

MAMBO

MODERN APPROACHES TO THE
MONITORING OF BIODIVERSITY

D2.1 Report on optimal positioning and linkage of MAMBO tools to KCBD and RI landscape

Version 2.0

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D2.1 Report on optimal positioning and linkage of MAMBO tools to KCBD and RI landscape

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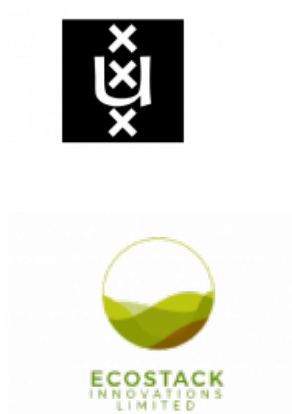
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Project Partners



Summary

Following directives set out by the EU Biodiversity Strategy and Kunming-Montreal Global Biodiversity Framework ([Target 20](#)), MAMBO seeks to deliver cutting-edge, interoperable tools for species and habitat monitoring by 2030. In order to optimally position and link the MAMBO tools under development to the Research Infrastructures (RIs) landscape and the Knowledge Centre on Biodiversity (KCBD) we developed a two step approach. First we collected details on RIs that are engaged in the biodiversity monitoring domain as a milestone of MAMBO task 2.1. Secondly, we conducted interviews with representatives of the identified RIs and asked them three questions: 1) Which of the six MAMBO tools are considered useful for your RI, 2) What is needed to achieve interoperability between existing research infrastructures and the MAMBO tools, and 3) what data standards are commonly used by leading Research Infrastructures (RIs) and organisations that are engaged with the monitoring of biodiversity. Not only does this consistency make the adoption of MAMBO tools easier for all, but it also ensures they will be accessible beyond the lifespan of the project.

Accordingly, between May and October 2023 Naturalis Biodiversity Center completed expert interviews with 23 representatives from 66 identified RIs and organisations from the biodiversity domain. Expert interviews were conducted to collect data on which of the six MAMBO tools are considered most useful for the respective RIs and what is needed for the seamless exchange of data between tools and the respective RIs. The six tools to be developed by MAMBO include: 1) image recognition software for species included in the annexes of the Habitats Directive, 2) sound recognition software for birds, bats, marine mammals, crickets and grasshoppers, 3) camera for monitoring nocturnal insects, 4) camera for monitoring pollinators, 5) habitat extent mapping tools, and 6) derivation of habitat status metrics from airborne LiDAR and/or drone data.

This study found that all six MAMBO tools were identified as useful by RIs/organisations for biodiversity monitoring going forward. In particular, image- and sound-recognition tools (MAMBO 1 and 2) were indicated as the most important. For optimal MAMBO tool use, RIs/organisations indicated the most important functionalities for tool use include: consistent use of data standards, available metadata, use of APIs and accurate GIS data. The use of a common taxonomic data infrastructure as provided by the Catalogue of Life (CoL) was considered as being most important for interoperability between the MAMBO tools and the RIs/Data providers, while the most popular metadata standards were Darwin Core (DwC), EML/XML and JSON.

1. Introduction

Interoperable and regularly updated biodiversity data is of crucial importance for streamlining biodiversity and ecosystem service monitoring, yet there is little integration across the EU and the globe. Tools are far too often built without consideration of the linkages to existing RIs and organisations. With the support of an advisory board and ten partners from biodiversity research institutes, MAMBO plans to invent, build, evaluate, and promote six tools in line with existing data collection efforts, and stakeholder and end-user needs (Table. 1). These tools will include the integration of “sensor development, deep learning, computer vision, acoustic ecology, remote sensing, biodiversity monitoring, citizen science, data pipelines and ecological modelling” which will be pivotal in bending the curve of biodiversity loss (Høye *et al.* 2023)¹.

¹ Høye, T., August, T., Balzan, M. V., Biesmeijer, K., Bonnet, P., Breeze, T., Dominik, C., Gerard, F., Joly, A., Kalkman, V., Kissling, W. D., Metodiev, T., Moeslund, J., Potts, S., Roy, D., Schweiger, O., Senapathi, D., Settele,



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Table 1. List of six MAMBO tools (and relevant WP) and the technology readiness levels (TRLs) at the start and end of MAMBO. TRL levels 1-9, where TRL1 represents the initial conceptualisation and TRL9 represents the fully operational and tested state of a tool.

MAMBO Tool	TRL start	TRL end
1. Image-recognition software for species on the annexes of the Habitats Directive (WP3)	2	7
2. Sound-recognition software for birds, bats, marine mammals, crickets, and grasshoppers (WP3)	2	5
3. Insect camera for monitoring nocturnal insects (WP3)	3	6
4. Insect camera for monitoring pollinators (WP3)	3	6
5. Habitat extent mapping tools (WP4)	2	6
6. Habitat condition metric derivation from airborne LiDAR and/or drone data (WP4)	3	6

Co-creation and user involvement are core aspects of the MAMBO project, especially for WP2 (Fig. 1). To ensure that the tools are accessible and long-lasting, it is necessary to identify the Research Infrastructures (RIs) and Data Providers in the biodiversity monitoring domain and data standards that they use. With this in mind, Naturalis conducted 23 expert interviews to gain insight on current EU biodiversity monitoring systems and biodiversity data requirements to determine the optimal positioning and linkage of MAMBO tools to the EU Knowledge Centre for Biodiversity (KCBD) and the Research Infrastructure (RI) and Data Provider landscape. The results of these interviews are presented in this MAMBO deliverable D2.1 report and builds on Milestone 2.1 “Inventory of relevant RIs and data providers” that created a database of 66 stakeholders who were contacted for an interview to capture the requirements of the MAMBO tools from their RI perspective to ensure that the MAMBO tools align with the needs of the wider stakeholder and end-user communities.

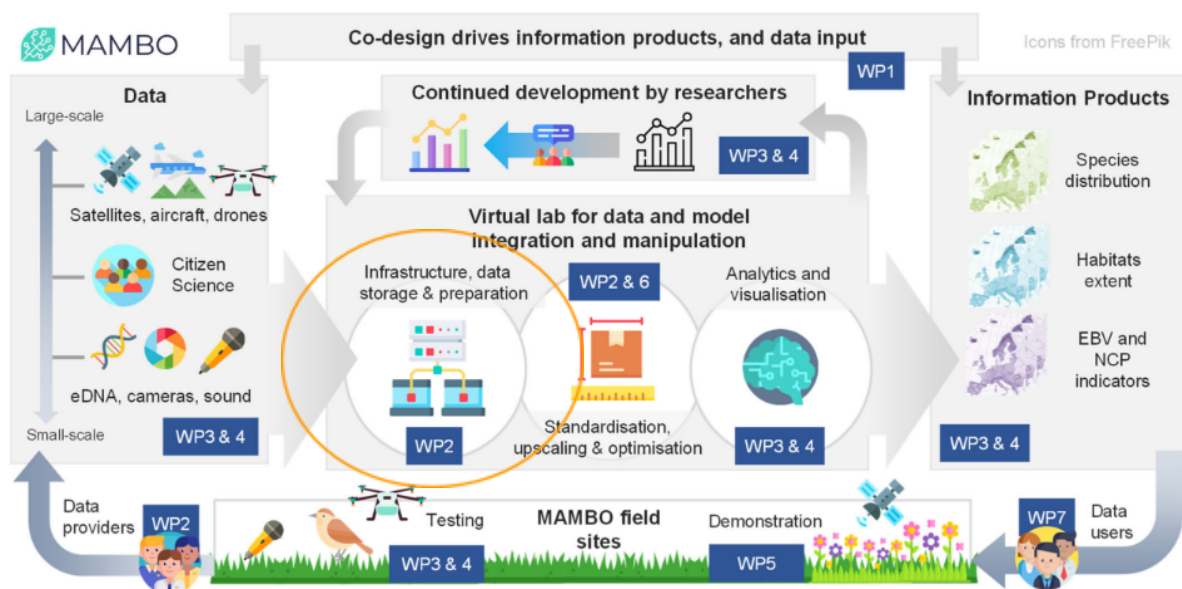


Figure 1. Schematic illustration of how the MAMBO project will contribute towards a cloud-based virtual lab solution for biodiversity assessment and monitoring.

2. Milestone 2.1: Inventory of Relevant Research Infrastructures (RIs) and Data Providers

As a preparatory step milestone 2.1 “Inventory of relevant Research Infrastructures (RIs) and Data Providers” was developed. For the milestone we identified RIs and data providers in the biodiversity domain, with the focus on Europe (Table 2). This was accomplished in consultation with MAMBO project partners and supplemented with an internet search resulting in a total of 66 different RIs and relevant organisations in the biodiversity monitoring and data domains (Appendix 1).

For all RIs/Organisations, data for the following seventeen parameters were collected:

- Acronym
- Full Name
- URL (Website)
- Contact (Contact Person)
- Contact Email (Email Person)
- Contact Profile (Profile Person)
- Leading Type of Initiative (EU/Others)
- Main Fields
- Approach
- Data types (Specific data types)
- Data Requirement (Interoperability)
- Software Requirement
- Remarks
- Date_Data Request contact (First request contact person)
- Date_Follow_Data Request / Date_data_provided (Follow contact person)
- Date_Interview
- Additional sources / Data ()
- Metadata

An extract of Milestone 2.1 is provided in Table 2. We were able to interview 23 of the 66 identified RIs which are indicated with green shading in Table 2. We were not able to retrieve personal contact details for all identified RIs, hence these were unsuccessfully addressed for an interview indicated in white. Given time constraints and the busy summer holiday and field work seasons we’re not able to have an interview with stakeholders indicated by yellow shading. The full data table can be consulted as ‘M2.1 Inventory of Relevant RIs and Data Providers’.

Table 2. Overview of identified RIs and organisations in the biodiversity domain, colour coded by those interviewed (green), non-interviewed (yellow), and unable to be reached (white).

ID	Acronym	fullName	URL	contact
1	Alternet	Alternet	https://alterneteurope.eu/	Tyler Kulfan (Alternet Secretariat)
2	ARISE	Authoritative and Rapid Identification System for Essential biodiversity information	https://www.arise-biodiversity.nl/	Elaine van Ommen Kloeke
3	BEEP	BEEP - Bee Monitoring	https://beep.nl/	Marten Schoonman
4	Belgian Biodiversity Platform	Belgian Biodiversity Platform	https://www.biodiversity.be/	contact@biodiversity.be
5	BGE	Biodiversity Genomics Europe	https://biodiversitygenomics.eu/	Roya Shokoohi
6	BiCIKL	Biodiversity Community Integrated Knowledge Library	https://bicikl-project.eu/	Lyubomir Penev
7	BioAgora	BioAgora	https://bioagora.eu/	Kati Vierikko



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8	Biodiversa+	Biodiversa+	https://www.biodiversa.eu/	https://www.biodiversa.eu/contact/
9	BioDT	Biodiversity Digital Twin	https://bioldt.eu/	Eva Alonso
10	BIOSCAN Europe	BIOSCAN Europe	https://www.bioscaneurope.org/	William Goodall Copestake
11	BirdNET	BirdNET Sound ID	https://birdnet.cornell.edu/	ccb-birdnet@cornell.edu
12	BOLD Systems	Barcode of Life Data System	http://www.boldsystems.org/	Sujeevan Ratnasingham
13	CETAF	Consortium of European Taxonomic Facilities	https://cetaf.org/	Ana Casio info@cetaf.org
14	COL	Catalogue of Life	https://www.catalogueoflife.org/	Olaf Banki
15	Copernicus	Satellite Earth Observation and in-situ (non-space) data	https://www.copernicus.eu/	Sergio Pérez Jorge Vinko Bandelj
16	DECIDE	Delivering Enhanced biodiversity information with adaptive Citizen science and Intelligent Digital Engagements	https://www.ceh.ac.uk/our-science/projects/decide	Michael Pocock
17	DentinE	Destination Earth	https://destination-earth.eu/	https://destination-earth.eu/contact-us/
18	DiSSCo	Distributed System of Scientific Collections	https://www.dissco.eu/	Eva Alonso
19	DTO-BioFlow	Integration of biodiversity monitoring data into the Digital Twin Ocean	https://www.seascapebelgium.be/dto-bioflow	Vicente Fernandez
20	Earth Biogenome Project	Earth Biogenome Project	Earthbiogenome.org	Harris Lewin
21	Easy RIDER	Real-time IDentification for Ecological Research and Monitoring	https://www.ceh.ac.uk/our-science/projects/easy-rider-real-time-identification-ecological-research-and-monitoring	David Roy
22	EcoStack	EcoStack	https://www.ecostack-h2020.eu/	Prof. Francesco Pennacchio
23	ECSITE	Ecsite - European Network Science Centers and Museums	https://www.ecsite.eu/	The Ecsite Executive Office
24	EEA	European Environment Agency	https://www.eea.europa.eu/en	Irina Levinsky Jan-Erik Petersen
25	eLTER	Integrated European Long-Term Ecosystem, critical zone and	https://elter-ri.eu/	Michael Mirtl



