



METHOD PROTOCOL

Building on existing relevant work on research agendas and knowledge gap analysis, identifying interdisciplinary research and action priorities, that contribute to a strategic research agenda on biodiversity and pandemics addressing the critical interlinkages between relevant sectors needed to make future actions more effective.

Requested by

European Commission's Directorate-Generals: Research & Innovation (EC-DG RTD), Environment (EC – DG ENV), Agriculture and Rural Development (EC-DG AGRI), Health Emergency preparedness and Response Authority (EC-DG HERA)

PREZODE (Preventing Zoonotic Disease Emergence),
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Method protocol

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INDEX

Glossary	i
Introduction	1
Background	1
Procedure	1
The Expert Working Group	2
Objectives	2
Methodology	3
Methodological framework	3
Literature-based method: Scoping review	4
Description of the method	5
Research question	5
Search strategy	5
Keyword search and text mining	5
Supplementary searches	5
Bibliographic databases	5
Organisational websites	6
Grey literature searches	6
Search language	6
Estimating the comprehensiveness of the search	6
Search record database	7
Article screening	7
Screening strategy	7
Consistency checking	7
Eligibility criteria	7
Data extraction	7
Limitations	9
Approach to organise Knowledge and Data	9
Initiatives-based method: Initiatives scoping	9
Description of the method	9
Approach to organise Knowledge and Data	9
People-based methods: online survey, Targeted expert consultation and online adapted focus group discussion	10

Description of the method	10
Online survey	12
Online/face-to-face targeted interviews	14
Online participatory workshops - Focus Group Discussion	14
Approach to organise Knowledge and Data	14
Visualisation of the results	15
Literature-based method: Scoping review	15
Initiatives-based method: Initiatives scoping	15
People-based methods: Online survey, Targeted expert consultation, and Online adapted focus group discussion	15
Expected results	15
Timeline	15
References	18
Annexes	19
Annexe 1: Keywords for Scoping review on Biodiversity and pandemics	19
Annexe 2: Preliminary literature search	21

GLOSSARY

Term	Definitions	Key References
Biodiversity	the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.	Convention on Biological Diversity
Agrobiodiversity	the variability of animals, plants and micro-organisms that are necessary for sustaining key functions of the agro-ecosystem, including its structure and processes for, and in support of, food production and food security.	FAO definition
Pandemic	rapid spread of an infectious disease across multiple continents; an epidemic occurring worldwide or over a very wide area, crossing international boundaries and usually affecting a large number of individuals.	WHO
Epidemic	regionally constrained rapid spread of an infectious disease.	Working definition of the authors
Zoonosis	disease or infection that is naturally transmissible from vertebrate animals to human beings.	WHO
Knowledge Gap	unavailability of evidence-based or non-anecdotal knowledge necessary to answer a specific question, leading to the need for further investigation, evidence synthesis, and knowledge exchange.	Working definition of the authors
Scoping review	a preliminary assessment of the potential size and scope of available research literature. It aims to identify the nature and extent of research evidence.	Grant and Booth, 2009

INTRODUCTION

BACKGROUND

The COVID-19 crisis has revealed how fragile and vulnerable our societies are to pandemics and how challenging informed political and policy responses become when faced with such an emergency. As a global community, we were not prepared. The potential risk of zoonoses linked to unprecedented land degradation and conversion, unleashed consumption of natural resources, increasing livestock production, and acceleration of biodiversity loss had been identified and did not come as a surprise to the scientific community. The pandemic has revealed a broad range of science-policy challenges and knowledge gaps. Addressing these will better prepare us for the next crisis that emerges. The request Biodiversity and Pandemics focuses on how to improve our understanding and application of the science of pandemics to optimise coordination and coherence across policy sectors, building better resilience and response strategies (proactive and reactive approaches) in the context of the interface between Biodiversity and Pandemics. Eklipse was granted additional funding by the European Commission, under the H2020 Green Deal Call, as part of the EU response to the COVID-19 pandemic in order to answer policy-relevant needs for evidence related to Biodiversity and Pandemics.

PROCEDURE

An online cross-sectoral workshop was co-organised in May 2021 by [Eklipse](#) and the [European Commission - Knowledge Centre for Biodiversity \(EC-KCBD\)](#) to explore these needs and identify highly policy-relevant topics. The workshop brought representatives from a range of European Commission services together with experienced scientists to identify challenges and evidence needs related to the links between Biodiversity and Human Health, including zoonotic and other infectious diseases. During the workshop, seven policy-relevant knowledge needs (hereafter referred to as “Requests”) were identified, and the one that was ranked highest was “Developing a strategic research agenda on Biodiversity and Pandemics, jointly with all relevant agencies and aligned with relevant sectoral policy agendas”.

