an observation-based representation of the species' distribution, including offshore and continental shelf areas that are not represented in the official maps. As such, these records offer independent evidence of the species' occurrence and can be used to support, validate and refine official distribution assessments, particularly in regions where systematic monitoring is limited.

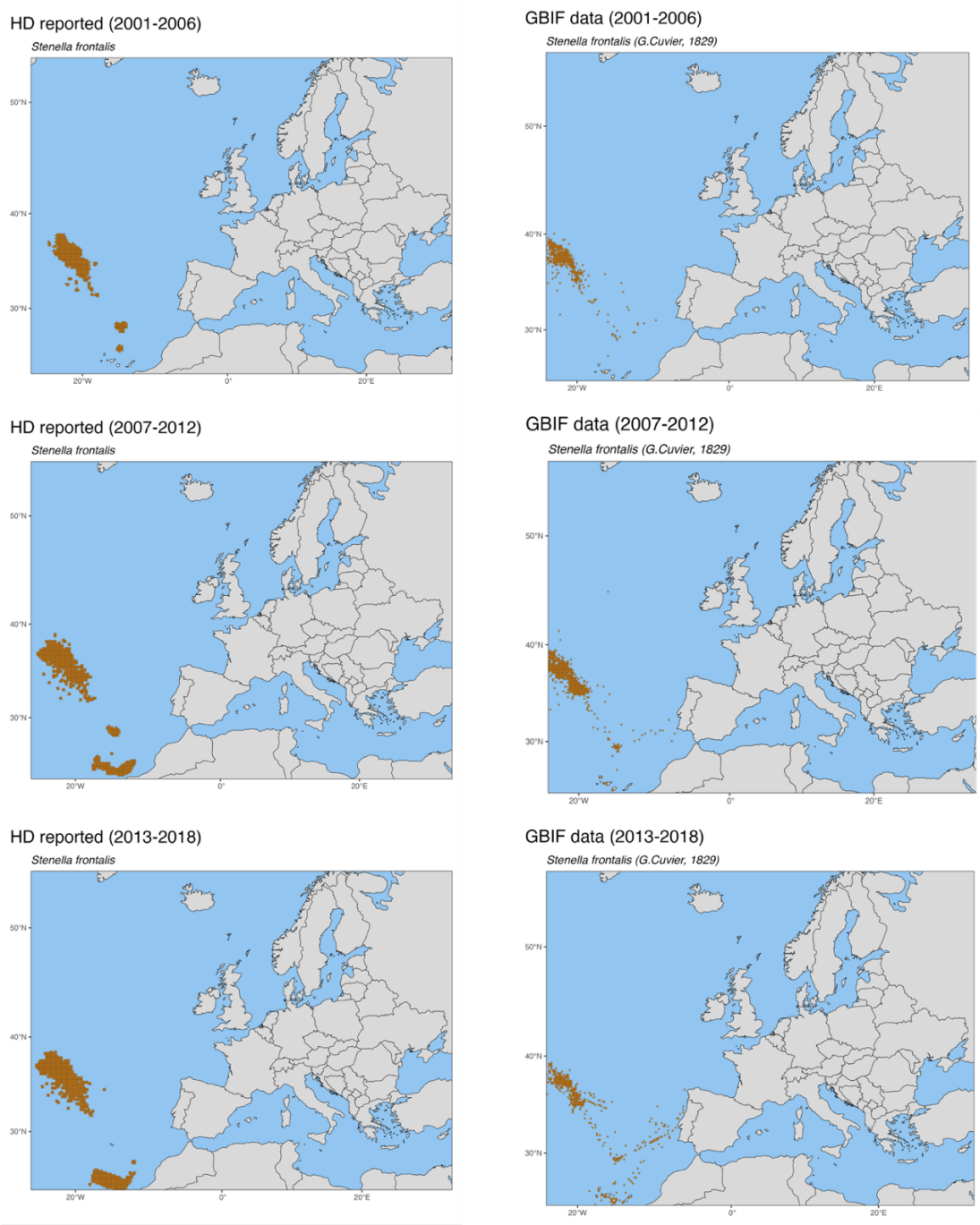


Figure 20. Official Article 17 distribution maps (left) and occurrence records in GBIF (right) for the Atlantic spotted dolphin (Stenella frontalis) during the three HD reporting periods (2001–2006, 2007–2012 and 2013–2018).

5.Conclusions

The Nature Directives, Birds and Habitats, are undergoing a **'Stress Test'** to assess whether they "*remain fit to achieve their objectives in a cost-efficient way, including by identifying opportunities to reduce unnecessary administrative burden*". This Commission's procedure aims to assess "*potential for simplification and digitalization"*, aiming to enhance EU competitiveness while safeguarding economic, social, and environmental goals.

The Commission is also proposing a **Regulation on speeding up environmental assessments**[7] to streamline and accelerate assessments for permitting procedures, including those under the Habitats Directives, here discussed. It recognizes that environmental assessments are at the "*core of the planning and permit-granting process*" and thus aims to "*promote faster and better environmental assessments*". It also recognizes that "*digitalisation has strong potential to enhance the efficiency, transparency, and effectiveness of environmental impact assessments and authorisation processes"* and that "*it is key to enable access to data, environmental reports and information on environmental assessment procedures*" which will not only facilitate "*the work of economic operators and public administrations, and stakeholder engagement*" but will also provide "*clear and timely information to decision-makers*".

As part of this case study, several B3 developments designed to facilitate the use of open biodiversity data from the world's largest biodiversity repository, the Global Biodiversity Information Facility (GBIF), in biodiversity policy applications were tested within the context of one of the EU's main nature conservation instruments—the Habitats Directive. This work demonstrates how open available biodiversity data can be integrated into policy-relevant workflows while ensuring transparency, reproducibility, and scientific robustness.