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		socio-ecological Research		
26	ENVRI	ENVironmental Research Infrastructures	https://envri.eu/	Andreas Petzold Sharif Slam
27	EoL	Encyclopaedia of Life	eol.org	Jen Hammock
28	EOSC	European Open Science Cloud	https://eosc-portal.eu/	Mark Van de Sanden
29	ERGA	The European Reference Genome Atlas	https://www.erga-biodiversity.eu/	Giulio Formenti
30	ESA	The European Space Agency	https://www.esa.int/	Estec
31	EUPoMS	EU Pollinator Monitoring Scheme	https://wikis.ec.europa.eu/pages/viewpage.action?pageId=23462107	JRC-POMS@ec.europa.eu
32	EUROPABON	Europa Biodiversity Observation Network	https://europabon.org/	Henrique Pereira (or through Daniel Kissling UvA)
33	GBIF	Global Biodiversity Information Facility	https://www.gbif.org/	Niels Raes
34	GEOBON	Global biodiversity observation network	https://geobon.org/	info@geobon.org
35	GUARDEN	safeGUARDing biodivErsity aNd critical ecosystem services across sectors and scales	https://guarden.org/	Pierre Bonnet
36	iBOL	International Barcode of Life	ibol.org	National Representative Hannah James
37	iNaturalist	iNaturalist	https://www.inaturalist.org/	help@inaturalist.org
38	InsectAI	InsectAI	https://www.cost.eu/actions/CA22129/	https://www.cost.eu/contact/
39	ITIS	Integrated Taxonomic Information System	https://www.itis.gov/	itiswebmaster@itis.gov
40	IUCN	International Union for Conservation of Nature	https://www.iucn.org/	IUCN Headquarters
41	KCBD	Knowledge Centre for Biodiversity	https://knowledge4policy.ec.europa.eu/biodiversity_en	Camino Liqueste Andrea Mandrici
42	LifeWatch	LifeWatch ERIC	https://www.lifewatch.eu/	Christos Arvanitidis
43	LIST	Luxembourg Institute of Science and Technology	https://www.list.lu/en/environment/	Dr. Habil Laurent Pfister
44	MARCO-BOLO CoP	MARCO-BOLO Community of Practice	https://marcobolo-project.eu/community-of-practice/	Vicente Fernandez Lisa Benedetti
45	MOBILISE	MOBILISE Action	https://www.mobilise-action.eu/	https://www.mobilise-a



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	Action			ction.eu/contact/
46	Motus	Motus Wildlife Tracking System	motus.org	N/A
47	NaturaConnect	NaturaConnect	https://naturaconnect.eu/	Matea Osti
48	NINA	Norwegian Institute for Nature Research	https://www.nina.no/english/Home	firmapost@nina.no
49	NSO	Netherlands Space Office	https://www.spaceoffice.nl/nl/	Jappe Jongejan
50	Observation International	Observation International	https://observation-international.org/en/	Dylan Verheul
51	OPPLA	Oppla is the EU Repository of Nature-Based Solutions.	https://oppla.eu/product/21728	info@oppla.eu
52	PESI	Pan-European Species directories Infrastructure	http://www.eu-nomen.eu/pesi/	N/A
53	PI@ntNET	PI@ntNET	https://plantnet.org/en/	Pierre Bonnet
54	Pollinator Academy	Pollinator Academy	https://pollinatoracademy.eu/	Merel Bozua
55	RESET	RESET	https://en.reset.org/	https://en.reset.org/contact/
56	Restor	Restor	https://restor.eco/?lat=26&lng=14.23&zoom=3	contact@restor.eco
57	SafeGUARD	Safeguarding European Wild Pollinators	https://www.safeguard.biozentrum.uni-wuerzburg.de/Project/About.aspx	Steffan Ingolf
58	SPRING	Strengthening Pollinator Recovery through INDicators and monitorinG	https://www.ufz.de/spring-pollination/	Mark van Nieuwstadt
59	STING	Science and Technology for Pollinating Insects	https://knowledge4policy.ec.europa.eu/projects-activities/sting-project_en	Simon Potts
60	Taxo-Fly	Taxo-Fly	https://www.luomus.fi/en/taxo-fly	Gunilla Ståhls
61	TETTRIs	Transforming European Taxonomy through Training, Research, and Innovations	https://tettris.eu/	Wouter Addink
62	The Wildlife Trusts/ORBIT	The Wildlife Trusts/ORBIT	https://www.wildlifetrusts.org/orbit	https://www.wildlifetrusts.org/contact-us
63	WildEye	WildEye	https://wildeyeconservation.org/ai/	Nicholas Osner
64	WILDLABS	WILDLABS	wildlabs.net	Stephanie O'Donnell
65	WWF	World Wildlife Fund	https://www.worldwildlife.org/	membership@wwfus.org



66	Xeno-Canto	Xeno-Canto	https://xeno-canto.org/	Willem-Pier Vellinga
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3. Methodology

After the initial identification of the 66 RIs and data providers, we reached out to those RIs that did not readily provide an email address of a representative that could be interviewed on behalf of the RI to collect information on the perceived relevance of the six MAMBO tools that are being developed (Table 1) and their requirements to facilitate data interoperability between the RIs and the MAMBO tools. We send an email as shown in Box 1 to the general contact information address that was found on the websites of the RIs. The Milestone document was updated with the provided contact information.

Box 1. Email template to request contact details of the respective RI.

Dear Ms/ Mr. (RI/ ORGANIZATION),

The EU MAMBO - Modern Approaches to the Monitoring of BiODiversity - project [<https://www.mambo-project.eu/>] is reaching out to other Research Infrastructures and organisations with a potential interest in the monitoring tools that are developed as a crucial output of the MAMBO project.

Your organisation is identified as a potential stakeholder with an interest in the MAMBO tools. To ensure maximum interoperability between the MAMBO tools under construction and your potential needs from these tools we would like to get in touch with one of your experts. Can you share contact details? Thank you very much in advance, and in case you have any further questions, don't hesitate to contact me.

Have an excellent day!

Kind regards,
Ana Maria Feijoo Q.
ana.feijooquezada@naturalis.nl

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3.1 Scheduling Interviews

All RIs for which contact information was retrieved were invited for an interview to provide their opinion on the six MAMBO tools (Table 1), the interoperability requirements from the perspective of their infrastructure, and the preferred data standards to facilitate interoperability. All addressed infrastructures were informed about the purpose of the interview through the email that is shown in Box 2. Due to the summer holiday season and field work commitments, many contacts were unable to respond or find time for an interview. For these reasons, we were not able to interview all addressed RIs within the limited time frame available for the deliverable.



Box 2. Email template used as an invitation for an interview.

Dear Ms/ Mr. (RI/ ORGANIZATION),

MAMBO, or the Modern Approaches to the Monitoring of BiODiversity [\[https://www.mambo-project.eu/\]](https://www.mambo-project.eu/) project, will develop, test, and implement enabling tools for monitoring conservation status and ecological requirements of species and habitats for which knowledge gaps still exist. The MAMBO project aims to contribute to the realisation of the EU Biodiversity Strategy for 2030 by harnessing the potential of cutting-edge tools for species and habitat monitoring to create a global community of practice for the development and application of new technologies for biodiversity monitoring. In this context, we would like to ensure that MAMBO tools under development can access, import, and export existing data sources to ensure interoperability with EU and other international biodiversity Research Infrastructures and biodiversity monitoring projects to serve the needs of stakeholders.

As part of MAMBO Work Package 2 on ‘Data providers and IT infrastructures’ task 2.1 on the ‘Inventory of, and agreement with RIs and organisations about MAMBO and its tools’ has completed a list of relevant stakeholders that we like to invite for an interview to ensure that the MAMBO tools align with the needs of the wider community. For that reason we reach out to you as a representative of **[RI / organisation]**. In order to further clarify our needs on information and to facilitate the interview we have compiled three questions to which we request input on behalf of your organisation which are provided below.

The MAMBO project will develop the following six tools:

1. Image-recognition **software** for species on the annexes of the Habitats Directive.
2. Sound-recognition **software** for birds, bats, marine mammals, crickets, and grasshoppers.
3. Insect **camera** for monitoring nocturnal insects.
4. Insect **camera** for monitoring pollinators.
5. Habitat extent **mapping tools**.
6. Habitat condition **metric derivation** from airborne LiDAR and/or drone data.

In order to facilitate seamless input and output of data to and from the tools under construction we have identified the following community-accepted file formats and data standards.

Format	Description
API	
POST API	A POST request, in simple terms, is a way for you to send data to a destination with the help of the internet.
REST API	A REST API is an API that conforms to the design principles of the REST, or representational state transfer architectural style.
SensorThings API	The OGC SensorThings API provides an open, geospatial-enabled and unified way to interconnect the Internet of Things (IoT) devices, data, and applications over the Web.
OPEN API	The OpenAPI Specification is a specification language for HTTP APIs that provides a standardised means to define your API to others.
Images	
jpeg	JPEG is a commonly used method of lossy compression for digital images, particularly for those images produced by digital photography.
PNG	Portable Network Graphics is a raster-graphics file format that supports lossless data



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	compression. PNG was developed as an improved, non-patented replacement for Graphics Interchange Format —unofficially, the initials PNG stood for the recursive acronym "PNG's not GIF".
GIF	GIF stands for Graphics Interchange Format. GIF is a raster file format designed for relatively basic images that appear mainly on the internet. Each file can support up to 8 bits per pixel and can contain 256 indexed colours. GIF files also allow images or frames to be combined, creating basic animations.
HIC	HIC: An image classification system based on supervised machine learning
ISO/IEC 10918-1	Digital compression and coding of continuous-tone still images image data to compressed image data
Sound	
PCM	PCM with uncompressed linear quantization is used for digital audio, with a sampling rate of 48kHz currently recommended by the Audio Engineering Society (AES) for the "origination, processing, and interchange of audio programs." 44.1kHz sampling is standard for audio CDs; 96kHz is a recommended sampling frequency for use when higher bandwidth is available, and is generally recommended for preservation reformatting. Telephony applications use non-linear quantization for more efficient use of low bandwidth for speech.
MP3	MP3 compression employs perceptual coding, an approach based on psychoacoustic models that permit the codec to discard or reduce the precision of audio components that are less audible to human hearing.
MP4	MP4 can contain video and audio streams. The video streams can be encoded in the MPEG-1, MPEG-2, MPEG-4 and H.264/AVC standards. The audio streams can be (HE)-AAC, MPEG-1 Audio Layer 1-2-3, CELP, TwinVQ, Vorbis or Apple Lossless.
WAV	The WAV audio format was developed by Microsoft and has become one of the primary formats of uncompressed audio. It stores audio at about 10 MB per minute at a 44.1 kHz sample rate using stereo 16-bit samples. The WAV format is by definition, the highest quality 16-bit audio format.
Maps	
SHP	The shapefile format is a geospatial vector data format for geographic information system (GIS) software. The shapefile format can spatially describe vector features: points, lines, and polygons, representing, for example, water wells, rivers, and lakes.
WKT	Well-Known Text - Representation of geometry
TIFF	A tag-based file format for storing and interchanging raster images. TIFF serves as a wrapper for different bitstream encodings for bit-mapped (raster) images. The different encodings may represent different compression schemes and different schemes for colour representation (photometric interpretation)
UTM	The Universal Transverse Mercator (UTM) is a map projection system for assigning coordinates to locations on the surface of the Earth. The UTM (Universal Transverse Mercator) coordinate system divides the world into sixty north-south zones, each 6 degrees of longitude wide.
Geo-Package	A GeoPackage is a platform-independent SQLite database file that contains data and metadata tables with names and structures having definitions, integrity assertions, format limitations and content constraints as described in the OGC GeoPackage Encoding Standard from the Open Geospatial Consortium.
OGC (WMS, WFS)	OGC WMS currently can provide the user with a choice of style options, the WMS can only tell the user the name of each style. It cannot tell the user what portrayal will look like on the map. Feature Server (WFS) or Web Coverage Server (WCS), or it might only be able to



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	symbolise data from a specific default feature/coverage store.
Satellite	
GeoTIFF	The GeoTIFF format was initially developed during the early 1990's (N. Ritter & Ruth, 1997). The objective was to leverage a mature platform independent file format (TIFF) by adding metadata required for describing and using geographic image data.
Cloud-optimised GeoTIFF	This is a regular GeoTIFF file, aimed at being hosted on a HTTP file server, with an internal organisation that enables more efficient workflows on the cloud. It does this by leveraging the ability of clients issuing HTTP GET range requests to ask for just the parts of a file they need.
GeoJSON	GeoJSON is a format for encoding a variety of geographic data structures.
Open Geospatial Consortium (OGC)	OGC Standards are the glue to geospatial information interoperability, and are used by thousands of organisations across the globe and represented in millions of lines of code. They are backed by international organisations, used in proposals, and implemented to speed up the process of innovation.
Drone	
SfM - Structure from Motion	Structure from Motion (SfM) is the process of estimating the 3-D structure of a scene from a set of 2-D images. SfM is used in many applications, such as 3-D scanning, augmented reality, and visual simultaneous localization and mapping (vSLAM).
Data	
WGSRPD	World Geographical Scheme for Recording Plant Distributions
POWO	Plants of the World Online - Plant names
CoL	Catalogue of Life - Taxonomic Names
ITIS	Integrated Taxonomic Information System - Taxonomic Names
Authors of Plant Names	Authors of Plant Names
IUCN	IUCN status
TDWG	Biodiversity Information Standards (TDWG)
Darwin Core	Darwin Core - Glossary of terms intended to facilitate the sharing of information about biological diversity by providing identifiers, labels, and definitions
csv / xls	Tabular
Humboldt Extension	Humboldt Extension - Capture of key information about inventories
FlatBuffer (binary, compressed)	Large files
eDNA	
MBrave Platform	mBRAVE is a multi-user platform supporting the storage, validation, analysis, and publication of highly multiplexed projects based on high-throughput sequencing (HTS) instruments. This system builds on the BOLD Platform to support species identification and discovery for HTS data.
Metadata	
AC	Audiovisual Core Multimedia Resources Metadata Schema / Audubon Core
EBV / GEOBON	Essential Biodiversity Variables
EML/XML	Ecological Metadata Language
EnvO	The Environment Ontology - Community ontology for the concise, controlled



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	description of environments
EXIF	Exchangeable Image File Format - is a standard that specifies formats for images, sound, and ancillary tags used by digital cameras, scanners, and other systems handling image and sound files recorded by digital cameras.
INSPIRE	Inspire METADATA
JSON	JavaScript Object Notation - Dates, locations, URL, descriptions, numbers, etc.
SML	Sensor Model Language
IUCN Habitats	Classification Scheme for habitat types
Language	
EN	default
ISO-639-1/2/3	Language codes

Questions:

1. Which of the six above-mentioned MAMBO tools are useful for your RI/organisation?
2. What are the essential functionalities/requirements of the tools for your research?
3. What file formats and data standards should be supported by the tools to make them useful for your work and to facilitate interoperability with your research infrastructure?