An Eklipse Scoping Group proceeded to a literature screening and a Call for Knowledge to gather relevant knowledge and searched for existing or planned initiatives. An online Focus Group was also organised to narrow down the request to be processed by an independent and interdisciplinary Eklipse Expert Working Group (EWG) and to ensure the selected request will meet all Eklipse criteria to start the answering process. This focus group led to the creation of a cross-sectoral consortium of requesters working with the European Commission's Directorate-General for Research and Innovation (EC-DG RTD), co-developing the knowledge needs and expecting a knowledge synthesis. This consortium will follow up the Eklipse process and ensure that the produced evidence will be jointly and timely taken up by policy. A framing exercise led to a provisional formulation of the request: “make sense/some analysis of the existing research agendas/knowledge gap analyses to extract the priorities in the view of interlinkages (between sectors).”

As a final step, the request was reformulated by the Eklipse scoping group, and the following final reformulation was agreed upon by the consortium of requesters:

“ Building on existing relevant work on research agendas and knowledge gap analysis, identifying interdisciplinary research and action priorities that contribute to a strategic research agenda on Biodiversity and Pandemics addressing the critical interlinkages between relevant sectors needed to make future actions more effective. ”

And it was also agreed that the request process would include:

- Mapping of existing research agendas and knowledge gap analysis
- Filtering or analysing research recommendations related to Biodiversity and Pandemics
- Prioritise the identified research recommendations based on their potential for maximising the impact on policies for relevant sectors.

THE EXPERT WORKING GROUP

To answer these primary questions, the Expert Working Group (EWG) on Mitigation hierarchy request was established. The group has been meeting remotely every week since 21.06.2021. It first received an introduction to the Eclipse call, a presentation on the request and the needs of the requester. The initial stages undertaken by Eclipse were also presented in a [Document of Work](#) and a summary of the recommended methods prepared by the Methods Expert Group (MEG). The EWG then selected four co-chairs to lead the subsequent meetings. After several discussions with the MEG, the EWG agreed on the research objectives and methods to be used.

More information can be found on the [Document of Work](#) of the request Biodiversity and Pandemics.

OBJECTIVES

After considering the request, the EWG and the Eclipse team interacted iteratively during weekly virtual meetings and agreed that the process of responding to the request would include:

1. **Rapidly reviewing and summarising the current state of evidence and knowledge as reflected in peer-reviewed articles, reports from organisational websites and grey literature on the topic of Biodiversity and Pandemics via a scoping review.**
2. **Synthesising knowledge on the ongoing research initiatives related to the topic of the relationship between Biodiversity and Pandemics based on data collected by the Eclipse Scoping Group.**
3. **Contacting a large number of outside experts working on the topic of Biodiversity and Pandemics to validate and extend results collected in the first two steps and to prioritise research recommendations related to identified knowledge gaps via an online survey, targeted expert consultation, and a focus-group discussion.**

METHODOLOGY

This section describes the methodology proposed by the Eclipse Expert Working Group in a two-step approach. In the first step – the methodological framework – we describe the methods in general, in relation to the objectives and each other. The second section will describe the methods proposed in more detail.

METHODOLOGICAL FRAMEWORK

To achieve the objectives formulated above, we propose the following three approaches (hereafter referred to as methods; see Figure 1 below for details):

1. **Literature-based method, scoping review** to summarise the current state of evidence and outline the knowledge gaps and address objective 1.
2. An **Initiative scoping** to analyse and summarise the current research recommendations relevant to “Biodiversity and Pandemics” and address objective 2.
3. **People-based methods (online survey-based expert consultation, optional targeted interviews, and focus groups)** to consolidate and validate results on knowledge gaps obtained from methods 1 & 2 and prioritise the knowledge gaps and research recommendations identified by the group, thus addressing objective 3.

These methods will be conducted in parallel, with an effective delayed start of the third method, in order to take into account the results of the first two methods (scoping review and initiative scoping) when formulating the questions in the online questionnaire (first of the two methods used for the objective 3). The use of the three approaches helps provide a more comprehensive answer to the request than a single method.