Given that the conservation status of many European species and habitats remains unfavourable, and that knowledge gaps and insufficient funding for nature conservation have been identified among the main factors limiting the effectiveness of the Nature Directives (Fitness Check Nature Directives, 2016[8]), the B3 developments presented here are particularly timely. In light of the European Commission's current initiatives to simplify, digitalise, and improve environmental assessments, B3 seeks to contribute to the ongoing public consultation on the **Birds and Habitats Directives Stress Test** (open until 10 August 2026). Specifically, it demonstrates how scientifically robust, transparent, and reproducible workflows based on open biodiversity data can support more cost-effective assessments, increase the frequency and timeliness of biodiversity information feeding into Habitats Directive reporting, and complement the targeted monitoring activities undertaken by Member States.

[7] Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on speeding-up environmental assessments COM/2025/984 final https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52025PC0984

[8] Fitness check of the EU Nature Legislation (Birds and Habitats Directives) https://commission.europa.eu/publications/fitness-check-eu-nature-legislation-birds-and-habitats-directives-directive-2009147ec-conservation_en

The results of this stakeholder-driven case study, together with the challenges and barriers to adopting open biodiversity data and more efficient automated workflows identified by Member States and GBIF National Nodes during dedicated workshops, will be synthesised in a Policy Brief that will directly contribute to this public consultation. The evidence gathered through this process aims to inform the ongoing *Birds and Habitats Directives Stress Test*, which will feed into the Commission's wider efforts to simplify and modernise the implementation of the Nature Directives.

6.Acknowledgements

We are grateful to all Member States representatives, EU Institutions and their experts, GBIF national nodes, ONGs and other experts in the scientific community that participated in the three B3 workshops that allowed focusing this stakeholder driven-case study.

We also sincerely thank Yanina V. Sica, Nikol Stoykova, and Toon Van Daele for their careful review of this report and for their constructive comments and suggestions.

7. References

B-Cubed (2026). Building Biodiversity Blocks for Policy [B-Cubed]. B-Cubed Legacy Booklet. Zenodo. https://doi.org/10.5281/zenodo.19625865

Chamberlain S (2017). rgbif: Interface to the Global 'Biodiversity' Information Facility 'API'. R package version 0.9.8. https://CRAN.R-project.org/package=rgbif

Chao A, Kubota Y, Zelený D, Chiu CH, Li CF, Kusumoto B, Yasuhara M, Thorn S, Wei CL, Costello M & Colwell RK (2020). Quantifying sample completeness and comparing diversities among assemblages. *Ecological Research*, *35*(2), 292-314.

Desmet P, Oldoni D, Blissett M, Robertson T (2023). Specification for species occurrence cubes and their production. https://docs.b-cubed.eu/guides/occurrence-cube/

DG Environment (2017). Reporting under Article 17 of the Habitats Directive: Explanatory notes and guidelines for the period 2013–2018. Brussels. Pp 188.

Dove, S. (2025). Report of the workflow of the implemented biodiversity indicators. B3 project deliverable D5.1. https://b-cubed.eu/storage/app/uploads/public/68c/8f1/9fe/68c8f19fee68b304301423.pdf#file_name=D5.1_2025_BiodiversityIndicators.pdf

Dove S (2026). b3gbi: General Biodiversity Indicators for Biodiversity Data Cubes. R package version 0.9.3, https://github.com/b-cubed-eu/b3gbi.

GBIF (2026). New and improved GBIF.org website. Available at: https://www.gbif.org/news/4LbSrCst35Afw9XLa6YWAP/new-and-improved-gbiforg-website (Accessed: 17 July 2026).

Groom, Q., Adriaens, T., Desmet, P., Vanderhoeven, S.& Yovcheva, N. (2026a). Why countries need the Global Biodiversity Information Facility: Lessons from Belgium [policy brief]. Zenodo. https://doi.org/10.5281/zenodo.20810630

Groom, Q., Stoykova, N., Rodrigues, A., Hillaert, J., Estupinan-Suarez, L. M., MacFadyen, S.& Langeraert, W. (2026b). Data pipelines for policy-relevant indicators [Policy brief]. Zenodo. https://doi.org/10.5281/zenodo.19604942

Estes, L., Elsen, P.R., Treuer, T. et al. (2018) The spatial and temporal domains of modern ecology. Nat Ecol Evol 2, 819–826. https://doi.org/10.1038/s41559-018-0524-4

Estupinan-Suarez, L. M., Groom, Q., Pereira, H., Preda, C., Rodrigues, A., Sica, Y., Teixeira, H., Yovcheva, N., Fernandez, M. (2024). Alignment of B3 with European Biodiversity Initiatives:Insights from EU policy. B3 project deliverable D1.5 https://b-cubed.eu/library

European Environment Agency (EEA) (2021). *Conservation Status of Habitat Types and Species: Datasets from Article 17, Habitats Directive 92/43/EEC reporting*. Dataset. Available at: EEA Datahub (Accessed: 15 September 2025).

European Environment Agency (EEA) (2026). *Article 17 web tool*. Available at: https://nature-art17.eionet.europa.eu/ (Accessed: 16 July 2026).

Langeraert W & Van Daele T (2026). Dubicube: Calculation and Interpretation of Data Cube Indicator Uncertainty. Version 0.12.3. https://b-cubed-eu.github.io/dubicube/

Langeraert W, Faulkner K, Cartuyvels E, Groom Q, Van Daele T (2026). Report on the criteria for data quality and species characteristics for estimating species status and trends. B3 project deliverable D4.3. https://b-cubed.eu/storage/app/uploads/public/69a/943/ea1/69a943ea17e66799908588.pdf

Machado AL & Teixeira H (2026). GBIF taxonomic keys for taxa reported under the EU Habitats Directive (Article 17): reporting cycles 2001-2006, 2007-2012 and 2013-2018 (Version 1.0) [Dataset]. Zenodo. https://doi.org/10.5281/zenodo.21457125

Röschel L, Noebel R, Stein U, Naumann S, Romão C, Tryfo E, Gaudillat Z, Roscher S, Moser D, Ellmauer T, Löhnertz M, Halada L, Staneva A & Rutherford C (2020). State of nature in the EU—methodological paper Methodologies under the nature directives reporting 2013–2018 and analysis for the State of Nature 2000. *European Environment Agency: Copenhagen, Denmark*.

