External Scientific Report

VectorNet European Network for Medical and Veterinary Entomology

APPROVED: 20 November 2025
doi:10.2903/sp.efsa.2025.EN-9798

Protocol of the systematic literature review on the vector status of potential vector species of selected vector-borne pathogens

Francesca Dagostin[1], Marieta Braks[2], Cedric Marsboom[3], Valentina Tagliapietra[1], Andrei Daniel Mihalca[4,5], Annapaola Rizzoli[1], Wim Van Bortel[6]

[1]Edmund Mach Foundation, Research and Innovation Centre, San Michele all'Adige (TN), Italy
[2]National Institute for Public Health and the Environment, Bilthoven, the Netherlands
[3]Avia-GIS, Zoersel, Belgium
[4]Parasitology Consultancy Group, Coruşu, Romania
[5]University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Romania
[6]Institute of Tropical Medicine, Department of Biomedical Sciences, Belgium

Abstract

Vector-borne diseases (VBDs) pose significant risks to animal and human health, emphasizing the need for ongoing surveillance and mapping to support risk assessments. EFSA-Animal disease profiles were created to visualize the current understanding of main characteristic of important pathogens affecting animal health, including information on the potential vector status of several VBDs. This report updates a previous protocol for a review of the vector status of 36 selected pathogens (Massoels et al., 2023); and adds the protocol for review of the vector status of tick-borne encephalitis virus (TBEV) and *Borrelia burgdorferi* s.l. complex. Two systematic literature reviews are conducted, focusing on detection of pathogens in field-collected arthropods and vector competence under laboratory conditions. In addition, the protocol also addresses mechanical transmission of pathogens by arthropods, an often-underestimated route of disease spread. A narrative review will investigate arthropod species that may serve as mechanical vectors of six pathogens: *Coxiella burnetii* (Q fever), equine infectious anaemia virus (EIAV), lumpy skin disease virus (LSDV), *Trypanosoma evansi* (surra), *Trypanosoma vivax*, and *Besnoitia besnoiti* (bovine besnoitiosis). Evidence will be collated from experimental transmission studies, field detection, and epidemiological investigations, and classified by type and strength. The integrated results will assess the vector status of arthropod species on a global scale, providing an updated overview of species suspected or confirmed to play a role in disease transmission. A pathogen-vector matrix will be created to support future risk assessments, surveillance strategies, and control measures for vector-borne and mechanically transmitted infections in the EU and neighbouring regions. This work aims to enhance the understanding of vector-borne diseases and inform evidence-based decision-making to mitigate the risks associated with these pathogens. By combining biological and mechanical transmission data, this initiative will provide a comprehensive framework for managing vector-borne diseases and protecting animal and human health.

Keywords: vector competence, vector-borne diseases, minimum infection rate, animal disease profiles, mechanical transmission, vector-borne pathogens

Question number: EFSA-Q-2025-00542

Correspondence: Ask a Question

Suggested citation: Dagostin, F., Braks, M., Marsboom, C., Tagliapietra, V., Mihalca, A. D., Rizzoli, A., Van Bortel, W., 2025. Protocol of the systematic literature review on the vector status of potential vector species of selected vector-borne pathogens. EFSA supporting publication 2025:EN-9798. 51 pp. doi:10.2903/sp.efsa.2025.EN-9798

ISSN: 2397-8325

The present document has been produced and adopted by the bodies identified above as authors. This task has been carried out exclusively by the authors in the context of a contract between the European Food Safety Authority and the authors, awarded following a tender procedure. The present document is published complying with the transparency principle to which the Authority is subject. It may not be considered as an output adopted by the Authority. The European Food Safety Authority reserves its rights, view and position as regards the issues addressed and the conclusions reached in the present document, without prejudice to the rights of the authors.

Summary

The EFSA-Animal Disease Profiles are regularly updated with the latest data on selected vector-borne diseases (VBDs) that affect animal health. These profiles are part of a living risk assessment project aimed at prioritizing surveillance strategies for emerging animal diseases based on their risk and potential impact on animal and public health. The profiles help identify knowledge gaps and suggest areas for further surveillance and risk assessments. A key feature of the profiles is the inclusion of current evidence on the geographic distribution of potential vectors (mosquitoes, sand flies, biting midges, and ticks) in the EU and neighbouring countries. To enhance the efficiency of displaying relevant vector species, EFSA requires an updated review of the evidence on potential vectors for the 36 VBDs, TBEV and *B. burgdorferi* s.l. complex, as well as mechanical transmission of pathogens such as *Coxiella burnetii* (Q fever), EIAV (equine infectious anaemia), LSDV (lumpy skin disease), *T. evansi* (surra), *T. vivax* (animal trypanosomosis), and *B. besnoiti* (bovine besnoitiosis).