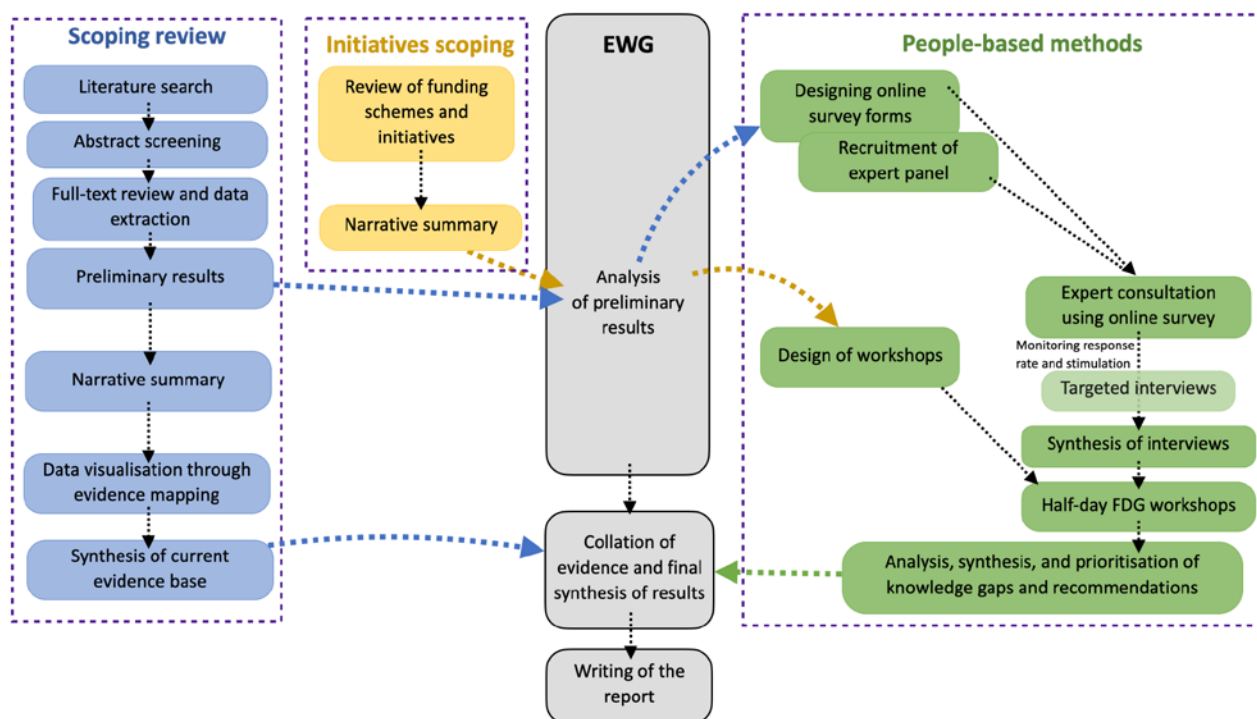


Figure 1. Graphical representation of the methodological framework

LITERATURE-BASED METHOD: SCOPING REVIEW

The scoping review aims to provide an informed conclusion of the quantity and quality of research evidence relevant to recommendations on positive and negative impacts that biodiversity can have on the risk of pandemics using a structured and robust scoping review, together with a summary of what that evidence indicates.

This method will be conducted as follow. The first phase will be a structured search of the peer-reviewed articles, reports from organisational websites and grey literature to summarise the current state of the knowledge and to identify potential contrasting evidence which might indicate knowledge gaps and the need for further investigation (please see the details below). We chose to conduct the literature search across a broad scope exploring the impact of biodiversity on disease outbreaks and spillovers and also the effect of such outbreaks on biodiversity. The second phase will consist of a synthesis of the selected evidence and summarise the existing state of knowledge and gaps in evidence to contribute to the questionnaire and, more crucially, the design and focus of the workshop(s) for the People-based methods. Finally, we will visualise the results of scoping review using evidence mapping methods to report the knowledge gaps and areas in need of further investigation.

The following methods protocol for the scoping review follows the Reporting Standards for Sytematic Evidence Synthesis (ROSES) protocol (Haddaway *et al.*, 2018).

Description of the method

Research question

We defined the key components of the research question based on the PerSPECTiF framework (Booth et al., 2019) for systematic evidence synthesis (see Table 1 below).

Table 1. Components of the research question based on the PerSPECTiF framework (Booth et al., 2019)

Perspective	Setting	Phenomenon of interest	Environment	Timing	Findings
International articles and reports relevant to biodiversity and infectious diseases	Global	Impact of biodiversity on disease outbreaks and pandemics, and the effect of pandemics on biodiversity.	Terrestrial, freshwater and marine ecosystems	From, and including, 2000	Current state of evidence and knowledge gaps in the area of Biodiversity and Pandemics

Search strategy

Keyword search and text mining

We propose to conduct text mining from abstracts of articles included in the previous literature search conducted by the Eclipse on the subject 'Biodiversity and Pandemics' using the litsearchr package (Grames et al., 2019) in R version 4.2.1. The use of a quasi-automated literature search method reduces the time to conduct the search whilst ensuring the transparency and reproducibility of the search by using text-mining and keyword co-occurrence networks to identify important search terms. We also plan to conduct a key search across bibliographic databases using the keywords listed in Annex 1 to ensure the completeness of the search. The keywords were defined in an iterative process to reflect the broad scope of this scoping review.

Supplementary searches

We plan to conduct supplementary searches by citation chasing to ensure the completeness of the search using citation chaser (<https://estech.shinyapps.io/citationchaser/>).

Bibliographic databases

The following electronic bibliographic databases will be searched:

- Web of Science (<https://clarivate.com/>)
- Scopus (<https://www.scopus.com/search/form.uri?display=basic#basic>)
- Social science databases: ProQuest and Ebsco

Organisational websites

We plan to carry out searches on international organisational websites relevant to biodiversity, outbreak preparedness, and OneHealth using the OpenAlex (<https://openalex.org>) search engine. The list of websites is inclusive but not restricted to the following:

- WOA (<https://www.woah.org/en/home/>)
- WHO (<https://www.who.int/>)
- EU Law - Regulations, Directives, and other acts (<https://eur-lex.europa.eu>)
- IUCN (<https://www.iucn.org/>)
- FAO (<https://www.fao.org/home/en/>)
- Ecohealth Alliance (<https://www.ecohealthalliance.org>)
- UNEP (<https://www.unep.org/>)

Grey literature searches

We propose using the Google search engine in “private” mode for grey literature searches (Adams, Smart and Huff, 2017). The search will be organised by relevance and checked until no further relevant hits appear. The threshold was decided arbitrarily to be 50 records. Grey literature search will be limited to the English language.