Annex

Annex 1: GBIF download keys and associated DOIs for all occurrence downloads used to construct the biodiversity data cubes in the stakeholder-driven case study. Downloads were generated for all species listed under the Annexes of the Habitats Directive, separately for each reporting cycle (2001–2006, 2007–2012, 2013–2018 and 2019–2024) and for each country with reporting obligations under Article 17 during the corresponding reporting cycle.

hd_cycle	country	rank	n_taxon_keys	download_key	doi
2001-2006	AT	GENUS	5	0005442-260519110011954	10.15468/dl.jq76pp
2001-2006	BE	GENUS	5	0005446-260519110011954	10.15468/dl.mpt68y
2001-2006	CY	GENUS	5	0005450-260519110011954	10.15468/dl.b62un6
2001-2006	CZ	GENUS	5	0005452-260519110011954	10.15468/dl.beb3zm
2001-2006	DE	GENUS	5	0005455-260519110011954	10.15468/dl.j7ut4h
2001-2006	DK	GENUS	5	0005458-260519110011954	10.15468/dl.5j467s
2001-2006	EE	GENUS	5	0005461-260519110011954	10.15468/dl.edf8k4
2001-2006	ES	GENUS	5	0005463-260519110011954	10.15468/dl.dvxxxn
2001-2006	FI	GENUS	5	0005468-260519110011954	10.15468/dl.gaub73
2001-2006	FR	GENUS	5	0005473-260519110011954	10.15468/dl.a68ddk
2001-2006	GB	GENUS	5	0005479-260519110011954	10.15468/dl.6gyzep
2001-2006	GR	GENUS	5	0005485-260519110011954	10.15468/dl.qwkfrv
2001-2006	HU	GENUS	5	0005488-260519110011954	10.15468/dl.qwkfrv
2001-2006	IE	GENUS	5	0005491-260519110011954	10.15468/dl.68tj2c
2001-2006	IT	GENUS	5	0005495-260519110011954	10.15468/dl.an6kx9
2001-2006	LT	GENUS	5	0005498-260519110011954	10.15468/dl.w5j2z6
2001-2006	LU	GENUS	5	0005505-260519110011954	10.15468/dl.4ryqbv
2001-2006	LV	GENUS	5	0005508-260519110011954	10.15468/dl.26u76j
2001-2006	MT	GENUS	5	0005512-260519110011954	10.15468/dl.2wrf8g
2001-2006	NL	GENUS	5	0005515-260519110011954	10.15468/dl.pbjtht
2001-2006	PL	GENUS	5	0005521-260519110011954	10.15468/dl.w834t6
2001-2006	PT	GENUS	5	0005529-260519110011954	10.15468/dl.zq5qcf
2001-2006	SE	GENUS	5	0005533-260519110011954	10.15468/dl.8yef34
2001-2006	SI	GENUS	5	0005555-260519110011954	10.15468/dl.g38qsh
2001-2006	SK	GENUS	5	0005559-260519110011954	10.15468/dl.2ykcs5
2007-2012	AT	GENUS	3	0005561-260519110011954	10.15468/dl.5w734m
2007-2012	BE	GENUS	3	0005566-260519110011954	10.15468/dl.ut4mtq
2007-2012	BG	GENUS	3	0005569-260519110011954	10.15468/dl.3wr394
2007-2012	CY	GENUS	3	0005576-260519110011954	10.15468/dl.8hyr75
2007-2012	CZ	GENUS	3	0005581-260519110011954	10.15468/dl.2n6hc8
2007-2012	DE	GENUS	3	0005584-260519110011954	10.15468/dl.9f86q4
2007-2012	DK	GENUS	3	0005591-260519110011954	10.15468/dl.57negq
2007-2012	EE	GENUS	3	0005598-260519110011954	10.15468/dl.ck9hcb
2007-2012	ES	GENUS	3	0005604-260519110011954	10.15468/dl.a34qbv
2007-2012	FI	GENUS	3	0005615-260519110011954	10.15468/dl.f52h7s
2007-2012	FR	GENUS	3	0005620-260519110011954	10.15468/dl.t55ugm
2007-2012	GB	GENUS	3	0005626-260519110011954	10.15468/dl.t3wdv5
2007-2012	GR	GENUS	3	0005633-260519110011954	10.15468/dl.2h8vn5
2007-2012	HU	GENUS	3	0005636-260519110011954	10.15468/dl.tgpwfm
2007-2012	IE	GENUS	3	0005642-260519110011954	10.15468/dl.jqtr8s
2007-2012	IT	GENUS	3	0005647-260519110011954	10.15468/dl.89pd28
2007-2012	LT	GENUS	3	0005655-260519110011954	10.15468/dl.u4pdnh
2007-2012	LU	GENUS	3	0005663-260519110011954	10.15468/dl.pxvj3a
2007-2012	LV	GENUS	3	0005666-260519110011954	10.15468/dl.gz6pv3
2007-2012	MT	GENUS	3	0005673-260519110011954	10.15468/dl.bh858n
2007-2012	NL	GENUS	3	0005676-260519110011954	10.15468/dl.2erjtt