We anticipate that the interview will take between 15-30 minutes of your time and the collected information is for exclusive use of the MAMBO project, and will not be shared for other purposes.

PROPOSED TIMES

Select the time you want to meet
Central European Summer Time

Mon, October 23

1pm – 1:30pm

Tue, October 24

3pm – 3:30pm

Thu, October 26

2pm – 2:30pm

Here you can find the tentative dates, we anticipate that the interview will take between 15-30 minutes of your time and the collected information is for the exclusive use of the MAMBO project, and will not be shared for other purposes.

Thank you very much in advance, and in case you have any further questions, don't hesitate to contact me.

Have an excellent day!
Kind regards

Ana Maria Feijoo Q.
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MAMBO PROJECT - Grant agreement No.101060639
<https://www.mambo-project.eu/>
Funded by the European Union



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3.2 Conducting Interviews

Interviews were conducted virtually or face-to-face and with permission, were recorded (with the purpose to keep concordance with the project, in order to obtain all the necessary information, avoiding omission of important details and the retention of information for no longer than three months after the final delivery of the report). Notes were written down in real time and information on the specific types of standards, tools, sources, and interoperability requirements with MAMBO were recorded in a database. The following three questions were asked after brief introductions:

1. Which of the six above-mentioned MAMBO tools are useful for your RI/organisation?
2. What are the essential functionalities/requirements of the tools for your research?
3. What file formats and data standards should be supported by the tools to make them useful for your work and to facilitate interoperability with your research infrastructure?

For the first question, interviewees indicated which tools are, or are not, useful for their respective RI/organisations. For the second question (open-ended), interviewees indicated what interoperability requirements are needed to make use of the tools. These qualitative responses were later grouped into 13 more generalised categories to allow quantification of the responses to the question. Interviewees spent the majority of their time on this question, explaining the standards and methodologies commonly used. For the last question, interviewees answered yes or no questions regarding their use of specific standards itemised in the second email sent to them (Box 2). In the process, interviewees elaborated on this checklist, sometimes adding data standards that were not listed. At the end of the interview, we asked participants broadly about their suggestions and recommendations for the MAMBO project. Interviews lasted between 15 and 45 minutes.

4. Results

From the pool of 66 Research Infrastructures (RIs) and organisations 23 (34.8%) were interviewed, 35 (53%) were identified but were unable to be interviewed, and 8 (12.1%) were unable to retrieve contact information (Fig. 2). Detailed descriptions of these three categories are as follows:

- **Interviewed:** RIs/organisations were contacted by email and agreed to have a short interview (Table 2 - green shading).
- **Non-Interviewed:** RIs/organisations were contacted but were unable or not-interested in scheduling an interview, or didn't show up to the interview (Table 2 - yellow shading).
- **Unable to be reached:** RIs/organisations were identified as key stakeholders, but were not contacted, or contacted indirectly through a website and for various reasons were not reachable (Table 2 - light grey shading).



D2.1 Report on optimal positioning and linkage of MAMBO tools to KCBD and RI landscape

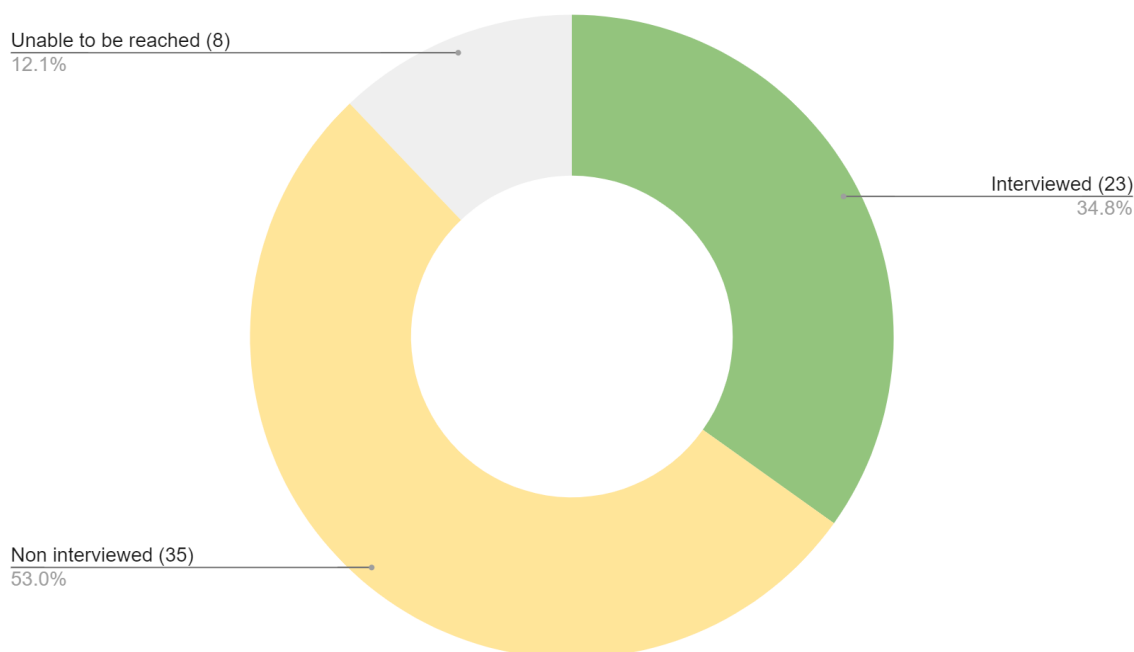


Figure 2. Breakdown of the RIs/organisations interviewed, contacted and identified.

From the 23 successful interviews, responses to the three questions were qualitatively and quantitatively analysed to determine important interoperability requirements for the MAMBO project’s six tools and their intended audience.

4.1 MAMBO Tools Usefulness

The first question of the interview “**Which of the six MAMBO tools are useful for your RI/organisation?**” is intended to capture the relative perceived importance of each of the six MAMBO tools by the community that was interviewed. The ‘Image recognition software’ MAMBO 1 was indicated as the most useful tool by 20 (87.0%) of the 23 interviewees indicating that this tool or the outcome thereof would be useful for their RI/organisation (Table 3). The second most useful MAMBO tool was the ‘Sound recognition’ MAMBO 2 tool, with 17 (73.9%) of the 23 interviewees indicating it would be useful, followed by the ‘Habitat extent mapping tool’ MAMBO 5 with 15 (69.5%) indicated by 23 interviewees to be useful for their organisation. The remaining tools, MAMBO 3, 4, and 6 received similarly positive responses, with 52.2%, 56.5%, and 65.2% of users indicating usefulness respectively (Fig. 3).

Table 3. Interviewee usefulness ratings (n=23) of six MAMBO tools for their RI. Value 1 indicates that the tool is useful, 0 indicates not useful for the RI or organisation.

ID	Acronym	MAMBO 1 Image- recognition software	MAMBO 2 Sound- recognition	MAMBO 3 Insect camera (nocturnal insects)	MAMBO 4 Insect camera (pollinators)	MAMBO 5 Habitat extent mapping tool	MAMBO 6 Airborne LiDAR and/or drone data	# Tools /RI
1	ARISE	1	1	1	1	1	1	6
2	BGE	0	0	1	1	1	1	4
3	BiCIKL	1	1	1	1	1	1	6
4	BioDT	1	1	0	0	0	0	2



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5	BIOSCAN Europe	1	1	1	0	1	1	5
6	BOLD Systems	1	1	1	1	1	1	6
7	Copernicus	1	1	0	0	1	1	4
8	DiSSCo	1	1	0	0	0	0	2
9	DTO-BioFlow	1	1	0	0	0	1	3
10	EEA	1	1	1	1	1	1	6
11	ENVRI	1	1	1	1	1	1	6
12	EoL	1	1	1	1	0	0	4
13	GBIF	0	0	0	0	0	0	0
14	GUARDEN	1	1	0	1	1	1	5
15	KCBD	1	1	0	0	0	0	2
16	Observation International	1	1	1	1	1	1	6
17	Pl@ntNet	1	0	0	0	1	1	3
18	Pollinator Academy	1	0	0	0	0	0	1
19	SPRING	1	0	0	1	1	0	3
20	TAXOFLY	0	0	0	1	1	1	3
21	TETTRIs	1	1	1	0	1	0	4
22	WILDEYE	1	1	1	1	1	1	6
23	WILDLABS	1	1	1	1	1	1	6
TOTAL		20	17	12	13	16	15	

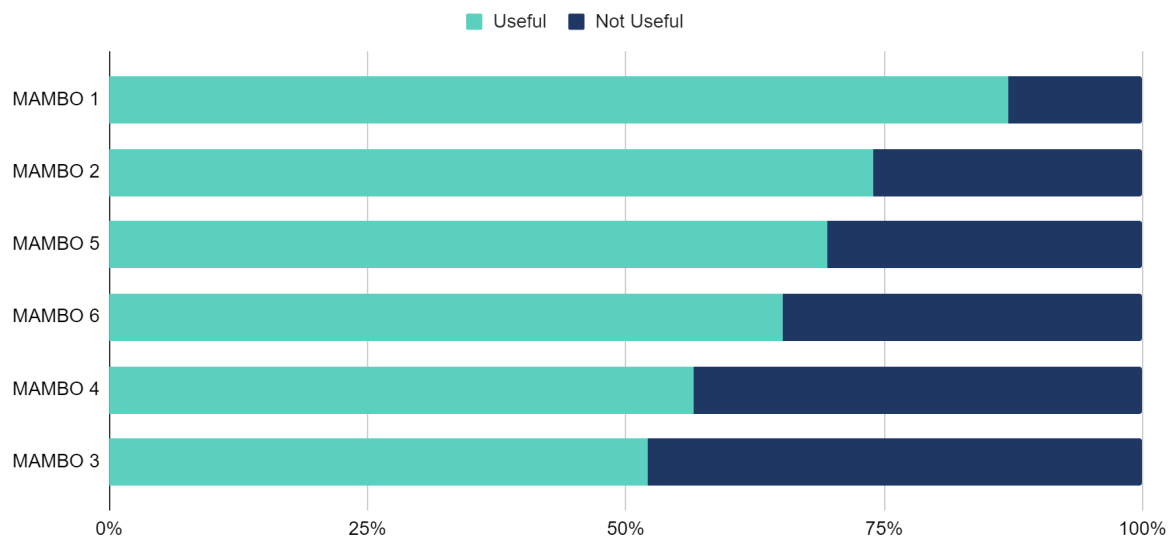


Figure 3. Percent of interviewees (n=23) indicating which MAMBO tool(s) or outcome thereof would be useful for their RI/organisation.



4.2 MAMBO Tool Requirements and Functionality

To capture the requirements and functionality of the tools we asked the interviewees “**What are the essential functionalities/requirements of the tools for your research?**” This question harvested qualitative data on required functionalities and standards to facilitate interoperability between the RI/Organisation and the MAMBO tools. Data was carefully grouped by similarity to quantify responses to determine priority functionalities (Table 4). The most important requirement for MAMBO tools is that they use the same data standards to facilitate interoperability between the RIs and the MAMBO tools, as indicated by 14 (60.9%) interviewees.

Table 4. List of functionalities identified by RIs/Organisations for future use, grouped by similarity, and the number of interviewees indicating their requirement for that functionality.

Essential functionalities/requirements	Priority
Use of the same standards to facilitate data interoperability (image, sound and metadata)	14
API documentation, use of persistent identifiers, rich metadata	10
Accurate GIS data	10
Long-term sustainability of the tools for the policy domain	10
Data should be FAIR (Findable-Accessible-Interoperable-Reusable)	6
Use of a standard backbone taxonomy, e.g. Catalogue of Life	6
All the tools should be Open-source	6
Use of controlled vocabularies, e.g. for different life stages	3
Facilitate Web Map Services (WMS) to accommodate high volume data requests	2
Facilitate high spatial resolution of data	2
Sensors with integrated autonomous analysis capacity including qualitative and quantitative species information, duration of activities, peaks of activities, others.	1
Manage a community of users of several hundreds to thousand users per day. Increase capacity of response of the platform for multiple user	1
Provide multi-language support and the use of local names for organisms	1

4.3 File Formats and Data Standards for Interoperability

The last question we presented to the interviewees was “**What file formats and data standards should be supported by the tools to make them useful for your work and to facilitate interoperability with your research infrastructure?**” The full list of file formats and data standards that are relevant for the MAMBO tools development is shown in Table 5. Descriptions of the different formats and standards are provided in Box 2. Each File format/Data Standard was scored based on how often it was considered useful by the interviewees. The most relevant is the use of the Catalogue of Life (CoL) as the taxonomic backbone mentioned by 13 RI/Organizations, followed by the Darwin Core (DwC) data standard (12 times), and the use of EML/XML and JSON as metadata standards mentioned 12 and 11 times, respectively. The complete and detailed table with responses to the relevance of each of the File Formats/Data Standards is presented in Appendix 2.