Search language

We determined the search languages of the bibliographic search (see Table 2 below) based on the language set of EWG members. While not all languages will be covered, potentially limiting the comprehensiveness of the search, a preliminary keyword search conducted on the Web Of Science found that >98% of articles were covered by the languages included in Table 2 (also, please consult Annex 1). Articles in languages unfamiliar to the members of the EWG will be translated to English using DeepL Pro. The grey literature search will be restricted to the English language.

Table 2. Languages included in the bibliographic search based on the language mapping of the EWG.

English	French	German	Portuguese	Spanish	Chinese
Polish	Dutch	Turkish	Arabic	Italian	

Estimating the comprehensiveness of the search

- Search is not limited to the English language
- More than two bibliography electronic databases are to be searched
- Reports from organisations relevant to biodiversity, pandemic prevention and One Health/Ecohealth are included in the search.
- Forward citation chasing the selected literature to ensure the comprehensiveness of the search.

Search record database

After the searches are complete, all references will be exported into Zotero, a citation manager, and duplicates will be removed.

Article screening

Screening strategy

We propose a single-stage article screening strategy due to time constraints involving three members of the EWG. To ensure alignment during the screening process, the three members will pilot test by screening the same randomly selected 20 articles independently to determine the eligibility criteria and test the screening tool. If the disagreement rate in the pilot test is over 10%, then the disagreements are reviewed, and the eligibility criteria is updated. The articles to be screened are then divided equally between two members of the group and are to be screened against the eligibility criteria using an offline article screening software, providing the reason for exclusion in each case of exclusion.

Consistency checking

Consistency checking will be undertaken at two stages of the screening process. To ensure consistency in the articles included, we propose a pilot testing of the screening tool prior to the article screening. Once the pilot testing is finished, any conflict in the decision to exclude an article will undergo a full-text screening by the three members of the article screening team.

Eligibility criteria

Studies discussing the following were included for data extraction:

- Impact of biodiversity on disease outbreaks, zoonotic spillovers and cross-species pathogen transmission.
- Current policy on disease emergence related to biodiversity.
- Impact of pandemics and outbreaks on biodiversity.
- Relationship between agro-biodiversity or agricultural biodiversity and disease transmission.
- Wildlife trade and bushmeat exploitation on disease outbreaks and transmission.
- Anthropogenic modifications to the surrounding environment related to biodiversity and disease.
- Deforestation and climate change related to biodiversity and its consequence on human infectious diseases.
- Monitoring and surveillance of pathogen transmission and spillover for pandemic preparedness.

Data extraction

The data will be extracted onto a collaborative online platform, Google Sheets. The metadata will be collected for each entry prior to distribution, appraisal and review of the literature by the reviewers and will be organised as follows:

- Article source
- Type of publication

- Publication details (title, authors, publication year, DOI)
- Language of publication

Prior to data extraction, an online workshop on data extraction tools will be conducted for the reviewers in the EWG to ensure consistency in the data extracted. The following study attribute data will be extracted by the EWG on a full-text review of the included literature:

- Geographical location (study area)
- Scale of the study (Global, multinational, national, regional /local)
- Theme (biodiversity loss, deforestation, land-use modification, habitat fragmentation, etc.)
- Ecosystem (Terrestrial, Freshwater or Marine)
- Conservation intervention proposed
- Research type
 - Hypothesis/theoretical
 - Experimental
 - Descriptive
 - Review
 - Solution proposal
 - Opinion/perspective
 - Evaluation research
- Knowledge areas
 - Model
 - Theory
 - Framework/protocol
 - Lessons learnt
 - Knowledge gaps
 - Guidelines
 - Tools
- Studied level of biodiversity
 - Genetic
 - Community/ecosystem
 - Species
- Outcomes
 - Direct and/indirect impact on biodiversity and disease outbreaks
 - Pathogen risk group (Viral, bacterial, protozoal, etc.)
 - Limitations and challenges
 - Recommendations and proposed solutions
- Quality of evidence
 - Based article type

- Researcher confidence
- Presence of bias

Limitations

- Due to time constraints, a full systematic review was not feasible to meet the deadlines proposed.
- Literature search, although extensive across a broad scope, was non-exhaustive due to language and timeline restrictions.
- With multiple social science databases available, we restricted the search to the two most easily accessible and comprehensive databases.

Approach to organise Knowledge and Data

The full texts and the translated reports for appraisal and review will be stored in a shared online password-protected folder accessible exclusively to the members of the EWG, and the focal and contacts points of other Eklipse governance bodies following the process (Methods Expert Group (MEG), Knowledge Coordination Body (KCB) and Eklipse Management Body (EMB)), along with the tools used through the review process. The data extracted for the purpose of this scoping review will be organised by geography and the predominant themes of the literature search in a collaborative spreadsheet. A narrative synthesis report summarising the current state of evidence and knowledge gaps will be produced. We propose to develop a matrix summarising the positive and negative impacts and knowledge gaps of various intervention strategies across the different themes exploring biodiversity, habitat fragmentation, climate change on disease outbreaks and prevention. We also plan to visualise the gaps in evidence using an evidence atlas, bubble maps, etc. The narrative report will be used in the development of online forms in the People-based methods.