2007-2012	PL	GENUS	3	0005682-260519110011954	10.15468/dl.peh5q3
2007-2012	PT	GENUS	3	0005687-260519110011954	10.15468/dl.vt3mdf
2007-2012	RO	GENUS	3	0005691-260519110011954	10.15468/dl.7pjg7h
2007-2012	SE	GENUS	3	0005700-260519110011954	10.15468/dl.5c6n2n
2007-2012	SI	GENUS	3	0005710-260519110011954	10.15468/dl.asw2cd
2007-2012	SK	GENUS	3	0005717-260519110011954	10.15468/dl.cw4had
2013-2018	AT	GENUS	3	0005720-260519110011954	10.15468/dl.spa4rk
2013-2018	BE	GENUS	3	0005725-260519110011954	10.15468/dl.ak2sd2
2013-2018	BG	GENUS	3	0005731-260519110011954	10.15468/dl.sd6r55
2013-2018	CY	GENUS	3	0005734-260519110011954	10.15468/dl.gwj3pq
2013-2018	CZ	GENUS	3	0005738-260519110011954	10.15468/dl.qpptzp
2013-2018	DE	GENUS	3	0005744-260519110011954	10.15468/dl.bah64h
2013-2018	DK	GENUS	3	0005747-260519110011954	10.15468/dl.cxgxyb
2013-2018	EE	GENUS	3	0005749-260519110011954	10.15468/dl.tmqucg
2013-2018	ES	GENUS	3	0005751-260519110011954	10.15468/dl.8u45ty
2013-2018	FI	GENUS	3	0005760-260519110011954	10.15468/dl.6j7kpn
2013-2018	FR	GENUS	3	0005764-260519110011954	10.15468/dl.rudyr2
2013-2018	GB	GENUS	3	0005769-260519110011954	10.15468/dl.yexwwu
2013-2018	GR	GENUS	3	0005775-260519110011954	10.15468/dl.n9ptnf
2013-2018	HR	GENUS	3	0005781-260519110011954	10.15468/dl.dhtsm4
2013-2018	HU	GENUS	3	0005792-260519110011954	10.15468/dl.eqswmg
2013-2018	IE	GENUS	3	0005803-260519110011954	10.15468/dl.h9va34
2013-2018	IT	GENUS	3	0005808-260519110011954	10.15468/dl.7gadtq
2013-2018	LT	GENUS	3	0005812-260519110011954	10.15468/dl.jem93z
2013-2018	LU	GENUS	3	0005817-260519110011954	10.15468/dl.et3v65
2013-2018	LV	GENUS	3	0005820-260519110011954	10.15468/dl.8jzy5v
2013-2018	MT	GENUS	3	0005829-260519110011954	10.15468/dl.jbcaev
2013-2018	NL	GENUS	3	0005832-260519110011954	10.15468/dl.xqvv7j
2013-2018	PL	GENUS	3	0005836-260519110011954	10.15468/dl.jjmrd4
2013-2018	PT	GENUS	3	0005843-260519110011954	10.15468/dl.eyc2e3
2013-2018	RO	GENUS	3	0005847-260519110011954	10.15468/dl.vtgtuf
2013-2018	SE	GENUS	3	0005851-260519110011954	10.15468/dl.8py36k
2013-2018	SI	GENUS	3	0005888-260519110011954	10.15468/dl.px9ume
2013-2018	SK	GENUS	3	0005891-260519110011954	10.15468/dl.c2xj2y
2019-2024	AT	GENUS	3	0005898-260519110011954	10.15468/dl.5vytt8
2019-2024	BE	GENUS	3	0005902-260519110011954	10.15468/dl.f5vc77
2019-2024	BG	GENUS	3	0005910-260519110011954	10.15468/dl.7ujcj7
2019-2024	CY	GENUS	3	0005915-260519110011954	10.15468/dl.ks9kad
2019-2024	CZ	GENUS	3	0005920-260519110011954	10.15468/dl.dhxcw8
2019-2024	DE	GENUS	3	0005926-260519110011954	10.15468/dl.5cwq42
2019-2024	DK	GENUS	3	0005930-260519110011954	10.15468/dl.m4n9v3
2019-2024	EE	GENUS	3	0005937-260519110011954	10.15468/dl.t8uu8j
2019-2024	ES	GENUS	3	0005944-260519110011954	10.15468/dl.z5pqex
2019-2024	FI	GENUS	3	0005949-260519110011954	10.15468/dl.ndv4z5
2019-2024	FR	GENUS	3	0005953-260519110011954	10.15468/dl.8szr3p
2019-2024	GB	GENUS	3	0005956-260519110011954	10.15468/dl.dap2ev
2019-2024	GR	GENUS	3	0005960-260519110011954	10.15468/dl.af2p8f
2019-2024	HR	GENUS	3	0005965-260519110011954	10.15468/dl.va2yfm
2019-2024	HU	GENUS	3	0005968-260519110011954	10.15468/dl.ns8rv5
2019-2024	IE	GENUS	3	0005972-260519110011954	10.15468/dl.6pg8sf
2019-2024	IT	GENUS	3	0005977-260519110011954	10.15468/dl.7yfrfs
2019-2024	LT	GENUS	3	0005982-260519110011954	10.15468/dl.9vyeaa
2019-2024	LU	GENUS	3	0005985-260519110011954	10.15468/dl.w47cqx
2019-2024	LV	GENUS	3	0005992-260519110011954	10.15468/dl.khm6yt
2019-2024	MT	GENUS	3	0005996-260519110011954	10.15468/dl.gce8y4
2019-2024	NL	GENUS	3	0006001-260519110011954	10.15468/dl.yyh5yb
2019-2024	PL	GENUS	3	0006031-260519110011954	10.15468/dl.hbdgy9