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Table 5. File formats and data standards required by RIs/organisations to ensure interoperability grouped by file/data standard type. Priority formats and standards are highlighted in green (10+ votes) and yellow (5-9 votes).

Type	File Format/Data Standard	No. of Votes
API	POST API	2
	REST API	8
	SensorThings API	2
	OPEN API	8
Images	jpeg	10
	PNG	9
	GIF	6
	HIC	3
	ISO/IEC 10918-1	3
Sound	PCM	2
	MP3	6
	MP4	8
	WAV	8
Maps	SHP	5
	WKT	0
	TIFF	6
	UTM	7
	GeoPackage	6
	OGC (WMS, WFS)	7
Satellite	GeoTIFF	5
	Cloud-optimised GeoTIFF	3
	GeoJSON	7
	Open Geospatial Consortium (OGC)	5
Drone	SfM - Structure from Motion	1
Data	WGSRPD	5
	POWO	5
	CoL	13
	ITIS	8
	Authors of Plant Names	3
	IUCN status	9
	TDWG	7
	Darwin Core	12
	csv / xls	8
	Humboldt Extension	5
	FlatBuffer (binary, compressed)	2
eDNA	MBrave Platform	1
Metadata	AC	9



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	EBV / GEOBON	5
	EML/XML	12
	EnvO	5
	EXIF	7
	INSPIRE	3
	JSON	11
	SML	5
	EUNIS habitat classification	1
	IUCN Habitats	8
Language	EN	5
	ISO-639-1/2/3	6

4.4 RI / Data Provider Specific Recommendations and Remarks

Additional to the answers on the three questions of the interview, many interviewees provided additional information of specific relevances for the RI/Organisation which is presented here.

ARISE - Authoritative and Rapid Identification System for Essential Biodiversity Information

Goal: Identify any species from specimens, images, sound, and DNA material in the Netherlands.

ARISE is interested in the development of the first four MAMBO tools and their interoperability with them. ARISE has an AI model repository that can be used for the MAMBO algorithms. Furthermore, ARISE has created a sensor Plug&Play service that allows linking of camera traps and sound recording devices to its infrastructure, retrieving data and metadata and processing these data on the fly to species identifications. The development of the insect cameras is especially interesting for ARISE and it would be important to link these to the ARISE infrastructure. ARISE is open to working together with MAMBO for the development of the tools and testing the camera for recognition of insects.

BGE - Biodiversity Genomics Europe

Goal: Identify any multicellular organisms in Europe through molecular data [DNA barcodes & Full genome sequence data]

BGE is interested in MAMBO tools 3 through 6, and especially tools 3 and 4 for the use of insect cameras to add relevant metadata to the DNA sequence records. They also expressed interest in the incorporation of Catalogue of Life IDs for consistent taxonomic identification and to link MAMBO derived data to the BGE sequence records. BGE supports open source data and metadata standards.

BiCIKL - Biodiversity Community Integrated Knowledge Library

Goal: BiCIKL aims to persistently connect all data generated across the research cycle.

BiCIKL is interested in developing use cases where metadata and data from the MAMBO tools is connected to infrastructures storing metadata from processing large amounts of data through the image recognition and sound recognition software. The requirements are to use the EML (Ecological Metadata Language) standard, the Darwin Core data standard, and to have data accessible through an API. The BiCIKL project is compliant with all TDWG data standards.

BioDT - Biodiversity Digital Twin

Goal: Understand biodiversity through advanced simulations, FAIR data, and AI-driven solutions for global biodiversity dynamics.



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BioDT is mainly interested in MAMBO's AI tools, which can be reused and shared as open source. For interoperability purposes BioDT requires detailed API documentation, use of persistent identifiers, structured metadata, list of essential terms for connecting datasets, the use of data standards like Darwin Core and FAIR data.

BIOSCAN Europe - Building a European Hub for DNA-based biomonitoring

Goal: Bring together existing European national networks, scientists, and projects that work on the monitoring of biodiversity using DNA to build an efficient European system of interconnected facilities for rapid identification and monitoring of species.

BIOSCAN indicated all MAMBO tools, except for tool 4, would be useful. They seek to use tools 1 and 2 for locating sampling sites that are targeted for DNA sequencing, tool 3 for identifying nocturnal insects that still need to be sequenced, and tools 5 and 6 allow selecting sites in different regenerative stages to be monitored through DNA techniques. When considering all the ways in which biodiversity can be monitored, what will be of great value to end users (particularly stakeholders with policy/decision-making roles) is clarity on the quality of the data they are presented with, and the ease with which this data can be ported into environmental management decision-making tools. BIOSCAN Europe's key requirement for interoperability is spatio-temporal structured data.

BOLD Systems - Barcode of Life Data Systems

Goal: Advance biodiversity science through DNA-based species identification.

BOLD Systems is interested in all six MAMBO tools, specifically tools 1, 2 and 3. MAMBO Tool 2 for sound recognition will be particularly useful when searching for species to collect DNA from. As for interoperability requirements, BOLD systems values standards for image capture (format and size) and the use of Catalogue of Life standards. They are interested in working together to develop a universal strategy for biodiversity monitoring and conduct sound research to support transfer learning.

Copernicus

Goal: Provide vast amounts of global data from satellites and ground-based, airborne, and seaborne measurement systems provide information to help service providers, public authorities, and other international organisations improve European citizens' quality of life and beyond. The information services provided are free and openly accessible to users.

Some Copernicus components are already using image- and sound-recognition tools (similar to MAMBO 1 and 2) for the monitoring of species distribution. Copernicus is also interested in Tools 5 and 6 and would like to see standards for metadata and algorithms, and the development of AI for the identification of marine mammals.

DiSSCo - Distributed System of Scientific Collections

Goal: To digitally unify all European natural science assets under common access, curation, policies and practices that ensure that all the data is easily Findable, Accessible, Interoperable and Reusable (FAIR principles).

The most useful tools for DiSSCo are MAMBO 1 and 2. Proper documentation, data accessible through an API, open standard format (JSON), the use of precise identifiers, structured metadata, Darwin core standards are all functional requirements for DiSSCo. They would also like to see a data search tool incorporated into MAMBO tools.

DTO-BioFlow - Integration of biodiversity monitoring data into the Digital Twin Ocean



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Goal: DTO-BioFlow seeks to collect, integrate and harmonise marine biodiversity data into the EU Digital Twin Ocean.

DTO-Bioflow is interested in MAMBO tools 1, 2, and 6 for underwater acoustic recognition of marine mammals. They would like to use LiDAR used to investigate seabed habitats. Their key interoperability requirements are for the metadata and meta standards to be Fair (Findable, accessible, interoperable and useful), with all the data for all the essential and biodiversity variables.

EEA - European Environment Agency

Goal: To deliver knowledge and data to support Europe's environment and climate goals together with the Eionet network.

EEA indicated MAMBO tools 5 and 6 are of high interest whereas tools 1 through 4 are of indirect interest, but still seen as beneficial. They are currently creating a map of habitats through mapping, similar to MAMBO tool 5 that is connected to the Nature Restoration Law. They see MAMBO tool 6 being important for their implementation of several policies, biodiversity strategies, restoration laws, and climate mitigation initiatives. They expressed strong interest in collaborating with and supporting the MAMBO project. As for interoperability requirements, EEA would like to see precise geospatial referencing and universal standards.

ENVRI - ENVIRONMENTAL RESEARCH INFRASTRUCTURES

Goal: The ENVRI Community brings together 26 European Research Infrastructures that are studying different aspects of the Earth system. ENVRI provides high-quality, open and FAIR in situ data from the four domains of earth: atmosphere, ecosystem, marine and solid earth.

The project is finished but is maintained for other researchers under LifeWatch. We couldn't obtain more information on LifeWatch. All six MAMBO tools were indicated as useful and in terms of functionality, and they would like to include the ability to move data between different infrastructures.

EoL - Encyclopedia of Life

Goal: To increase awareness and understanding of living nature through an Encyclopedia of Life that gathers, generates, and shares knowledge in an open, freely accessible and trusted digital resource.

EoL doesn't use identification tools, they inherit information from projects as MAMBO. The first four MAMBO tools are indirectly beneficial for the EoL system, for the purposes of information sharing of observation records and occurrence data.

GBIF - Global Biodiversity Information Facility

Goal: A global biodiversity data aggregator infrastructure aimed at providing open access to data about all types of life on Earth. They are currently mobilising 2.6 billion records from more than 90 thousand datasets of more than two thousand data publishers.

As GBIF is not the owner of the data it has no direct interest in deploying and using the MAMBO tools. However, the development and use of AI algorithms for sound and image recognition and the development of automatic sensors by data publishers increases the availability of biodiversity data to GBIF which is welcomed and promoted by GBIF. The data standards used by GBIF to facilitate seamless exchange of data are captured in the results section.

GUARDEN - Safeguarding Biodiversity and Critical Ecosystems Services across sectors and scales

Goal: Safeguarding biodiversity and critical ecosystem services across sectors and scales



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GUARDEN indicated that all six MAMBO tools, except for tool 3, were relevant and a priority for their community. Some of their important conditions for use include: the incorporation of precise, high quality spatial data resolution (3-5m), the use of the WMS (Web Map Services), autonomous field capture of qualitative (behavioural) and quantitative (frequency) data, AI for metadata interpretation, longevity of the tools, and the addition of EUNIS Habitat Classification Standard for a policy domain.

KCBD - Knowledge Centre for Biodiversity

Goal: Enhance the knowledge base, facilitate its sharing and foster cross-sectorial policy dialogue for EU policy making in biodiversity and related fields. KCBD produces outputs from data gathered by other organisations, but works alongside [Digital Observatory for Protected Areas](#) (DOPA), a technical interface performing aspects of their data collection.

KCBD indicated that MAMBO tools 1 and 2 were the most useful, but more so for advancing EU biodiversity monitoring than for the organisation itself. As for interoperability and file format requirements, there was an emphasis on frequently updated, comprehensive, global datasets being crucial for their analyses, as well as the use of the Darwin core data standard. While they weren't able to provide the perspective of an end-user, KCBD revealed insights on needs for streamlined data interpretation and communication.

Observation International

Goal: Observation International provides a worldwide platform for storing, validating, and sharing nature information.

Observation International expressed a strong interest in the MAMBO project and its six tools. They are specifically interested in the opportunities to work together in the field, improving monitoring with camera traps and other technologies.

Pl@ntNet

Goal: Pl@ntNet is a tool to help to identify plants with pictures. It is organised in different thematic and geographical floras.

Pl@ntNet sees great potential in the MAMBO Project, specifically tools 1, 5, and 6. Their requirements include having on-the-spot analysis, an accessible user interface, the ability to accommodate thousands of users per day, access to many languages, and use of all international standards for interoperability.

Pollinator Academy

Goal: The Pollinator Academy is a European, open source platform for sharing taxonomic knowledge. Their goals are to unlock taxonomic knowledge at a European level, offer educational materials and identification tools, and provide access to knowledge hubs and specialists.

For The Pollinator Academy, all of the MAMBO tools have the potential for use but only MAMBO tool 1 is of current use for them. For functionality requirements, the tools would need to be embedded as part of the platform using an API.

SPRING - Strengthening Pollinator Recovery through Indicators and Monitoring

Goal: The aim is to systematically map insect populations on a large scale in order to provide the scientific basis needed to effectively protect pollinators in Europe.

SPRING was primarily interested in MAMBO tools 1, 4, and 5. For the tools to be useful, they indicated that pollinators would need to be incorporated, such as for tool 4. SPRING also mentioned that The EU pollinator monitoring has identified 5 different taxonomic groups and for each one,



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there is a completely different use of tools which makes it difficult to capture images, identify, and recognize them.

Taxo-Fly - Taxonomic information for all European hoverfly species

Goal: An EU-funded project gathering taxonomic information for all European hoverfly species.

Taxofly has indicated that it would be really useful to consider a standard plant list. Additional to taxonomic information on hoverflies Taxofly used standardised codes, ISO standard for language, and Nuts2021 codes (2 levels) complemented with some ISO codes for countries.

TETTRIs - Transforming European Taxonomy through Training, Research, and Innovations

Goal: TETTRIs aims to produce a transformative change in the role played by taxonomy in tackling biodiversity challenges by boosting taxonomic capacity and transferring critical scientific knowledge to societal actors.

For TETTRIs, the first two tools are really important and they see potential use for MAMBO tools 3 and 5. For tool 5, it would be particularly useful to overlay species distribution data to better understand their identified habitat, temperature, soil, and vegetation. Their primary requirements for the project were to collect many field images of and acoustics for grasshopper species.

WildEye - Wild Eye Conservation

Goal: To use technology to give back to the planet from which we have taken so much.

WildEye is looking for AI for conservation applications, in a specific case for habitat conservation, considering that for this purpose, using satellite images is not really useful for the high scale. WildEye is really open in working together with the MAMBO project, and contributes to creating or looking for more aspects that can be incorporated in the tools that should be open source and open access, with some requirements such as Metadata, AI classification, using existing frameworks, using international standards.