For a species to be considered a vector of a pathogen, it must meet four criteria, as defined by the World Health Organization (WHO): (1) the species should be associated with the disease in the field; (2) the pathogen or its genetic material must be found in field-collected specimens; (3) the species must be capable of becoming infected orally; and (4) the species must be able to transmit the pathogen biologically.

The biological transmission SLRs examine field data on pathogen detection in arthropods worldwide (SLR 1) and laboratory studies of vector competence and transmission ability (SLR 2).

The mechanical transmission narrative review will identify eligible studies on insects with painful or persistent biting habits, such as horse flies, stable flies, horn flies, and keds, and categorize each record according to study type, type of evidence, and strength of evidence. Eligible arthropod groups include Tabanidae, *Stomoxys*, *Haematobia*, *Haematobosca*, *Simulium*, Hippoboscidae, and *Culicoides*.

The results from both reviews will be combined to identify the potential vectors of high-risk VBDs in the EU, including both biological and mechanical transmission routes. The final outcome will be a consolidated overview of vector species for the selected VBDs, including a pathogen-vector matrix highlighting confirmed, suspected, and speculative vectors. This synthesis will provide a scientific basis for risk assessment, guide future research to close existing knowledge gaps, and inform EFSA's surveillance and risk assessment strategies to mitigate the risks associated with vector-borne diseases. By combining biological and mechanical transmission data, this initiative will provide a comprehensive framework for managing vector-borne diseases and protecting animal and human health.

Table of contents

1 Introduction

1.1 Background and terms of reference as provided by the requestor

This contract was awarded by EFSA to: VectorNet

Contractor: VectorNet, AVIA-GIS, Zoersel, Belgium

Contract title: European network for medical and veterinary entomology (VectorNet 3)

Contract number: SPECIFIC CONTRACT No 01 implementing Framework contract No EFSA/2023/OP/0009 (OC/EFSA/BIOHAW/2023/05)

1.2 Interpretation of the Terms of Reference

The EFSA-Animal Disease Profiles are regularly updated with the latest evidence on selected vector-borne diseases (VBDs) that are relevant to animal health (EFSA, 2023). These "living" systematic literature reviews form a core component of a living risk assessment project aimed at prioritizing surveillance strategies for emerging animal diseases, based on their incursion risk and potential impact on both animal and public health. The profiles help identify knowledge gaps and highlight the need for more detailed surveillance and risk assessments for priority diseases.

Designed to provide a user-friendly, interactive, and up-to-date overview of the most relevant characteristics of these VBDs, the EFSA-Animal Disease Profiles are based solely on published data.

A key element of the profiles is the provision of current evidence regarding the geographic distribution of potential vectors in the EU and neighbouring countries for each VBD. To improve the efficiency of displaying relevant vector species in the profiles, EFSA requires an updated review of available evidence on the potential vectors of selected VBDs and the potential vectors of tick-borne encephalitis virus (TBEV) and *Borrelia burgdorferi* s.l. complex in the EU and neighbouring regions. This will enable a more automated and accurate selection of vector species for inclusion in the disease profiles.

EFSA also requires a narrative review of arthropod species that may act as potential mechanical vectors for six pathogens of veterinary importance: *Coxiella burnetii*, equine infectious anaemia virus, lumpy skin disease virus, *Trypanosoma evansi*, *Trypanosoma vivax*, and *Besnoitia besnoiti*. These pathogens were selected because mechanical transmission is either proven or strongly suspected to contribute to their epidemiology, yet consolidated evidence on the responsible vector species remains limited.

According to the World Health Organisation (WHO, 2020) '*vectors are living organisms that can transmit infectious pathogens between humans, or from animals to humans. Many of these vectors are bloodsucking insects, which ingest disease-producing microorganisms during a blood meal from an infected host (human or animal) and later transmit it into a new host, after the pathogen has replicated. Often, once a vector becomes infectious, they are*

capable of transmitting the pathogen for the rest of their life during each subsequent bite/blood meal.'