2019-2024	PT	GENUS	3	0006034-260519110011954	10.15468/dl.39bn33
2019-2024	RO	GENUS	3	0006038-260519110011954	10.15468/dl.h7yagn
2019-2024	SE	GENUS	3	0006044-260519110011954	10.15468/dl.vfmuqf
2019-2024	SI	GENUS	3	0006069-260519110011954	10.15468/dl.ppm68k
2019-2024	SK	GENUS	3	0006073-260519110011954	10.15468/dl.sks552
2001-2006	AT	SPECIES	1039	0006079-260519110011954	10.15468/dl.yamt7y
2001-2006	BE	SPECIES	1039	0006086-260519110011954	10.15468/dl.fthen8
2001-2006	CY	SPECIES	1039	0006092-260519110011954	10.15468/dl.4d2vwx
2001-2006	CZ	SPECIES	1039	0006096-260519110011954	10.15468/dl.757wfx
2001-2006	DE	SPECIES	1039	0006102-260519110011954	10.15468/dl.xmta6c
2001-2006	DK	SPECIES	1039	0006108-260519110011954	10.15468/dl.f5d2sh
2001-2006	EE	SPECIES	1039	0006114-260519110011954	10.15468/dl.rrjkwy
2001-2006	ES	SPECIES	1039	0006120-260519110011954	10.15468/dl.sbfmya
2001-2006	FI	SPECIES	1039	0006146-260519110011954	10.15468/dl.8cxuna
2001-2006	FR	SPECIES	1039	0006150-260519110011954	10.15468/dl.ebvdmt
2001-2006	GB	SPECIES	1039	0006202-260519110011954	10.15468/dl.sb7qmg
2001-2006	GR	SPECIES	1039	0006241-260519110011954	10.15468/dl.eyjmn2
2001-2006	HU	SPECIES	1039	0006245-260519110011954	10.15468/dl.vkwem6
2001-2006	IE	SPECIES	1039	0006250-260519110011954	10.15468/dl.ahhgx2
2001-2006	IT	SPECIES	1039	0006252-260519110011954	10.15468/dl.m22jnu
2001-2006	LT	SPECIES	1039	0006257-260519110011954	10.15468/dl.gjufed
2001-2006	LU	SPECIES	1039	0006260-260519110011954	10.15468/dl.yqaz6b
2001-2006	LV	SPECIES	1039	0006266-260519110011954	10.15468/dl.um56u7
2001-2006	MT	SPECIES	1039	0006272-260519110011954	10.15468/dl.xcgmsq
2001-2006	NL	SPECIES	1039	0006276-260519110011954	10.15468/dl.erjpky
2001-2006	PL	SPECIES	1039	0006281-260519110011954	10.15468/dl.km6wj4
2001-2006	PT	SPECIES	1039	0006292-260519110011954	10.15468/dl.bh6qr4
2001-2006	SE	SPECIES	1039	0006333-260519110011954	10.15468/dl.wtdw2q
2001-2006	SI	SPECIES	1039	0006362-260519110011954	10.15468/dl.hntfyt
2001-2006	SK	SPECIES	1039	0006368-260519110011954	10.15468/dl.v7zjrh
2007-2012	AT	SPECIES	1188	0006372-260519110011954	10.15468/dl.44yfxs
2007-2012	BE	SPECIES	1188	0006383-260519110011954	10.15468/dl.pjdkga
2007-2012	BG	SPECIES	1188	0006430-260519110011954	10.15468/dl.7e72vx
2007-2012	CY	SPECIES	1188	0006436-260519110011954	10.15468/dl.vpj8mn
2007-2012	CZ	SPECIES	1188	0006444-260519110011954	10.15468/dl.46nrxt
2007-2012	DE	SPECIES	1188	0006450-260519110011954	10.15468/dl.kk6b9v
2007-2012	DK	SPECIES	1188	0006458-260519110011954	10.15468/dl.5mtjd4
2007-2012	EE	SPECIES	1188	0006493-260519110011954	10.15468/dl.v8v53x
2007-2012	ES	SPECIES	1188	0006498-260519110011954	10.15468/dl.mmzqd6
2007-2012	FI	SPECIES	1188	0006542-260519110011954	10.15468/dl.97nkhx
2007-2012	FR	SPECIES	1188	0006550-260519110011954	10.15468/dl.c6hvsq
2007-2012	GB	SPECIES	1188	0006587-260519110011954	10.15468/dl.7c5aaf
2007-2012	GR	SPECIES	1188	0006627-260519110011954	10.15468/dl.4qsdn2
2007-2012	HU	SPECIES	1188	0006633-260519110011954	10.15468/dl.gh6mzu
2007-2012	IE	SPECIES	1188	0006639-260519110011954	10.15468/dl.3xvjdb
2007-2012	IT	SPECIES	1188	0006646-260519110011954	10.15468/dl.5vsc2z
2007-2012	LT	SPECIES	1188	0006650-260519110011954	10.15468/dl.synqnc
2007-2012	LU	SPECIES	1188	0006653-260519110011954	10.15468/dl.hehmdw
2007-2012	LV	SPECIES	1188	0006656-260519110011954	10.15468/dl.qdtxza
2007-2012	MT	SPECIES	1188	0006659-260519110011954	10.15468/dl.qs9mvr
2007-2012	NL	SPECIES	1188	0006662-260519110011954	10.15468/dl.2yyh4y
2007-2012	PL	SPECIES	1188	0006693-260519110011954	10.15468/dl.wb67ue
2007-2012	PT	SPECIES	1188	0006697-260519110011954	10.15468/dl.mhwzu5
2007-2012	RO	SPECIES	1188	0006721-260519110011954	10.15468/dl.dqqsnh
2007-2012	SE	SPECIES	1188	0006724-260519110011954	10.15468/dl.y5c53f
2007-2012	SI	SPECIES	1188	0006737-260519110011954	10.15468/dl.zzc3g7
2007-2012	SK	SPECIES	1188	0006738-260519110011954	10.15468/dl.wcjx8j