WildLabs - The global conservation technology community

Goal: To unite the conservation technology community to maximise the benefits of cross-sector innovation for conservation impact.

WILDLABS is interested in working together with MAMBO, and has an interest in all the tools for the network of organisations that are part of WILDLABS. The technical information was not proportionate in the interview, more in a general aspect.

5. Discussion

We consider the response rate of 23 interviewees (35%) from the pool of 66 identified Research Infrastructures (RIs) to be a strong indicator of success for “D2.1 Report on optimal positioning and linkage of MAMBO tools to KCBD and RI landscape” (Fig. 2). We attribute this success to the interest in and need for MAMBO tools by the stakeholder community, as well as the use of expert interviews to glean information on the optimal positioning and linkage of MAMBO tools. In order to collect both qualitative and quantitative results, we developed an interview invitation letter (Box 2) that explained the purpose of the interview, provided relevant background information on the MAMBO tools and proposed data standards and file formats, and asked three questions to reveal key functionality requirements for MAMBO tool use and interoperability. This seems to have been an appropriate methodology. We are also pleased with the diversity of RIs/organisations that were included in the pool of 23 interviewees, suggesting that the results are representative of a wider audience. In addition to the 23 interviewees reached, the remainder of RIs/organisations were



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likewise informed about the MAMBO project thereby adding to the positioning of the MAMBO tools.

For our first question on MAMBO tool relevancy to RIs, results indicated that the majority (87%) had an interest in tool 1 which develops image-recognition software for species on the annexes of the Habitat Directive (Fig. 3). This result does not come as a surprise given the reporting obligations of EU member states on the status of species listed on the annex of the Habitats Directive. The three RIs that did not positively respond to direct usefulness of tool 1 were Biodiversity Genomics Europe (BGE) which focuses on DNA data, GBIF which is a biodiversity data aggregator and not a data producer or owner, and TAXOFLY which gathers taxonomic information on hoverflies (Table 3). Slightly less stakeholders expressed an interest in tool 2 (74%) on sound recognition software based on deploying AI algorithms to identify birds, bats, marine mammals, crickets and grasshoppers (Fig. 3). Beyond the first two species identification tools, RIs also expressed great interest (70%) in tool 5 for habitat extent mapping (Fig. 3). This relates to the identification of EUNIS (European Nature Information System) habitat types which is part of the reporting obligations for EU member states. Seven (30.4%) of the interviewees indicated that all six of the MAMBO tools or their outcomes would be useful for their RI/organisation.

Results from our second question on the functional requirements of MAMBO tools revealed five important conditions of the MAMBO tools for adoption by the wider stakeholder community and to facilitate interoperability between the tools and RIs. Not surprisingly, 61% of RIs indicated that the use of commonly accepted data standards is required for interoperability, specifically for image and sound file formats and standards, but also for metadata (Table 4). To exchange data from machine to machine and from MAMBO tool to RI, the use of APIs was recognized by 43% of RIs as important (Table 4). In order to make use of APIs it is essential that they are correctly documented, that the data makes use of persistent identifiers (PIDs), and that the data and tools are appropriately described by metadata. A third often-mentioned requirement was the use of accurate GIS data or high precision spatial coordinates for observations and mapping. Fourth, many of the priority species that are identified by MAMBO tools are included in the appendices of the EU nature directives for which EU member states have reporting obligations. This makes the MAMBO tools also of interest to the policy domain. In order to make the MAMBO tools relevant for the policy domain, however, it is essential that they are long-term sustained and supported (Table 4). Lastly, data generated by the MAMBO tools should be FAIR, meaning that they should be Findable, Accessible, Interoperable and Reusable. Details on the FAIR data requirements are shared on the GO FAIR website [<https://www.go-fair.org/fair-principles>].

Finally we asked the interviewees to indicate which file types and data standards need to be supported in order to facilitate interoperability between the MAMBO tools and RIs (Table 5). The need for a common taxonomic data infrastructure, and specifically the Catalogue of Life, was widely recognised by stakeholders (13/23). Using a shared taxonomic name infrastructure allows linking of outputs from MAMBO to RIs and data providers. Perceived as almost equally important was the implementation of the Darwin Core (DwC) data standard (12/23) in MAMBO tools. The DwC standard is developed and maintained by the 'Biodiversity Information Standards', formerly known as the 'Taxonomic Databases Working Group', or TDWG. DwC is widely adopted by the biodiversity informatics community. The use of DwC as data standards enables seamless integration of data generated by the MAMBO tools with the Global Biodiversity Information Facility - GBIF, the world's largest aggregated biodiversity data repository, as well as with many other RIs and data repositories. Besides the need for standardised data, the stakeholder community also indicated the need for standardised metadata using the Ecological Metadata Language (EML), XML and/or JSON is required to facilitate interoperability between initiatives. For the complete and detailed responses of the interviewed RIs and data providers we refer to Appendix 2.



5.1 KCBD and EEA

From the 23 stakeholders that we were able to take part in an interview there were two which have a strong and important position in the EU policy domain, knowingly the Knowledge Centre for Biodiversity (KCBD) and the European Environment Agency (EEA). KCBD facilitates sharing of its knowledge base and fosters cross-sectorial policy dialogue for EU policy making in biodiversity and related fields. KCBD expressed recognizing the importance for the development of the MAMBO tools, but their interest in the tools is mainly indirect through data gathered and provided by other organisations for large-scale metadata analyses such as the Digital Observatory for Protected Areas ([DOPA](#)), a technical interface performing aspects of the EU Joint Research Centre (JRC) data collection. As for interoperability and file format requirements, there was an emphasis on frequently updated, comprehensive, global datasets being crucial for their analyses, as well as the use of the Darwin core data standard.

The main goal for the EEA is to deliver knowledge and data to support Europe's environment and climate goals together with the Eionet network. From that perspective the EEA is most interested in MAMBO tool 5 on 'habitat extent mapping', and tool 6 on 'habitat condition metrics', whereas tools 1 through 4 are of indirect interest, but still seen as beneficial. The EEA is currently developing a map of EUNIS habitat types using a methodology which is similar to MAMBO tool 5, and that is connected to monitoring for the EU Nature Restoration Law. MAMBO tool 6 is considered to be useful for the implementation of several policies, the EU biodiversity strategy and restoration law, and climate mitigation initiatives. They expressed strong interest in collaborating with and supporting the MAMBO project. As for interoperability requirements, EEA would like to see high geospatial accuracy and the use of universal data standards and file formats.

6. Acknowledgments

Thank you to the MAMBO project network for identifying and facilitating connections with our 66 identified stakeholders. We also take this opportunity to thank the 23 RIs/organisations that found the time to interview during the busy summer fieldwork and holiday seasons. Your feedback on MAMBO tools and interoperability requirements is a crucial aspect of this project and innovation could not be possible without your involvement.

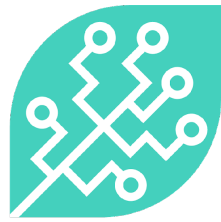
Thanks to the community MAMBO for the valuable support and help with WP2.