INITIATIVES–BASED METHOD: INITIATIVES SCOPING

Description of the method

The initiative scoping aims to provide an overview of the current funding schemes and initiatives relevant to researching and improving our understanding of the relationships between biodiversity and the risk of pandemics. This will involve summarising the data collected and compiled by the Eklipse Scoping Group's search for existing or planned initiatives, conducted before the formation of the EWG, complimenting the Literature-Based Methods scoping review. The results will be incorporated into the People-Based Methods focus group by providing a means for experts to identify gaps between available funding and initiatives and what they believe is necessary to fill in the existing knowledge gaps regarding the relationship between biodiversity and the risk of pandemics.

Approach to organise Knowledge and Data

Using the data collected and compiled by the Eklipse Scoping Group, we will summarise the amount of funding and duration of projects supported by the identified initiatives, as well as the geographic location(s) of both the

research projects and the research teams conducting them. Eligibility in terms of the type of organisation (academic, industry, NGO), location of teams (EU-only, third countries, etc.), and allowed expenses (students or postdocs, travel, equipment) will also be recorded. This data may be visualised with heat maps illustrating the number of initiatives, the amount of funding available, and the number of projects conducted across countries. The data will also be presented to participants in the People Based Methods focus group, who will be asked to comment on how well the amount, duration, and eligibility criteria of funding for research projects on Biodiversity and Pandemics align with what they believe is needed.

PEOPLE-BASED METHODS: ONLINE SURVEY, TARGETED EXPERT CONSULTATION AND ONLINE ADAPTED FOCUS GROUP DISCUSSION

In order to answer the following elements of the request: *“Filtering or analysing research recommendations related to Biodiversity and Pandemics”* and *“Prioritise the identified research recommendations, based on their potential for maximising the impact on policies for relevant sectors”*, it was decided to select People-based methods.

People-based knowledge synthesis methods are used to assess current and recent activities, set research agendas and involve a range of consultation methods, which may be part of a wider deliberative process or stand-alone *People-based decision methods* support prioritisation and decisions by ranking, sorting or prioritising identified items. Methods include deliberative tools like the Delphi process, or prioritisation or ranking techniques such as multi-criteria decision analysis (MCDA) or structured decision making. Rather than relying on any single method, we will use a combination of these two families of methods to address the key goals of this project.

The main argument for choosing People-based methods was that the literature-based method would only cover the existing published literature, including grey and scientific ones. Given the mismatch between what is published and what is currently worked on due to publication delays, there is a need for the EWG to capture the research frontiers, research priorities and research controversies currently unfolding in research groups as well as current trends in NGOs or international organisations. It was noted that given the recent COVID-19 pandemic, that mismatch could be lesser than usual as a major effort in research and publication has been ongoing since 2020 on the topic, and most relevant organisations have worked hard to update and review their policies and recommendations.

Description of the method

A selection of three tools was chosen in order to achieve the objectives:

- **Wide expert consultation using an online survey** in order to create a preliminary list of gaps in knowledge and research recommendations in a quantitative way (i.e., to get as many inputs of medium quality as possible)

Example: Questions for the Survey

Please provide a score for each of the following research needs:

Importance: 1 to 7 (1-not a priority; 2-very low priority; 3-low priority; 4- neutral priority; 5- moderate priority; 6 high priority; 7 highest priority; I don't know)

Sufficiency of current research (1-no current research exists; 2-very little research exists; 3-little research exists; 4- fair amount of research; 5- moderate amount of research exists; 6 high amount of research exists; 7 no additional research necessary; I don't know)

Urgency: 1 to 3 (1-low; 2-medium; 3-high; I don't know)

Research needs	Importance of issue to pandemic prevention (1 low-7 highest priority)	Sufficiency of current research (1 insufficient to 7 sufficient)	Urgency of initiating new research (1 low- 2 medium- 3 high)
The effect of extreme weather and climate changes on infection occurrence and transmission			
Phylogenetic studies comparing old and new strains of already know pathogenic species			
Identify transmission sources and/or sentinels for animal diseases (vectors, arthropods, wildlife, domestic or wild relay hosts, animalcules...)			
The impact of habitat degradation on pathogen spillover into human populations			
The relationship between changes in biodiversity levels and pathogen transmission from animals to humans			
The role of wildlife trade and related activities in zoonotic spillover events			

- **Targeted expert consultation using virtual interviews** (or face to face when possible) in order to achieve qualitative information and review and consolidate the lists produced above. This tool was considered optional to target individuals who would not have responded to the online survey but considered important to interview due to their knowledge or position.
- **Online adapted focus group discussion (FGD)** organised around one or more workshops (depending on the number of willing participants and time zones) with the objectives to validate, consolidate and prioritise the items on the lists of gaps in knowledge and research recommendations developed based on interviews/survey and the literature-based (method 1).