2013-2018	AT	SPECIES	1403	0006743-260519110011954	10.15468/dl.wzef6e
2013-2018	BE	SPECIES	1403	0006745-260519110011954	10.15468/dl.cxw97u
2013-2018	BG	SPECIES	1403	0006762-260519110011954	10.15468/dl.46hs3d
2013-2018	CY	SPECIES	1403	0006764-260519110011954	10.15468/dl.fjyncn
2013-2018	CZ	SPECIES	1403	0006769-260519110011954	10.15468/dl.9wb7v8
2013-2018	DE	SPECIES	1403	0006772-260519110011954	10.15468/dl.5ngnws
2013-2018	DK	SPECIES	1403	0006798-260519110011954	10.15468/dl.q8qf76
2013-2018	EE	SPECIES	1403	0006816-260519110011954	10.15468/dl.88h6ym
2013-2018	ES	SPECIES	1403	0006818-260519110011954	10.15468/dl.88davz
2013-2018	FI	SPECIES	1403	0006843-260519110011954	10.15468/dl.3sqjg6
2013-2018	FR	SPECIES	1403	0006855-260519110011954	10.15468/dl.hxr3mj
2013-2018	GB	SPECIES	1403	0006871-260519110011954	10.15468/dl.kj5rvv
2013-2018	GR	SPECIES	1403	0006883-260519110011954	10.15468/dl.x95efm
2013-2018	HR	SPECIES	1403	0006885-260519110011954	10.15468/dl.qhchtr
2013-2018	HU	SPECIES	1403	0006887-260519110011954	10.15468/dl.ef85r2
2013-2018	IE	SPECIES	1403	0006888-260519110011954	10.15468/dl.jgp85z
2013-2018	IT	SPECIES	1403	0006891-260519110011954	10.15468/dl.gf9v7p
2013-2018	LT	SPECIES	1403	0006894-260519110011954	10.15468/dl.6hqqad
2013-2018	LU	SPECIES	1403	0006896-260519110011954	10.15468/dl.55uxd7
2013-2018	LV	SPECIES	1403	0006899-260519110011954	10.15468/dl.vpg9xe
2013-2018	MT	SPECIES	1403	0006904-260519110011954	10.15468/dl.c577na
2013-2018	NL	SPECIES	1403	0006908-260519110011954	10.15468/dl.n542gm
2013-2018	PL	SPECIES	1403	0006932-260519110011954	10.15468/dl.z7hv3u
2013-2018	PT	SPECIES	1403	0006937-260519110011954	10.15468/dl.jp5fjz
2013-2018	RO	SPECIES	1403	0006962-260519110011954	10.15468/dl.yad9ku
2013-2018	SE	SPECIES	1403	0006964-260519110011954	10.15468/dl.3yrabg
2013-2018	SI	SPECIES	1403	0006979-260519110011954	10.15468/dl.2f6feq
2013-2018	SK	SPECIES	1403	0006982-260519110011954	10.15468/dl.e4hpkd
2019-2024	AT	SPECIES	1403	0006985-260519110011954	10.15468/dl.6p22n4
2019-2024	BE	SPECIES	1403	0007002-260519110011954	10.15468/dl.nza4v7
2019-2024	BG	SPECIES	1403	0007020-260519110011954	10.15468/dl.s6hcsf
2019-2024	CY	SPECIES	1403	0007023-260519110011954	10.15468/dl.6kbzbv
2019-2024	CZ	SPECIES	1403	0007026-260519110011954	10.15468/dl.xfgknn
2019-2024	DE	SPECIES	1403	0007028-260519110011954	10.15468/dl.2a88v6
2019-2024	DK	SPECIES	1403	0007038-260519110011954	10.15468/dl.5rb9d2
2019-2024	EE	SPECIES	1403	0007056-260519110011954	10.15468/dl.vp96h9
2019-2024	ES	SPECIES	1403	0007057-260519110011954	10.15468/dl.z28dkh
2019-2024	FI	SPECIES	1403	0007067-260519110011954	10.15468/dl.2s6bwp
2019-2024	FR	SPECIES	1403	0007077-260519110011954	10.15468/dl.jj73ds
2019-2024	GB	SPECIES	1403	0007097-260519110011954	10.15468/dl.ytegnp
2019-2024	GR	SPECIES	1403	0007112-260519110011954	10.15468/dl.kut66u
2019-2024	HR	SPECIES	1403	0007116-260519110011954	10.15468/dl.kyjmg8
2019-2024	HU	SPECIES	1403	0007118-260519110011954	10.15468/dl.gcfey9
2019-2024	IE	SPECIES	1403	0007121-260519110011954	10.15468/dl.9ujv5u
2019-2024	IT	SPECIES	1403	0007123-260519110011954	10.15468/dl.zebkhf
2019-2024	LT	SPECIES	1403	0007135-260519110011954	10.15468/dl.se3s93
2019-2024	LU	SPECIES	1403	0007138-260519110011954	10.15468/dl.cuuwht
2019-2024	LV	SPECIES	1403	0007141-260519110011954	10.15468/dl.addqya
2019-2024	MT	SPECIES	1403	0007144-260519110011954	10.15468/dl.kgnz2y
2019-2024	NL	SPECIES	1403	0007146-260519110011954	10.15468/dl.v5xv3h
2019-2024	PL	SPECIES	1403	0007157-260519110011954	10.15468/dl.5b8a74
2019-2024	PT	SPECIES	1403	0007158-260519110011954	10.15468/dl.yj2hmh
2019-2024	RO	SPECIES	1403	0007164-260519110011954	10.15468/dl.fxrgy2
2019-2024	SE	SPECIES	1403	0007166-260519110011954	10.15468/dl.zc7wqw
2019-2024	SI	SPECIES	1403	0007179-260519110011954	10.15468/dl.ybgv74
2019-2024	SK	SPECIES	1403	0007182-260519110011954	10.15468/dl.wf38fg
2001-2006	AT	SUBSPECIES	52	0007183-260519110011954	10.15468/dl.sh6h2t