7. Appendices

MAMBO D2.1 Appendix 1 - M2.1 Inventory of relevant RIs and data providers

MAMBO D2.1 Appendix 2 - Relevant Formats and Standards





MAMBO

MODERN APPROACHES TO THE
MONITORING OF BIODIVERSITY

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ID	Acronym	fullName	URL	contact	contactEmail	contactProfile	Leading	Type of Initiative	Main Fields	Approach	Data types	Data Requirement	Software Requirement	Remarks	Date_Data Request contact	Date_Follow_Data Request / 15/06/2023	Date_Interview	Additional sources / Data	Metadata		
1	Alternet	Alternet	https://alternet-europe.eu/	Tyler Kulfan (Alternet Secretariat)	secretariat@alterneturope.eu	Alternet Secretariat	N/A	EU Network of Excellence	Fostering the European science-policy interface on biodiversity and ecosystem services	Alternet is an international non-profit organization based in Brussels, Belgium. The activities of Alternet are supported by the contributions of its partners. Currently, Alternet comprises 32 partner institutes from a total of 21 countries.	N/A	N/A	N/A	N/A	25/07/2023		N/A	N/A	N/A		
2	ARISE	Authoritative and Rapid Identification System for Essential biodiversity Information	https://www.arise-biodiversity.eu/	Elaine van Ommen Kooke	elaine.vanommenkooke@naturals.nl	Project Leader	Naturalis	National RI	Species identification and monitoring	The ARISE project will build an infrastructure that will identify and monitor all multicellular species in the Netherlands.	Molecular, image, sound, radar, records	validated genetic information (input DNA concentration, how DNA extraction needs)	N/A	This integrated infrastructure and facility will provide Dutch researchers, nature conservation organizations, policy makers, industry, regional water authorities, infrastructure developers, and many more with access to the most advanced near-real-time	14/07/23		24/8/23	Darwin Core IUCN status Biodiversity Information Standards (TDWG)	AC EML/XML JSON		
3	BEET	BEET - Bee Monitoring	https://beet.nl/	Marten Schoonman	marten.schoonman@naturals.nl	co-founder and co-director	N/A	N/A	Mission-driven, not-for-profit, for honeybees, beekeepers and researchers	BEET is a mission-driven, not-for-profit organization. The development of the tools is made possible through crowdfunding and subsidies. Openness and cooperation with the wider community are core values. The Belgian Biodiversity Platform has developed this searchable tool to provide its users with an overview of the existing Biodiversity Research Infrastructures (BRIs) that are available to the Belgian scientific community.	N/A	N/A	N/A	N/A	25/08/23						
4	Belgian Biodiversity Platform	Belgian Biodiversity Platform	https://www.biodiversity.be/	contact@biodivest.ybe	contact@biodivest.be	N/A	N/A	N/A	Biodiversity Research Infrastructures (BRIs)		N/A	N/A	N/A	N/A	25/07/23		15/08/23				
5	BGE	Biodiversity Genomics Europe	https://biodiversitygenomics.eu/	Roya Shokohi	roya.shokohi@naturalis.nl	Coordinator	Naturalis	Horizon Europe	Barcode/Genomic infrastructure	Distributed infrastructure for generation, analysis and application of molecular data	Molecular data (DNA barcodes & Full genome sequence data)	BGE is interested in having interaction with a catalog of life, and different taxonomies	N/A	BGE has the aim of accelerating and upscaling the use of genomic science in Europe. By bringing together two newly formed networks, BIOSCAN Europe (which focuses on DNA barcoding) and the European Reference Genome Atlas, ERGA (which focuses on genome sequencing), BGE aims to create a strong and interconnected European biodiversity genomics network with the capacity to accelerate and upscale the production of genomic data and the application of genomic tools to tackle biodiversity	02/08/23		29/08/23	Habitat conditions Genetic of the species Metadata (location conditions) Short habitats and communities Water services Including Pollinators (sampling in BGI) Join different datasets taxonomic	Taxonomic Names - Catalogue of Life (CAL) - Check List Biodiversity Names - Integrated Taxonomic		
6	BICKL	Biodiversity Community Integrated Knowledge Library	https://bickl-project.eu/	Lyubomir Penev	lpenev@pensoft.net	Project Director, Head of ODS sector	Pensoft Publishers (Bulgaria)	H2020	Collector/Biodiversity databasing	Workflow for integrating, harvesting and linking data	Data linking, databasing and analysis	To use EML Ecological Metadata Language Standards	N/A	BICKL will initiate and build a new European starting community of key research infrastructures in biodiversity and life sciences, solidifying open science practices through provision of access to data, associated tools and services at 1) each separate stage of, and 2) along the entire research cycle. BICKL will provide for the BioGora is a five year EU-funded project aiming to support sustainable transformation for biodiversity in Europe.	14/08/23		24/08/23	Excellent quality of metadata standardized with EML format.	Darwin Core Everything that is set up with the Biodiversity Information		
7	BioGora	BioGora	https://biogora.eu/	Kati Vierikko	contact@biogora.eu	N/A	N/A	Project	connect research results on biodiversity to the needs of decision-making in a targeted dialogue between scientists, other	BioGora is a collaborative European project funded by the Horizon Europe programme. It aims to connect research results on biodiversity to the needs of policy making in a targeted dialogue between scientists, other	N/A	N/A	N/A	N/A	14/07/23		26/09/23				
8	Biodiversa+	Biodiversa+	https://www.biodiversa.eu/en/for-eu/	contact@biodiversa.eu	N/A	N/A	N/A	European Biodiversity Partnership	N/A	Biodiversa+ is the European Biodiversity Partnership supporting excellent research on biodiversity with an impact for society and policy. It was jointly developed by Biodiversa and the European Commission as part of the EU Biodiversity Strategy 2030, and will contribute to the ambition that "by 2030, nature in Europe is back on a path of recovery, and that by 2050 people are living in harmony with Nature".	N/A	N/A	N/A	N/A	25/07/23		15/08/23				
9	BIODT	Biodiversity Digital Twin	https://bioldt.eu/	Sharif Islam	sharif.islam@naturalis.nl	Infrastructure Director	CSC Tieteen Tietoteknikan Keskus Oy (CSC - IT CENTER FOR SCIENCE LTD.) - Finland	Horizon Europe	Biodiversity modelling and simulation (Digital Twinning)	Biodiversity data analysis using the ULM1 Supercomputer (Finland)	Biodiversity data	Code/documentation Persistent identifiers Structure metadata List of essential terms and mapping (connecting datasets) FAIR	Habitat extent mapping tools.	The Biodiversity Digital Twin prototype provides advanced models for simulation and prediction capabilities, through practical use cases addressing critical issues related to global biodiversity dynamics. BioDT exploits the ULM1 Supercomputer and employs FAIR data combined with digital infrastructure, predictive modelling and AI solutions, facilitating evidence-based solutions for biodiversity restoration and resilience. The concept: A shared European perspective and framework for effective DNA-based biodiversity monitoring, connecting and enhancing national DNA barcoding infrastructures and initiatives.	25/7/23		02/08/23	SMIL SENSOR MODEL LANGUAGE EML ECOLOGICAL METADATA LANGUAGE			
10	BIOSCAN Europe	BIOSCAN Europe	https://www.bioscan-europe.org/	William Goodall Copeslate	wgoodall@opeslate@rge.ac.uk	N/A	N/A	Research Network	DNA-based biodiversity monitoring	BUILDING A EUROPEAN HUB for DNA-based biodiversity monitoring	molecular data (DNA barcodes) DNA to identify and therefore monitor species/Biodiversity	BOLD SYSTEM (https://www.boldsystems.org/)	N/A	One of the standards use Catalog of Life, even when it is not starting integrating bugs but when they are will be fundamental.	08/08/23		25/08/23	Designing some strategies Portability Defining Species for the Genetic Data (DNA Barcode)			
11	BIRDNET	BIRDNET Sound ID	https://birdnet.cornell.edu/	ccb-birdnet@cornell.edu	ccb-birdnet@cornell.edu	N/A	Cornell lab of ornithology	University lab (US)	Bird sound AI	BIRDNET is a research platform that aims at recognizing birds by sound at scale.	Sound recordings	N/A	N/A	We support various hardware and operating systems such as Arduino microcontrollers, the Raspberry Pi, smartphones, web browsers, workstation PCs, and even cloud services. BIRDNET is a citizen science platform as well as an analysis software for extremely large collections of audio. BIRDNET aims to provide innovative tools for conservationists, biologists, and birders alike.	25/07/2023		15/08/23				
12	BOLD Systems	Barcode of Life Data System	http://www.boldsystems.org/	Sujevan Ratnasingham	sratinasi@boldsystems.org	Informatic Director	Centre for Biodiversity Genomics in Canada	Designed to support the generation & application of DNA Barcode Data	It is a collaborative hub for the scientific community and a public resource for citizens at large	BOLD is a cloud-based data storage and analysis platform developed at the Centre for Biodiversity Genomics in Canada. It consists of four main modules, a data portal, an educational portal, a registry of BINs (putative species), and a data collection and analysis workflow.	N/A	Standards image format, standard image size and configuration sound	N/A		15/8/23		04/09/23	AC EML/XML EBF IUCN Habitats			
13	CEIAS	Consortium of European Taxonomic Facilities	https://ceias.org/	Ana Casino	ana.casino@ceias.org	Head of CEIAS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25/07/23		26/09/23	N/A	N/A		
14	COL	Catalogue of Life	https://www.catalogueoflife.org/	Olaf Banks	olaf.banks@naturalis.nl	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25/07/23		15/08/23	N/A	N/A		
15	Copernicus	New Copernicus Capability for Tropic Ocean Networks	https://www.copernicus.eu/en/what-we-do/infrastructure/infrastructure-projects/necton	Sergio Pérez Jorge Vinko Bandelj	sergio.p.jorge@vax.pt vbandelj@rge.it	Marine Ecology phd	Copernicus	The EU funded NECTON project will fuse new data into innovative ecosystem models. Grant agreement ID: 101081373	NECTON is already using the first and second tools for MAMBO specifically for monitoring marine species distribution for the dolphins in the Adriatic Sea. Recognition of coastal habitats, especially in seagrasses beds in all areas of the Mediterranean sea, and compare different models. NECTON has a model based on GBIF Data of the presence of species and with the Copernicus environmental variables	Valid amounts of global data from satellites and ground-based, airborne, and seabase measurement systems provide information to help service providers, public authorities, and other international organisations improve European citizens' quality of life and beyond. The information services provided are free and openly accessible to users.	Artificial intelligence Metadata Standards Algorithms	Spatial data need to be better developed.	N/A	NECTON is transforming the European capability to predict and protect the biodiversity of marine ecosystems. New modelling products of habitats, pollution and benthic habitats will enable the Copernicus Marine Service to better inform ocean policymakers, managers and public	25/07/23		22/08/23 22/10/2023 26/09/23 29/08/23	N/A	AC EXIF		
16	DECIDE	Delivering Enhanced biodiversity information with adaptive Citizen science and Intelligent Digital Engagements	https://www.ech.ac.uk/our-research-projects/decide	Michael Pocock	michael.pocock@ech.ac.uk	UK Centre for Ecology and Hydrology	N/A	The DECIDE Project is funded by the Natural Environment Research Council through the Constructing a Digital Environment Strategic Priorities Fund.	DECIDE Project is funded by the Natural Environment Research Council through the Constructing a Digital Environment Strategic Priorities Fund.	Citizen science observations	Observations	N/A	N/A	DECIDE aims to collect new species occurrence data to improve biodiversity models for decision-making by putting recorders' motivations at the heart of the process. Focusing initially on butterflies, moths and grasshoppers, this pioneering project aims to map 1,000 species at fine-resolution and to improve these models through the records submitted by recorders. Recorders will be guided where and when to make records in their region, so that their records can optimally improve the species maps - a process called 'adaptive sampling'	14/8/23		24/8/23 31/08/23	N/A			
17	DestiNE	Destination Earth	https://destination-earth.eu/contact-us/	Request for Contact Details / without replied	N/A	N/A	N/A	EU Green Deal and Digital Strategy	Digital Twinning	Monitor and simulate the Earth's system developments (land, marine, atmosphere, biosphere) and human interventions.	The data lake will bring together data from ESA, EUMETSAT, ECMWF as well as from Copernicus, and many other	N/A	N/A	Destination Earth (DestiNE) is an ambitious initiative of the European Union to create a highly accurate digital model of Earth that will be used to monitor the effects of natural and human	25/7/2023		15/08/23	N/A			
18	DISSCO	Distributed System of Scientific Collections	https://www.dissco.eu/	Eva Alonso	eva.alonso@naturalis.nl	DISSCO Head of Governance Affairs	Naturalis	H2020	Collections digitization, databasing and FAIR Digital Object Infrastructure	Natural science collections digitization and integration	Collections digitization	Code/documentation Persistent identifiers for species on the annexes of the Habitats Directive.	Image-recognition software for species on the annexes of the Habitats Directive.	The DISSCO aims to build one single European Natural Science Collection that digitally unifies all European natural science assets under common access, curation, policies and metadata. DISSCO is committed to do this while ensuring that the data is DTB BioFlow will transform access to data on ocean biodiversity metadata and meta standards, at the European level	26/07/23		01/08/23	OpenAPI https://www.openapi.org/ EML GEOSON DOC	SMIL		
19	DTB-BioFlow	Integration of biodiversity monitoring data into the Digital Twin Ocean	https://www.dtb-bioflow.eu/	Vicente Fernandez fernandez@seaspacebelgium.be	N/A	N/A	N/A	DTB-BioFlow will unlock "sleeping" biodiversity data enabling the sustained flow of these and new data via primary integrators and EMOData into the EU Digital Twin. Powerful advances in genome sequencing technology, informatics, automation, and artificial intelligence, have propelled humankind to the threshold of a new beginning in understanding, utilising, and conserving biodiversity.	The key to the interoperability of DTB-BioFlow with the MAMBO Project is metadata and meta standards, at the a monitor for biology aims to sequence, catalog and characterize the genomes of all of Earth's eukaryotic biodiversity over a period of ten years.	DTB-BioFlow will unlock "sleeping" biodiversity data enabling the sustained flow of these and new data via primary integrators and EMOData into the EU Digital Twin. Powerful advances in genome sequencing technology, informatics, automation, and artificial intelligence, have propelled humankind to the threshold of a new beginning in understanding, utilising, and conserving biodiversity.	bioflow	N/A	DTB-BioFlow will transform access to data on ocean biodiversity metadata and meta standards, at the European level	N/A	DTB-BioFlow will transform access to data on ocean biodiversity metadata and meta standards, at the European level	25/07/23		27/7/23 16/06/23	29/08/23	Essential and biodiversity variables	EML
20	Earth Biogenome Project	Earth Biogenome Project	earthbiogenome.org	Harris Lewin	info@earthbiogenome.org	N/A	N/A	N/A	Sequencing Life for the Future of Life								16/08/23	19/09/23			
21	Easy RIDER	Real-time Identification for Ecological Research and Monitoring	https://www.ech.ac.uk/our-research-projects/easy-rider-real-time-identification-ecological-research-and-monitoring	David Roy	dbr@ech.ac.uk	UK Centre for Ecology and Hydrology	UKRI Natural Environment Research Council Global Partnerships Seedcorn Fund	Automated insect camera traps	Easy RIDER aims to develop new international partnerships and networks to underpin the development of long-term and sustainable collaborations for this exciting, yet nascent, research field that spans engineering, computing and biology.	Easy RIDER aims to develop new international partnerships and networks to underpin the development of long-term and sustainable collaborations for this exciting, yet nascent, research field that spans engineering, computing and biology.	insect camera trap images	N/A	N/A	A UK Research and Innovation Global Partnership Seedcorn fund project to support the development of long-term partnerships with international researchers (UKRI, UK, Naturalis). Easy RIDER will standardise automated insect camera traps with a global community (e.g. through Wikidata), and field testing traps in multiple locations.	15/8/2023		19/09/23	N/A	N/A		
22	EcoStack	EcoStack	https://www.ecostack-h2020.eu/	Francesco Pennacchio	info@ecostack-h2020.eu	Professor of Entomology Department of Agricultural Sciences University of Napoli "Federico II" Italy	N/A	H2020	crop production	The overall objective of EcoStack is to develop and support ecologically, economically and socially sustainable crop production via stacking and protection of functional biodiversity	research	N/A	N/A	Four objectives: - sustainable crop production needs, - optimize role of off-crop habitats, - design and test in-crop interventions, - develop integrated crop production systems.	25/07/23		15/08/23	N/A	N/A		