Online survey

The EWG will design the online forms for the surveys with input from the results of the scoping review. The form will start with a preliminary list of “gaps in knowledge” and “policy & research recommendations” based on the scoping review. Experts will then be asked to complete the list with their inputs.

The online survey participants will be researchers and professionals working on the relationship between Biodiversity and Pandemics. A large dissemination process will be needed but targeted to professionals with expert knowledge to ensure feedback quality. Participants will be selected using a structured process, which will cover a wide range of disciplines, ecosystems and habitats, as well as represent various organisational backgrounds and geographic regions. The list of targeted participants will be wide (with a target of between 300 and 400 individuals - the list already has more than 220 entries). In the list, contact details (name, email, city & country of residence), professional position and institution will be added with a column indicating if this participant could also have relevant experience to be involved in the targeted interviews and focus group discussion. The list is populated from each EWG member's existing network; other expert lists obtained through Eclipse; other working groups known to the EWG; and the academic readings and expertise of the EWG members obtained in method 1. It will include, therefore: i) Relevant persons who an EWG member knows personally (a column captures which EWG member knows this participant personally); ii) Relevant persons who we don't know personally but we “know” them (through reading articles, attending conferences etc.); iii) Authors of relevant articles that will be identified through the literature review. Attention will be given to the geographic coverage of the list that should be wide, as well as the thematic coverage (e.g., health, environment, social & sustainability sciences, as well as academic, public, private and voluntary sectors).

This form should not request more than 15 to 20 minutes for reading and contributions. Tests will be run. The target would be to get a 10 to 20% response rate which with a list of 300 to 400 targeted individuals should come to between 30 to 80 respondents. The outputs of this online survey will be consolidated lists of gaps in knowledge and policy & research recommendations (later G&Rs) that will be synthesised by the EWG and the first layer of prioritisation of the items in these lists by the participants. Most of the responses will be close-ended responses. Respondents will be asked to contribute additional G&Rs (see proposed format below). The ranking of G&Rs will be synthesised across participants to identify which G&Rs are the most prioritised. Further analysis of results will be considered, such as differences/similarities between policy makers' and researchers' responses or associations between G&Rs (e.g., ecologists tend to prioritise items X

& Y when human health practitioners prioritise W & Z). The new G&Rs submitted by respondents will be reviewed by EWG and merged with existing G&Rs, or existing G&Rs will be modified, taking these new G&Rs into consideration, or they will be added as a new contribution to the G&R lists.

A brief and preliminary structure of this form could be as follow:

- *Informed consent*: participants will need to understand how we will use their inputs; they need to answer in terms of their personal capacity; responses will be anonymous (outside of the EWG to select for FGD) - this part will be designed by the Eclipse team
- *Survey Blurb*: this will present the objective of the Eclipse consultation and how this online survey will contribute to it (including the timeline, for example).
- *Preliminary lists presented*:
 - Gaps in knowledge on the positive and negative impacts that Biodiversity can have on the risk of pandemic and *vice versa*
 - Recommendations for research on the positive and negative impacts that Biodiversity can have on the risk of pandemic and *vice versa*
 - Recommendations for research need to inform policies on the positive and negative impacts that Biodiversity can have on the risk of pandemics and *vice versa*
- *Request for inputs* of participants on each of the lists if they feel something is missing or needs reformulation.
 - Inputs must meet at least one of the following criteria: i) Novelty (either in the phenomenon or marked change in that phenomenon); ii) Potential for major effects on biodiversity or pandemics (maybe human health) in the future; iii) Relevance to the two-way linkage between Biodiversity and Pandemics; iv) Reasonable likelihood that the importance of topic will increase in future.
- *Voting* for the most important five gaps in knowledge and five recommendations in order to have the first layer of prioritisation as requested.
- *Additional potential questions* (discussed during last meeting, open to discussion):
 - Optimal funding size to address your most important question
 - Optimal length of the research project/aspect of continuity between projects
 - If you have been involved in responding to a call, feedback on responding and management of the call?
- *Willingness to attend a participatory workshop* (2 to 3h) to validate, consolidate and prioritise gaps & recommendations?"

Online/face-to-face targeted interviews

This tool is currently considered optional, to be used in the case that experts who are invited to fill out the online survey do not respond. Its main aim will be to target key individuals (meaning for their knowledge, skills and expertise, not driven by their position) from key institutions (research centres, international organisations) whose input is considered particularly valuable. The interview will follow the structure of the online survey with preliminary lists sent by email before the interview. This should represent between 0 and 20 interviews maximum conducted by members of the EWG. Interviewees will also be asked if they are willing to participate in a follow-up workshop.