2001-2006	BE	SUBSPECIES	52	0007186-260519110011954	10.15468/dl.29aesb
2001-2006	CY	SUBSPECIES	52	0007189-260519110011954	10.15468/dl.yjkfc3
2001-2006	CZ	SUBSPECIES	52	0007191-260519110011954	10.15468/dl.s7vsgc
2001-2006	DE	SUBSPECIES	52	0007193-260519110011954	10.15468/dl.wu4cgh
2001-2006	DK	SUBSPECIES	52	0007195-260519110011954	10.15468/dl.uxuyvk
2001-2006	EE	SUBSPECIES	52	0007196-260519110011954	10.15468/dl.kupqy4
2001-2006	ES	SUBSPECIES	52	0007197-260519110011954	10.15468/dl.ht8tu4
2001-2006	FI	SUBSPECIES	52	0007198-260519110011954	10.15468/dl.a745hg
2001-2006	FR	SUBSPECIES	52	0007200-260519110011954	10.15468/dl.gnjs5w
2001-2006	GB	SUBSPECIES	52	0007203-260519110011954	10.15468/dl.xwh9kw
2001-2006	GR	SUBSPECIES	52	0007204-260519110011954	10.15468/dl.cbp2y2
2001-2006	HU	SUBSPECIES	52	0007207-260519110011954	10.15468/dl.nkagvk
2001-2006	IE	SUBSPECIES	52	0007208-260519110011954	10.15468/dl.8944uu
2001-2006	IT	SUBSPECIES	52	0007210-260519110011954	10.15468/dl.5p64eg
2001-2006	LT	SUBSPECIES	52	0007211-260519110011954	10.15468/dl.puszu2
2001-2006	LU	SUBSPECIES	52	0007212-260519110011954	10.15468/dl.3wytqw
2001-2006	LV	SUBSPECIES	52	0007213-260519110011954	10.15468/dl.922rzq
2001-2006	MT	SUBSPECIES	52	0007214-260519110011954	10.15468/dl.wvs2yx
2001-2006	NL	SUBSPECIES	52	0007216-260519110011954	10.15468/dl.58nns5
2001-2006	PL	SUBSPECIES	52	0007217-260519110011954	10.15468/dl.y4ydbq
2001-2006	PT	SUBSPECIES	52	0007219-260519110011954	10.15468/dl.5n9hmb
2001-2006	SE	SUBSPECIES	52	0007222-260519110011954	10.15468/dl.am4w2h
2001-2006	SI	SUBSPECIES	52	0007224-260519110011954	10.15468/dl.8j2kbs
2001-2006	SK	SUBSPECIES	52	0007226-260519110011954	10.15468/dl.d3x8nz
2007-2012	AT	SUBSPECIES	53	0007228-260519110011954	10.15468/dl.2y5cr9
2007-2012	BE	SUBSPECIES	53	0007231-260519110011954	10.15468/dl.e4q7w7
2007-2012	BG	SUBSPECIES	53	0007234-260519110011954	10.15468/dl.26d7zk
2007-2012	CY	SUBSPECIES	53	0007237-260519110011954	10.15468/dl.urzcuf
2007-2012	CZ	SUBSPECIES	53	0007240-260519110011954	10.15468/dl.us4cz5
2007-2012	DE	SUBSPECIES	53	0007242-260519110011954	10.15468/dl.e8a6gz
2007-2012	DK	SUBSPECIES	53	0007244-260519110011954	10.15468/dl.pbpefz
2007-2012	EE	SUBSPECIES	53	0007248-260519110011954	10.15468/dl.6fxt7b
2007-2012	ES	SUBSPECIES	53	0007249-260519110011954	10.15468/dl.w5s3tt
2007-2012	FI	SUBSPECIES	53	0007252-260519110011954	10.15468/dl.26xwe2
2007-2012	FR	SUBSPECIES	53	0007256-260519110011954	10.15468/dl.hexvd2
2007-2012	GB	SUBSPECIES	53	0007259-260519110011954	10.15468/dl.mwms89
2007-2012	GR	SUBSPECIES	53	0007261-260519110011954	10.15468/dl.fxkwth
2007-2012	HU	SUBSPECIES	53	0007263-260519110011954	10.15468/dl.bqjad7
2007-2012	IE	SUBSPECIES	53	0007268-260519110011954	10.15468/dl.9tx8j4
2007-2012	IT	SUBSPECIES	53	0007272-260519110011954	10.15468/dl.8qcwqk
2007-2012	LT	SUBSPECIES	53	0007276-260519110011954	10.15468/dl.ps6qy9
2007-2012	LU	SUBSPECIES	53	0007280-260519110011954	10.15468/dl.h9wf55
2007-2012	LV	SUBSPECIES	53	0007283-260519110011954	10.15468/dl.cjf55d
2007-2012	MT	SUBSPECIES	53	0007286-260519110011954	10.15468/dl.sd8u5u
2007-2012	NL	SUBSPECIES	53	0007290-260519110011954	10.15468/dl.yygt5q
2007-2012	PL	SUBSPECIES	53	0007295-260519110011954	10.15468/dl.hyyb2x
2007-2012	PT	SUBSPECIES	53	0007298-260519110011954	10.15468/dl.dxcnxx
2007-2012	RO	SUBSPECIES	53	0007303-260519110011954	10.15468/dl.bp555w
2007-2012	SE	SUBSPECIES	53	0007305-260519110011954	10.15468/dl.mvh4q3
2007-2012	SI	SUBSPECIES	53	0007308-260519110011954	10.15468/dl.wrj3cz
2007-2012	SK	SUBSPECIES	53	0007310-260519110011954	10.15468/dl.yc22dt
2013-2018	AT	SUBSPECIES	75	0007313-260519110011954	10.15468/dl.zrebgp
2013-2018	BE	SUBSPECIES	75	0007315-260519110011954	10.15468/dl.7j2mae
2013-2018	BG	SUBSPECIES	75	0007318-260519110011954	10.15468/dl.uq3sax
2013-2018	CY	SUBSPECIES	75	0007319-260519110011954	10.15468/dl.vefv64
2013-2018	CZ	SUBSPECIES	75	0007320-260519110011954	10.15468/dl.nchk4b
2013-2018	DE	SUBSPECIES	75	0007321-260519110011954	10.15468/dl.vevq7u