ID	Acronym	FullName	URL	contact	contactEmail	contactProfile	Leading	Type of Initiative	Main Fields	Approach	Data types	Data Requirement	Software Requirement	Remarks	Date_Data Request contact	Date_Follow_Data Request /	Date_Interview	Additional sources / Data	Metadata	
23	ECSTE	Ecste - European Network Science Centers and Museums	https://www.ecste.eu/	The Ecste Executive Office	info@ecste.eu communications@ecste.eu	Phone: +32 2 649 7383	N/A	Ecste connects, inspires and empowers science engagement organisations and professionals, extending the reach and strengthening the impact of their work.	N/A	Empower professionals in our network around initiatives where science engagement organisations make a real difference on societal topics like climate equity and trust in science. As such, we work towards our common ambition - to deepen the impact of the crucial role we play in the world.	N/A	N/A	N/A	EU Pollinators Initiative sets strategic objectives and a set of actions to be taken by the EU and its Member States to address the decline of pollinators in the EU and contribute to global conservation efforts. It sets the framework for an integrated approach to the problem and a more effective use of existing tools and policies. The initiative sets long term objectives (towards 2030), and short term actions under three priorities: improving knowledge of pollinator decline, its causes and consequences; Tackling the causes of pollinator decline; and Raising awareness, engaging society at-large and promoting collaboration.	25/7/23	15/08/23	N/A	N/A		
24	EA	European Environment Agency	https://www.eea.europa.eu/en	Inira Levisky Jan-Erik Petersen	inira.levisky@eea.europa.eu jan-erik.petersen@eea.europa.eu	N/A	Nature Restoration Lead at European Environment Agency - EEA	European Environment Agency - EEA	Nature Restoration	Together with our Eionet network, They provide the knowledge and the data needed to achieve sustainability in Europe.	N/A	N/A	N/A	N/A	25/07/23		28/08/23	N/A	N/A	
25	eTER	Integrated European Long-Term Ecosystem, critical zone and socio-ecological Research	https://eter.risc.eu/	Michael Merrill	office@eter.risc.eu	N/A	UFZ/EEA Germany/Austria	EU RI	(socio-)Ecological Research	eTER provides researchers with access to over +500 sites and +50 larger ITSER Platforms across Europe, including forest, and biogeographical regions, establishing and offering harmonised and standardised data, services and training	any field derived data	N/A	N/A	eTER responds to the challenge of understanding the complex interactions between people and nature over the long term. Environmental sustainability can only be achieved on the basis of the robust knowledge and empirical evidence needed to identify and mitigate human impacts on ecosystems. eTER catalyses scientific discovery and insights through its state-of-the-art research infrastructure, collaborative working culture, and transdisciplinary expertise. This enables the development and application of evidence-based solutions for the wellbeing of current and future generations.	28/08/23	04/10/23	04/10/23	N/A	N/A	
26	ENVI	Environmental Research Infrastructures	https://envi.eu/	Andreas Petzold	a.petzold@fz-juelich.de	N/A	FORSCUNGSZENTRUM JÜLICH GmbH - Germany	RI Collaboration	Biodiversity data stewardship	Make the data and services findable, accessible, interoperable and reusable to enable high quality and holistic understanding of the Earth system.	Biodiversity, open access, European network, Environmental projects, EOSC, Research infrastructure	Detectors and sensors (resolutions)	N/A	To implement the FAIR principles in the ENVI community and connect it to the European Open Science Cloud (EOSC). Common policies, open standards, interoperability solutions, operational services, and stewardship of data on the basis of FAIR (Findable, Accessible, Interoperable, Re-usable) principles require a common approach. The final goal is to provide the open access platform for interdisciplinary environmental research data in the European Research Area utilising the EOSC.	26/07/23		02/08/23	N/A	N/A	
27	Eol	Encyclopedia of Life	eol.org	Jon Hammock	hammock@eol.org	N/A	SI-MNH Research Informatics Program National Museum of Natural History	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22/11/23	27/11/23	N/A	N/A	
28	EOSC	European Open Science Cloud	https://www.eosc.eu/	Mark Van de Sanden	mark.vandesanden@surf.nl	https://www.eosc.eu/secretariat	N/A	EU RI	N/A	The European Open Science Cloud (EOSC) is an environment for hosting and processing research data to	N/A	N/A	N/A	N/A	N/A	22/11/23	N/A	N/A	N/A	
29	ERGA	The European Reference Genome Atlas	https://www.erga-biodiversity.eu/	Giulio Formenti	contact@erga-biodiversity.eu	N/A	N/A	N/A	N/A	The European Reference Genome Atlas (ERGA) initiative is a pan-European scientific response to current threats to biodiversity. Reference genomes provide the most complete insight into the genetic basis that forms each species and represent a powerful resource in understanding how biodiversity functions.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30	ESA	The European Space Agency	https://www.esa.int/	Estec	contact@esa.int	Phone: +31 71 565 65 65	N/A	N/A	N/A	This is the European Space Agency, dedicated to the peaceful exploration and use of space for the benefit of humankind.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
31	EURAMS	EU Pollinator Monitoring Scheme	https://eupams.europa.eu/eupams/observa-tion?pagina=23862107	JRC-POMMS@ec.europa.eu	JRC-POMMS@ec.europa.eu	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
32	EUROPADON	Europa Biodiversity Observation Network	https://europadon.org/	Henrique Pereira	info@europadon.org	N/A	German Centre for Integrative Biodiversity Research (Idiv)	N/A	N/A	N/A	biodiversity data, EBVs and EESVs	N/A	N/A	EuropaDON will work with stakeholders to identify user and policy needs for biodiversity monitoring and investigate the feasibility of setting up a center to coordinate monitoring activities across Europe. Together with stakeholders, EuropaDON will assess current monitoring efforts to identify gaps, data and workflow bottlenecks, and analyse cost-effectiveness of different schemes. The results of this assessment will be used to inform the design of improved monitoring schemes able to integrate in-situ and remote sensing data through models, and using novel technologies, to deliver more complete and less biased biodiversity information with multiple benefits to users and society. A set of EuropaDON showcases will demonstrate how the EBVs and EESVs provide timely and relevant data for EU member states and regions, including policy-relevant indicators to assess progress in biodiversity targets, short-term biodiversity and ecosystem services forecasts, and scenarios that support IPBES and other assessments.	N/A	N/A	N/A	N/A	N/A	
33	GBIF	Global Biodiversity Information Facility	https://www.gbif.org/	Niels Raes	niels.raes@naturalis.nl	Node manager NLBIF (National Node of GBIF)	GBIF Secretariat DK 2100 Copenhagen Denmark	International Network and Data Infrastructure	Biodiversity data stewardship	GBIF is an international network and data infrastructure funded by the world's governments and aimed at providing anyone, anywhere, open access to data about all types of life on Earth.	Biodiversity records	N/A	N/A	Coordinated through its Secretariat in Copenhagen, the GBIF network of participating countries and organizations, working through the participant nodes, provides data-holding institutions around the world with common standards, best practices and open-source tools enabling them to share information about where and when species have been recorded. This knowledge derives from many different kinds of sources, including everything from museum specimens collected in the 18th and 19th century to DNA barcodes and smartphone photos recorded in recent days and weeks.	20/10/2023	N/A	06/11/2023	N/A	N/A	
34	GEODON	Global biodiversity observation network	https://geodon.org/	info@geodon.org	info@geodon.org	N/A	N/A	N/A	N/A	Improve the acquisition, coordination and delivery of biodiversity observations and related services to users including decision makers and the scientific community.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
35	GUARDEN	GUARDEN - safeGUARDing biodiversity and critical ecosystem services across sectors and scales	https://guarden.org/	Pierre Bonnet	pierre.bonnet@ciudad.fr	Coordinator of GUARDEN	C.I.R.A.D. - (France)	Funded by the European Union	To activate Multi-stakeholder Partnerships for improved governance of biodiversity and ecosystem services	Integration of multispatial data for biomonitoring and modelling	Biodiversity databases + Citizen Science Obs.	N/A	N/A	GUARDEN's main mission is to safeguard biodiversity and its contributions to people by bringing them at the forefront of policy and decision-making. This will be achieved through the development of innovative monitoring and assessment approaches of our planet's biodiversity resources.	20/10/2023	25/10/23	06/11/2023	N/A	AC EBV / GEODON (MAMBO) - EEA	
36	IBOL	International Barcode of Life	ibol.org	National Representative Hannah James	info@ibol.org h.james@ibol.org	N/A	N/A	N/A	N/A	Our vision is to illuminate biodiversity for the benefit of all life. We will accomplish this goal by developing a globally accessible DNA-based system for the discovery and identification of all multicellular life.	N/A	N/A	N/A	N/A	N/A	22/11/23	N/A	N/A	N/A	N/A
37	Naturalist	Naturalist	https://www.naturalist.org/	help@naturalist.org	help@naturalist.org	N/A	N/A	N/A	N/A	One of the world's most popular nature apps. Naturalist helps you identify the plants and animals around you. Every observation can contribute to biodiversity science, from the rarest butterfly to the most common backyard weed. We share your findings with scientific data repositories like the Global Biodiversity Information Facility to help scientists find and use your data. All you have to do is observe.	N/A	N/A	N/A	Naturalist is a joint initiative by the California Academy of Sciences and the National Geographic Society. Vision - Naturalist's vision is a world where everyone can understand and sustain biodiversity through the practice of observing wild organisms and sharing information about them. Mission - Naturalist's mission is to build a global community of 100 million naturalists by 2030 in order to connect people to nature and advance biodiversity science and conservation.	25/7/23	N/A	N/A	N/A	N/A	
38	InsectAI	InsectAI	https://www.cost.eu/actions/CA22129/	https://www.cost.eu/contact	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
39	ITS	Integrated Taxonomic Information System	https://www.its.gov/	itswebmaster@its.gov	itswebmaster@its.gov	N/A	N/A	N/A	N/A	Communicate a comprehensive taxonomy of global species that enables biodiversity information to be discovered, indexed, and connected across all human endeavors.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
40	IUCN	International Union for Conservation of Nature	https://www.iucn.org/	IUCN Headquarters	https://www.iucn.org/contact	Phone: +41 (0) 22 999000	IUCN	IUCN is a membership Union of government and civil society organisations. Together, we work to advance sustainable development and create a just world that values and conserves nature.	Biodiversity Conservation	Data, analysis, convening and action.	From Biodiversity records to Red Lists and reports	N/A	N/A	IUCN provides public, private and non-governmental organisations with the knowledge, tools and projects that enable societies, economies and nature to thrive together. These include data, assessments and analysis, trusted standards, neutral convening fora, and capacity-building resources.	25/7/23	N/A	N/A	N/A	N/A	
41	KCBD	Knowledge Centre for Biodiversity	https://knowledge.kcbdc.europa.eu/biodiversity_en	Camino Liqueite	Camino.LIQUEITE@ec.europa.eu	Scientific/technical officer	European Commission	EU	Biodiversity knowledge	KCBD aims to provide biodiversity knowledge for policy.	N/A	N/A	N/A	The Knowledge Centre for Biodiversity supports policymaking by developing tools that support the implementation of the EU Biodiversity Strategy, including its goal dimension: identifying, filtering and structuring relevant information and making it accessible bringing together researchers, policy makers, NGOs, industry and citizens; Analysing, synthesising available evidence and communicating it in a transparent, tailored and concise manner.	02/10/23	16/10/23	24/10/23	N/A	N/A	
42	LifeWatch	LifeWatch ERIC (European Research Infrastructure Consortium)	https://www.lifewatch.eu/	Christos Arvanitidis	ceo@lifewatch.eu	CEO	N/A	N/A	N/A	Become the Research Infrastructure providing access to the world's biodiversity content, services and communities in one click.	N/A	N/A	N/A	N/A	25/7/23	N/A	N/A	N/A	26/7/23	