Online participatory workshops - Focus Group Discussion

The objectives of these workshops will be to validate, consolidate and prioritise further the lists of gaps in knowledge and research recommendations by key individuals. This workshop, not longer than half a day (2 to 3 hours), would be an online workshop using a facilitation board (e.g., Klaxoon; Cirad has a licence) and should gather between 15 and 25 participants. Their draft structure that will need to be adapted following the outputs of the other phases of the methods could be:

- First, *validation phase (45')*: present to the participants the Eclipse request and the process that produced the list of gaps in knowledge and research recommendations synthesised after the online survey and literature-based Method 1 (some preliminary material that should facilitate this presentation will be sent to the participants beforehand); a 30mn discussion could then engage the participants to comment these lists;
- Then, *consolidation phase (30')*: participants will be asked to contribute to the online board stickers with new contributions to these lists.
- Finally, in the *prioritisation phase (60')*: participants will prioritise the gaps and recommendations by interacting with the online board.

The number and specific structure of the workshop(s) will depend on the results from the online form and literature-based method (scoping review) and the number of external experts who agree to participate. The virtual format will increase the potential number here, and we have a professional zoom platform to enable multiple break-out rooms. We will take a professional approach to these sessions with experienced facilitators.

The final output of the entire process will be the prioritised lists of gaps in knowledge and research recommendations, synthesised and commented on by the EWG. Workshop participants will contribute in writing through "post-its" allocated on the board, responding to the different questions prepared by the EWG. One or two members of the facilitation team will take notes, and the discussions will be recorded after the consent of the respondents.

Approach to organise Knowledge and Data

A narrative synthesis report will be produced summarising each step's methodology and the outputs. The main content of this report will be the prioritised lists of gaps in knowledge and research recommendations that will be commented on and organised by the EWG according to themes and critically reviewed by its expertise and comments.

VISUALISATION OF THE RESULTS

LITERATURE-BASED METHOD: SCOPING REVIEW

The main output of the scoping review includes a narrative summary of the current state of evidence and the gaps in research relevant to Biodiversity and Pandemics. We propose to tabulate and chart our results organised by geography and predominant themes. The key areas to target future research efforts will also be summarised and tabulated. We plan to use evidence mapping tools to better visualise the outputs using mapping tools such as evidence atlas, map databases, heat maps, and bubble maps.

INITIATIVES-BASED METHOD: INITIATIVES SCOPING

The main output of the initiative scoping will be a narrative summary of the current funding schemes and initiatives relevant to researching Biodiversity and Pandemics, focusing on funding amounts, project duration, and geographic distribution of research teams and project sites. This data may be visualised with heat maps to illustrate the distribution of initiatives, funding, and projects. We will also use wordcloud of keywords.

PEOPLE-BASED METHODS: ONLINE SURVEY, TARGETED EXPERT CONSULTATION, AND ONLINE ADAPTED FOCUS GROUP DISCUSSION

The main outputs of the People-based method will be lists of gaps in knowledge and research recommendations. Efforts will be necessary to present them in a relevant and attractive way to the reader.

EXPECTED RESULTS

The EWG expects to integrate the results of the literature-based methods, initiative scoping, and People-based methods into a single report that will summarise the current knowledge on the relationships between Biodiversity and Pandemics, identify gaps in our knowledge and determine how well existing funding schemes and initiatives align with the needs of researchers to close these gaps. Based on these results, we will also propose recommendations for policy-makers regarding research needs, research policy, and funding to fill the knowledge gaps regarding Biodiversity and Pandemics most effectively and efficiently.

TIMELINE

The following key activities with milestones and proposed duration is described in Figure 2 and Table 3 below.