2013-2018	DK	SUBSPECIES	75	0007325-260519110011954	10.15468/dl.g3hrnp
2013-2018	EE	SUBSPECIES	75	0007329-260519110011954	10.15468/dl.me3kyt
2013-2018	ES	SUBSPECIES	75	0007335-260519110011954	10.15468/dl.x6efqd
2013-2018	FI	SUBSPECIES	75	0007344-260519110011954	10.15468/dl.9pvje6
2013-2018	FR	SUBSPECIES	75	0007351-260519110011954	10.15468/dl.kkzuz2
2013-2018	GB	SUBSPECIES	75	0007357-260519110011954	10.15468/dl.nutzf3
2013-2018	GR	SUBSPECIES	75	0007361-260519110011954	10.15468/dl.247tqm
2013-2018	HR	SUBSPECIES	75	0007365-260519110011954	10.15468/dl.cdcb4z
2013-2018	HU	SUBSPECIES	75	0007369-260519110011954	10.15468/dl.tgvehq
2013-2018	IE	SUBSPECIES	75	0007372-260519110011954	10.15468/dl.xrf3vq
2013-2018	IT	SUBSPECIES	75	0007376-260519110011954	10.15468/dl.9uz9q4
2013-2018	LT	SUBSPECIES	75	0007379-260519110011954	10.15468/dl.agjrhe
2013-2018	LU	SUBSPECIES	75	0007384-260519110011954	10.15468/dl.dxjvu9
2013-2018	LV	SUBSPECIES	75	0007387-260519110011954	10.15468/dl.bmfsbk
2013-2018	MT	SUBSPECIES	75	0007395-260519110011954	10.15468/dl.hsh83x
2013-2018	NL	SUBSPECIES	75	0007404-260519110011954	10.15468/dl.n8a67m
2013-2018	PL	SUBSPECIES	75	0007412-260519110011954	10.15468/dl.d7sr3x
2013-2018	PT	SUBSPECIES	75	0007416-260519110011954	10.15468/dl.vzhcuv
2013-2018	RO	SUBSPECIES	75	0007417-260519110011954	10.15468/dl.e3n529
2013-2018	SE	SUBSPECIES	75	0007421-260519110011954	10.15468/dl.ytxf7z
2013-2018	SI	SUBSPECIES	75	0007424-260519110011954	10.15468/dl.dszbv7
2013-2018	SK	SUBSPECIES	75	0007427-260519110011954	10.15468/dl.gthwyz
2019-2024	AT	SUBSPECIES	75	0007429-260519110011954	10.15468/dl.2b5x84
2019-2024	BE	SUBSPECIES	75	0007434-260519110011954	10.15468/dl.us35za
2019-2024	BG	SUBSPECIES	75	0007438-260519110011954	10.15468/dl.w9sssp
2019-2024	CY	SUBSPECIES	75	0007441-260519110011954	10.15468/dl.88yau2
2019-2024	CZ	SUBSPECIES	75	0007443-260519110011954	10.15468/dl.ajaakk
2019-2024	DE	SUBSPECIES	75	0007446-260519110011954	10.15468/dl.4avdnk
2019-2024	DK	SUBSPECIES	75	0007451-260519110011954	10.15468/dl.qsukka
2019-2024	EE	SUBSPECIES	75	0007455-260519110011954	10.15468/dl.whbbva
2019-2024	ES	SUBSPECIES	75	0007461-260519110011954	10.15468/dl.ttp8wy
2019-2024	FI	SUBSPECIES	75	0007467-260519110011954	10.15468/dl.rxyn6y
2019-2024	FR	SUBSPECIES	75	0007472-260519110011954	10.15468/dl.vgtxcy
2019-2024	GB	SUBSPECIES	75	0007478-260519110011954	10.15468/dl.qqsbk2
2019-2024	GR	SUBSPECIES	75	0007482-260519110011954	10.15468/dl.aa7pqd
2019-2024	HR	SUBSPECIES	75	0007488-260519110011954	10.15468/dl.6g4fe8
2019-2024	HU	SUBSPECIES	75	0007494-260519110011954	10.15468/dl.rm4d2s
2019-2024	IE	SUBSPECIES	75	0007498-260519110011954	10.15468/dl.8rb3m8
2019-2024	IT	SUBSPECIES	75	0007502-260519110011954	10.15468/dl.4gce7g
2019-2024	LT	SUBSPECIES	75	0007507-260519110011954	10.15468/dl.mu95x6
2019-2024	LU	SUBSPECIES	75	0007510-260519110011954	10.15468/dl.mdt349
2019-2024	LV	SUBSPECIES	75	0007514-260519110011954	10.15468/dl.kwg4x7
2019-2024	MT	SUBSPECIES	75	0007517-260519110011954	10.15468/dl.esp4mw
2019-2024	NL	SUBSPECIES	75	0007523-260519110011954	10.15468/dl.s7zqfq
2019-2024	PL	SUBSPECIES	75	0007527-260519110011954	10.15468/dl.junfxq
2019-2024	PT	SUBSPECIES	75	0007528-260519110011954	10.15468/dl.rm8bqd
2019-2024	RO	SUBSPECIES	75	0007530-260519110011954	10.15468/dl.dkda74
2019-2024	SE	SUBSPECIES	75	0007533-260519110011954	10.15468/dl.3928nx
2019-2024	SI	SUBSPECIES	75	0007536-260519110011954	10.15468/dl.sy93mf
2019-2024	SK	SUBSPECIES	75	0007542-260519110011954	10.15468/dl.wfg3ba