ID	Acronym	fullName	URL	contact	contactEmail	contactProfile	Leading	Type of Initiative	Main Fields	Approach	Data types	Data Requirement	Software Requirement	Remarks	Date_Data Request contact	Date_Follow_Data Request /	Date_Interview	Additional sources / Data	Metadata
43	LIST	Luxembourg Institute of Science and Technology	https://www.list.lu/en/environment/	Habli Laurent Pfeifer	laurent.pfeifer@list.lu	N/A	N/A	N/A	Research and technological innovation	The mission of the Environmental Research and Innovation (ERIN) department is to carry out responsible impact driven research and technological innovation & policy support for a sustainable resources management and the reduction of environmental impact of human activities, in order to enable and accelerate the transition towards a sustainable, resilient and digital economy and society in Luxembourg and abroad.	N/A	N/A	N/A	N/A	N/A	22/11/23	N/A	N/A	N/A
44	MARCO-BOLD	MARCO BOLD Community of Practice	https://marcobold-project.eu/en/	Vicente Fernandez Lisa Benedetti	vicente.fernandez@saascapebelgium.be	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22/11/23	N/A	N/A	N/A
45	MOBIUSE Action	MOBIUSE Action	https://www.mobiuise-action.eu/		https://www.mobiuise-action.eu/contact/	N/A	N/A	N/A	Standards and Guidelines	Mobilising Data, Policies and Experts in Scientific Collections	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
46	Motus	Motus Wildlife Tracking System	motus.org	Motus Wildlife Tracking System	motus@birds canada.org	N/A	N/A	N/A	Automated radio telemetry currently allows researchers to track the smallest animals possible with high temporal and geographic precision, over great distances	The Motus Wildlife Tracking System is an international collaborative network of researchers that use automated radio telemetry to simultaneously track hundreds of individuals of numerous species of birds, bats, and insects.	N/A	N/A	N/A	N/A	25/7/23	N/A	N/A	N/A	N/A
47	NaturaConnect	NaturaConnect	https://naturaconnect.eu/	Matea Osti	osti@iasa.ac.at	https://naturaconnect.eu/contact/	N/A	N/A	Building a resilient ecological network of conserved areas across Europe for nature and people.	NaturaConnect aims to design and develop a blueprint for a truly coherent Trans-European Nature Network (TEN-N) of conserved areas that protect at least 30% of land in the European Union, with at least one third of it under strict protection.	N/A	N/A	N/A	N/A	25/7/23	N/A	N/A	N/A	N/A
48	NINA	Norwegian Institute for Nature Research	https://www.nina.no/english/home	firmapost@nina.no	firmapost@nina.no	N/A	N/A	Cooperation and expertise for a sustainable future	Genetic analyses	The Norwegian Institute for Nature Research, NINA, is as an independent foundation focusing on environmental research, emphasizing the interaction between human society, natural resources and biodiversity.	N/A	N/A	N/A	N/A	25/7/23	N/A	N/A	N/A	N/A
49	NSO	Netherlands Space Office	https://www.spaceoffice.nl/en/	Jeppe Jongen	jjongen@spaceoffice.nl	adviseur@netherlands.spaceoffice.nl	N/A	N/A	Advisor of Satellite applications	The Netherlands Space Office (NSO) is the space agency of the Dutch government. The task of the NSO is to advise and realize the national space policy.	N/A	N/A	N/A	N/A	N/A	22/11/2023	N/A	N/A	N/A
50	Observation International	Observation International	https://observation-international.org/en/	Dylan Verheul	dylan.verheul@naturalis.nl	office@observation.org	N/A	Observation International is a non-profit foundation under Dutch law.	Citizen Science	Observation International provides a worldwide platform for storing, validating and sharing nature information.	Citizen Science observations, with or without images and sound recordings	Taxonomy is really important for image recognition because you want to group species exactly as they are displayed equally, and when using a specimen you can use a barcode level and display with AI identify	There are other different parameters to consider such as spatial coordinates, time coordinates, where and when they were found, elevation, weather conditions and location. If you have a stationary temperature or humidity sensor for permanent monitoring or collect data for the weather station. You can capture different types of data.	25/7/23	15/08/23	Common dictionary for international Taxonomy Model of recognition software have for annotations about organisms, some organisms in the image (adult, egg, etc) that makes the specific of biodiversity recognition from image recognition.	JSON		
51	OPPLA	Oppla is the EU Repository of Nature-Based Solutions.	https://oppla.eu/product/21228	info@oppla.eu	info@oppla.eu	Phone: +44 (0) 161 236 3432	N/A	N/A	N/A	Oppla is an open platform that is designed for people with diverse needs and interests - from science, policy and practice, public, private and voluntary sectors, organisations large and small, as well as individuals.	N/A	N/A	N/A	N/A	25/7/23	N/A	N/A	N/A	N/A
52	PESI	Pan-European Species directories Infrastructure	https://www.eu-nomen.eu/psdi/	N/A	N/A	Yde de Jong	N/A	PESI will provide a robust infrastructure to support the nomenclature needs of European users and stakeholders. PESI will specifically address the issues of pooling resources, standardisation, sustainability, accessibility and international cooperation.	N/A	PESI provides standardised and authoritative taxonomic information by integrating and securing Europe's taxonomically authoritative species name registers and nomenclatures (native databases) and associated expert (ISE) networks that underpin the management of biodiversity in Europe.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
53	PI@nET	PI@nET	https://pi@net.org/en/	Pierre Bonnet	pierre.bonnet@iraad.fr	Coordinator of the PI@nET project	N/A	Citizen science project	Helps you identify plants thanks to your pictures	PI@nET is a system based on image recognition	World Geographical Scheme for Recording Plant Distributions (WGSRPD) Plants of the World Online (POWO) - Plant names IUCN status Biodiversity Information Standards (ITIS) Darwin Core - Glossary of terms intended to facilitate the sharing of information about biological diversity by providing identifiers, labels, and definitions	Have access on a taxonomical scale mainly for plants only, and Genus, GenusFem, and Ferom, that is the taxonomical scope ideally the solution will cover these three specific groups mentioned.	POST API	Mambo Solutions can provide results based on Latin names because for PI@nET are important all these parameters and to give access to all the community, in European and not European languages.	26/7/23	25/10/23	06/11/2023	In terms of interoperability, using international standards for plants is really important. Using international standards for languages.	IC EBI / GBIF EXP INSPIRE JSON IUCN Habitats EN ISO 639-1/2/3
54	Pollinator Academy	Pollinator Academy	https://pollinatoracademy.eu/	Merel Bouas	merel.bouas@naturalis.nl	Project Support Officer NL Biodiversity and Society	N/A	EU initiative	Open source platform for sharing taxonomic knowledge.	The Pollinator Academy is a European, open source platform for sharing taxonomic knowledge. It is a learning platform aiming to strengthen taxonomic capacity throughout Europe and was created through close collaboration between specialists and trainers from different institutes.	N/A	N/A	API	N/A	15/9/23	27/11/23			
55	RESET	RESET	https://en.reset.org/en/about/	N/A	https://en.reset.org/en/about/	N/A	N/A	N/A	RESET supports entrepreneurs with consultation and expertise.	RESET makes solutions-driven, independent journalism, reporting on a sustainable digital future. We share stories and insights about projects and businesses that are using innovative ideas for positive impact. As an impact organisation, RESET supports entrepreneurs with consultation and expertise.	N/A	N/A	N/A	N/A	26/7/23	N/A	N/A	N/A	N/A
56	Restor	Restor	https://restor.eco/?lang=en&id=143&zoom=3	contact@restor.eco	contact@restor.eco	N/A	N/A	A global network of actors is working together to advance restoration. Restor brings these actors together to enable the exchange of data, funding, and local knowledge.	Bringing back healthy forests, grasslands, coastal, and ocean restoration. Restor brings these actors together to enable the exchange of data, funding, and local knowledge.	N/A	N/A	N/A	N/A	N/A	27/7/23	N/A	N/A	N/A	N/A
57	Safeguard	Safeguarding European Wild Pollinators	https://www.safeguard-biodiversity.eu/en/about-us	Steffan Ingolf	ingolf.steffan@uni-wuerzburg.de	N/A	N/A	N/A	N/A	Our goal is to inspire the development of management and policy guidelines for the public and private sectors to safeguard wild pollinators and the benefits they provide.	N/A	N/A	N/A	N/A	15/8/23	N/A	N/A	N/A	N/A
58	SPRING	Strengthening Pollinator Recovery through Indicators and monitoring	https://www.efi.de/efi-springs-pollinator/	Mark van Nieuwstadt	mark.vannieuwstadt@naturalis.nl	Program coordinator	The European Pollinator Monitoring Scheme, or EU-POMS	Heimholtz Centre for Environmental Research (UFZ) - Germany	EU DG Env	The aim is to systematically map insect populations on a large scale in order to provide the scientific basis needed to effectively protect pollinators in Europe.	Contributing data that will directly impact on European Level policy (EU Pollinator Monitoring Scheme)	Pollinators should be considered as part of the species then the Tools can be considered useful.	-Expand and create new monitoring schemes via Citizen Science Networks Monitoring using AI identification and DNA barcodes	The Commission launched the SPRING project (Strengthening pollinator recovery through indicators and monitoring) with an aim to strengthen taxonomic capacity with regard to pollinating insects, support preparation for the implementation of an EU Pollinator Monitoring Scheme and pilot the scheme in all 27 EU countries. The budget of the project is EUR 5 million. The project will provide a critical contribution to the establishment of a scientifically robust and sustainable EU Pollinator Monitoring Scheme that will provide a series of indicators, capable of detecting any significant changes in the abundance of pollinators across the whole of the EU.	25/07/23	08/08/23	Add pollinators for most of the tools, otherwise will be not useful/ increase butterfly and pollinators database increase the taxonomic terms / Larger Taxonomic Groups: 500 butterflies, 1000 butterflies, 2000 bees, 4000-8000 moths depending micro or macro moths.	N/A	
59	STING	Science and Technology for Pollinating Insects	https://knowledge4policy.ec.europa.eu/projects_en	Simon Potts	s.p.potts@reading.ac.uk	N/A	N/A	European Initiative on Pollinators (COH2018) 395)	N/A	Consists in raising awareness, engaging society at large and promoting collaboration on pollinators' decline	N/A	N/A	N/A	N/A	07/11/2023	20/11/2023	N/A	Science and Technology for pollinating insects (STING): A pool of experts assisting the European Commission with Action 3 of the EU Pollinators Initiative (design of the EU Pollinator Monitoring Scheme). Chaired by UREAD with Naturalis, UFZ, UKRIH. Major end user for MAMBO technologies and tools.	

ID	Acronym	fullName	URL	contact	contactEmail	contactProfile	Leading	Type of Initiative	Main Fields	Approach	Data types	Data Requirement	Software Requirement	Remarks	Date_Data Request contact	Date_Follow_Data Request /	Date_Interview	Additional sources / Data	Metadata
60	Taxo-Fly	Taxo-Fly	https://www.luoma.fi/en/Taxo-Fly	Gunilla Ståhl	gunilla.stahl@helsinki.fi	University of Helsinki Head of Laboratory, Zoology Unit	N/A	European Commission (EC)	The tasks carried out by Taxo-Fly project members will support other European Commission funded projects, such as the EU Pollinator Monitoring Scheme (EUPHANS), the Preparatory Action for EU Pollinator Monitoring Scheme and indicators (SPRING project), the Horizon 2020 Europe research projects (PCSHBE, SAFEGUARD), and European National action plans for pollinators.	Create a new taxonomic knowledge base, which lays the ground for the identification of the Hoverflies of Europe.	N/A	ISO standard for language	N/A	Taxo-Fly - an EU-funded project gathering taxonomic information for all European hoverfly species	15/8/23	3/9/23	04/09/23	TAXOFLY is working with the data standards for the EU. Creating taxonomic standards for the hoverflies. Catalogue of life	N/A
61	TETTRIS	Transforming European Taxonomy through Training, Research, and Innovations	https://tettris.eu/	Wouter Addink	wouteraddink@naturalsci.nl	Coordinator Research data and E-infrastructure / Systems Manager	contact Naturalis RBINS - (Belgium)	EU TETTRIS Grant Agreement 101081903	Taxonomic knowledge capacity building	Integration and expansion of taxonomy in education, governance, and research	Taxonomic knowledge application	N/A	N/A	TETTRIS, envisions a transformative change in the field of taxonomy to build and sustain taxonomic research capacity through increasing knowledge and developing systems. TETTRIS will achieve this aim by creating joint knowledge in reference collections, training frameworks, and with innovative tools as well as by developing centralized resources providing access to an expertise marketplace, the taxonomic knowledge platform, and career paths. The core methodology for reaching these objectives includes co-creation with citizen scientists, and professionals in biodiversity hotspots.			15/8/23	N/A	N/A
62	The Wildlife Trusts/ORBIT	The Wildlife Trusts/ORBIT	https://www.wildlifetrusts.org/orbit	http://www.wildlifetrusts.org/contact-us	https://www.wildlifetrusts.org/contact-us					Our purpose is to bring wildlife back, to empower people to take meaningful action for nature, and to create an inclusive society where nature matters.				Developing resources for European bee inventory and taxonomy (UREAD) aims to create a centralised taxonomic facility that lays the groundwork for the identification of European wild bees that will support other European projects such the EU Pollinator Monitoring Scheme (EU POMS)	25/7/23	N/A	N/A	N/A	N/A
63	WildEye	WildEye	https://wildeyeconservation.org.uk/	Nicholas Ormer	nicholas@wildeyeconservation.org	TrapTagger Project Lead	N/A	Private projects combined under a new AI-conservation organisation known as WildEye	Our goal is to use technology to give back to the planet from which we have taken so much.	We are an organisation that aims to assist the conservation community at large by leveraging the latest machine vision technologies to increase both the efficiency and accuracy of existing processes, as well as to solve new problems.	TrapTagger OpenSource Microsoft's MegaDetector - MegaDetector model	N/A	N/A	Apply modern technology, especially in the form of machine vision, to solving challenging conservation problems in order to serve the conservation community at large.	14/8/23		29/8/23	EU / Nature Fest / Biodiversity Goals	N/A
64	WILDLABS	WILDLABS	wildlabs.net	Stephanie Odonnell	stephanie.odonnell@wildlabs.net	N/A	N/A	N/A	N/A	WILDLABS is the global, open online community dedicated to conservation technology.	N/A	N/A	N/A	N/A	26/7/23		1/9/23	N/A	N/A
65	WWF	World Wildlife Fund	https://www.worldwildlife.org/	membership@wwfus.org	membership@wwfus.org	N/A	N/A	N/A	N/A	WWF works to help local communities conserve the natural resources they depend upon; transform markets and policies toward sustainability; and protect and restore species and their habitats.	N/A	N/A	N/A	N/A	27/7/23		N/A	N/A	N/A
66	Xeno-Canto	Xeno-Canto	https://xeno-canto.org/	Willem Pier Vellinga	wp@xeno-canto.org	Founder	N/A	The Xeno-canto foundation (or the "Stichting Xeno-canto voor natuurgeeluden") is the legal body set up in the Netherlands to run the website.	Biodiversity monitoring through sound recordings	www.xeno-canto.org ("Xeno-canto", "XC") is a website for sharing recordings of wildlife sounds from all across the world.	Sound recordings	N/A	N/A	N/A	15/8/23	27/08/23	12/10/23	Didn't show	

Type	Format	Description	Link	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	TOTAL		
				ARISE	BGE	BICKL	BIODT	BIOSCAN Europe	Bold_System	Copernicus	DiSSCo	DTO-BioFlow	EEA	ENVRI	EoL	GBIF	GUARDEN	KCBD	Observation International	PI@nNET	Pollinator Academy	SPRING	TaxoFly	TETTRIS	WILDEYE	WildLabs			
	MP3	MP3 compression employs perceptual coding, an approach based on psychoacoustic models that permit the codec to discard or reduce the precision of audio components that are less audible to human hearing.	https://www.loc.gov/preservation/digital/formats/fdd/fdd000012.shtml						1						1	1	1		1		1							6	
	MP4	MP4 can contain video and audio streams. The video streams can be encoded in the MPEG-1, MPEG-2, MPEG-4 and H.264/AVC standards. The audio streams can be (HE)-AAC, MPEG-1 Audio Layer 1-2-3, CELP, TwinVQ, Vorbis or Apple Lossless.	https://www.w3.org/2008/WebVideo/Fragments/wiki/State_of_the_Art/Containers#:~:text=MP4%20can%20contain%20video%20and,TwinVQ%2C%20Vorbis%20or%20Apple%20Lossless.						1	1					1	1	1		1		1			1				8	
	WAV	The WAV audio format was developed by Microsoft and has become one of the primary formats of uncompressed audio. It stores audio at about 10 MB per minute at a 44.1 kHz sample rate using stereo 16-bit samples. The WAV format is by definition, the highest quality 16-bit audio format.	https://isip.piconepress.com/projects/speech/software/tutorials/production/fundamentals/v1.0/section_02/s02_01_p05.html#:~:text=The%20WAV%20audio%20format%20was,quality%2016%2Dbit%20audio%20format.						1	1					1	1	1		1					1	1			8	
Maps	SHP	The shapefile format is a geospatial vector data format for geographic information system (GIS) software. The shapefile format can spatially describe vector features: points, lines, and polygons, representing, for example, water wells, rivers, and lakes.	https://en.wikipedia.org/wiki/Shapefile						1	1							1	1		1								5	
	WKT	Well-Known Text - Representation of geometry	https://libgeos.org/specifications/wkt/																										0
	TIFF	A tag-based file format for storing and interchanging raster images. TIFF serves as a wrapper for different bitstream encodings for bit-mapped (raster) images. The different encodings may represent different compression schemes and different schemes for color representation (photometric interpretation)	https://www.loc.gov/preservation/digital/formats/fdd/fdd000022.shtml						1	1					1		1	1		1								6	
	UTM	The Universal Transverse Mercator (UTM) is a map projection system for assigning coordinates to locations on the surface of the Earth. The UTM (Universal Transverse Mercator) coordinate system divides the world into sixty north-south zones, each 6 degrees of longitude wide.	https://www.usgs.gov/faqs/how-are-utm-coordinates-measured-usgs-topographic-maps						1	1					1		1	1		1					1			7	