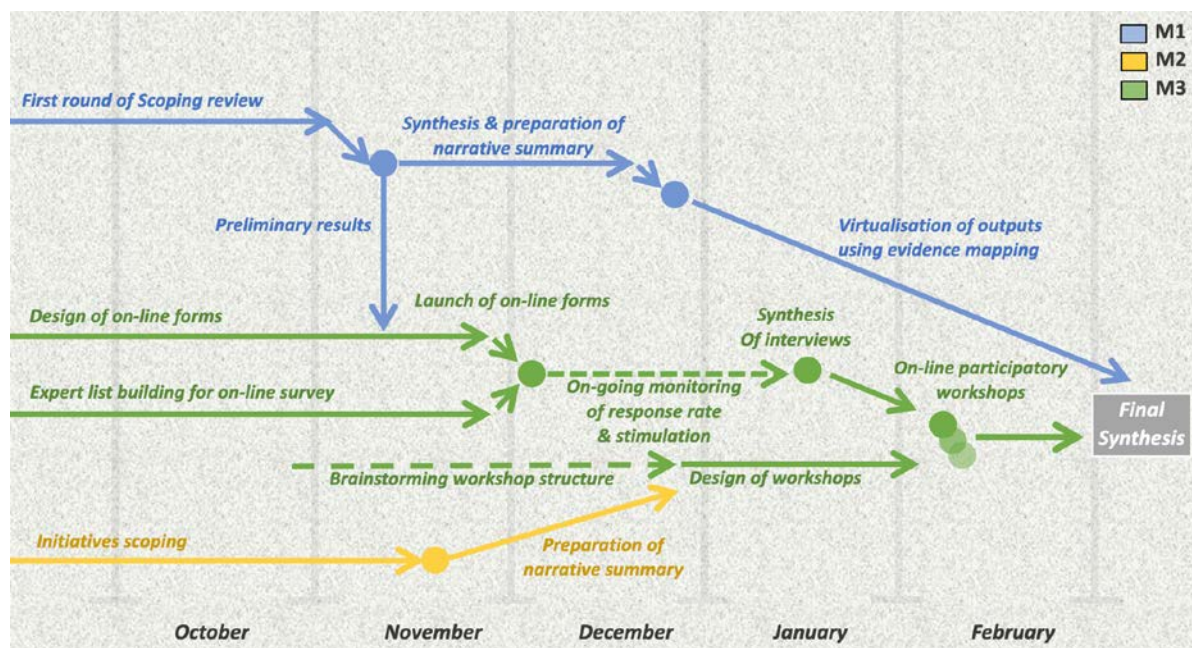


Figure 2: Timeline of the different methods.

Table 3. Overview of the process indicates the different tasks, milestones and timelines.

Activities	Description	Duration/Deadline
Task 1	Method protocol	2.5 months
Milestone 1	Final Method protocol	October 27th 2022
	Methods protocol finalised draft	September 26 th 2022
	Open Call for Methodological Protocol Peer Review and Open Consultation	September 26 th - October 17 th 2022
	Method protocol peer-review finished	November 2 nd 2022
	Reply comments peer review	November 2 nd 2022
Task 2	Scoping review	Two months

Milestone 2	Final Scoping review database	December 2022
Task 3	Initiative scoping	1,5 months
Milestone 3	Final Initiative scoping database	November 2022
Task 4	People-based methods	Three months
Milestone 4	Consultation finished	February 2023
Task 5	Report writing	February-March 2023
Milestone 5.1	Draft report ready for peer review	Beginning of March 2023
Milestone 5.2	Report finished	Beginning of April 2023

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ANNEXES

ANNEXE 1: KEYWORDS FOR SCOPING REVIEW ON BIODIVERSITY AND PANDEMICS

Term	Keywords
General keywords related to disease and pandemic	Disease; infection*; outbreak*; epidemics; spillover; emerging; infectious disease; zoonotic disease; zoonoses, vector-borne diseases; cross-species disease; pathogen transmission; human-animal interface; disease spread; disease emergence use with “AND”
General keywords related to policy	Science-policy interface; European research; IPBES; Network of knowledge; conservation policy; sustainability; ecosystem disservices research; ecosystem service research; biodiversity research; social-ecosystem system use with “AND”
Biodiversity loss	Biodiversity; biodiversity and human health; biodiversity loss; disease ecology; disease reservoirs; ecosystem health; ecosystem service; dilution effect; disease amplification; amplification effect; community structure; Host population threshold; critical community size
Agro biodiversity	Agricultural biodiversity; agrobiodiversity Index; food market, consumption; conservation; seed systems; neglected species; fish richness; soil microbiome
Habitat fragmentation	Deforestation; afforestation; forest fragmentation; habitat fragmentation; roads; edge effect; forest edge; suburban edge; logging; logging roads

Bushmeat and wild animal trade	Bushmeat preparation; butcher*; bushmeat; bushmeat handl*; poach*; trophy hunting; wild meat; game meat; illegal animal trade, illegal wildlife trade, wildlife trade, animal traffic, wild animal trade, wild* supply chain; wet market*; fur trade; bushmeat market; traditional medicine; bushmeat consumption; bushmeat vendors; illegal meat; bushmeat bans wildlife farm*; game farm*; ecotourism; wild animal farm*;
Land-use modifications	Land use change; agricultural land; land conservation; cropland; agricultural expansion; plantation*; agriculture intensification; industrial agriculture; rapid infrastructure expansion; mining; pasture; concentrated animal feeding operation; livestock; cattle rearing; ranch*; livestock wildlife interface; livestock production; poultry; pig*; pastoralism; isolation
Climate change	Environment change, climate change; global warming, flood*; climat*, desertification; global temperatures; severe events; rising seas levels

ANNEXE 2: PRELIMINARY LITERATURE SEARCH

Search string:	(((((((((ALL=(biodiversity)) OR ALL=(agricultural biodiversity)) OR ALL=(biodiversity loss)) OR ALL=(human-animal interface)) OR ALL=(wildlife trade)) OR ALL=(deforestation)) OR ALL=(land-use change)) AND ALL=(zoonotic disease outbreaks)) OR ALL=(pathogen transmission)) OR ALL=(cross-species disease)) OR ALL=(zoonotic spillover)
Database searched:	Web of Science
Search timeline:	From and including the year 2000

Search results

Total number of articles found: 38340



Number of articles published from and including the year 2000: 36470

Articles classified by languages:

Language	Number of articles
English	35778
German	213
Spanish	133
French	97
Portuguese	55
Polish	50
Russian	29
Turkish	26
Hungarian	16
Chinese*	15
Italian	10
Czech*	9
Indonesian*	7
Korean	7
Greek	6
Japanese*	6
Dutch	4
Ukrainian	3
Lithuanian*	2
Croatian*	1

Serbian*	1
Slovenian*	1
Unspecified	1