To consider an arthropod species as a vector for a pathogen, the following four criteria should be satisfied (WHO, 1967):

1. the species should be repeatedly associated with the disease in the field (season and places)
2. the pathogen or its DNA/RNA should be recovered from field-collected specimens that do not have a fresh blood meal in the body
3. the species should be able to become infected after oral infection
4. the species should be able to transmit the pathogen biologically

In mosquitoes, sand flies and biting midges, adult females are the only sex and life-stage capable of transmitting pathogens to a host, while in ticks, nymphs, both adult sexes and sometimes larvae can act as vectors too, depending on the family and genus to which they belong.

On the other side, "mechanical transmission" is defined as the passive transfer of a pathogen by an arthropod, without replication or development of the agent within the vector. The mechanical transmission typically involves blood-feeding insects with painful or interrupted feeding behaviours, which facilitate transfer of infected blood retained on their mouthparts or external surfaces between hosts.

The scope of the narrative review is therefore restricted to hematophagous insects (e.g. tabanids, stable flies, horn flies, mosquitoes, lice, keds, etc.) that may be implicated in mechanical transmission. Other routes of mechanical spread, such as iatrogenic transmission or fomites, are not included.

To identify the potentially relevant vectors for the selected VBDs, we divided the initial questions into two separate systematic literature reviews.

1. The first review (**SLR 1**) focuses on the information on the **36 relevant pathogens detected in arthropods in the field**, worldwide. This SLR will help address the second criterion i.e., the pathogen should be recovered from field-collected arthropod specimens that do not have a fresh blood meal in the gut.
2. The second review (**SLR 2**) includes studies identifying the **transmission of a pathogen in a given arthropod species under laboratory conditions**, answering two questions:
   a) Which arthropod species can become infected after oral infection (in vitro or in vivo), i.e., vector competence studies?
   b) Which arthropod species can transmit the pathogen biologically?
   This second SLR (SLR 2) would help resolve the third and fourth criteria i.e., the species must be able to become infected after oral infection; and the species must be able to transmit the infection biologically.

Results from SLR 1 and SLR 2 will be combined to identify potential vectors of the 36 vector-borne pathogens that are of high risk to the EU as identified by EFSA.

The same approach will be used to identify the potentially relevant vectors for tick-borne encephalitis virus (TBEV) and *B. burgdorferi* s.l. complex:

1. The first review (**SLR 1**) focuses on the information of the **pathogens detected in ticks in the field**, in the VectorNet area.
2. The second review (**SLR 2**) includes studies identifying the **transmission of a pathogen in tick species under laboratory conditions**, answering two questions:
   a) Which tick species can become infected after oral infection (*in vitro* or *in vivo*), *i.e.*, vector competence studies?
   b) Which tick species can transmit the pathogen biologically?

Results from SLR 1 and SLR 2 will be combined to identify potential vectors of tick-borne encephalitis virus (TBEV) and *B. burgdorferi* s.l. complex.

Last, the narrative review on mechanical vectors will review and synthesize published evidence from experimental laboratory and field studies, outbreak investigations, and epidemiological observations concerning mechanical vector species for each of the six pathogens. The results will be presented narratively, and a pathogen–vector matrix will be produced to summarize the strength of evidence for the incriminated species.

2 Data and methodologies

2.1 SLR on the vector status of potential vectors species of 36 vector-borne pathogens

2.1.1 SLR 1: Systematic literature review on pathogen detection in vectors collected in the field

Within this systematic literature review we aim to answer the following research questions:

1. In which arthropod species have the 36 vector-borne pathogens been found in the field, worldwide?
2. What are the minimum infection rates (MIR) of arthropod vectors for each of the 36 pathogens?

2.1.1.1 Eligibility criteria

Pathogens

The vector-borne pathogens causing diseases of veterinary importance, included in this review, are listed in Annex A.1.

Vectors

Publications are included for species of the following vector groups:

- Mosquitoes
- Sand flies
- Biting midges
- Ticks

All arthropod species belonging to one of the four vector groups are eligible for inclusion. Arthropod species outside of these four groups are excluded.

Outcome

Results from any valid test method for the detection of one of the 36 pathogens listed in Annex A.1. in the four vector groups collected in the field are eligible for inclusion:

- Test results detecting VBD's' pathogens from individual and/or pooled samples
- Reported MIR

Temporal delineation

Braks et al. (2017) conducted a systematic literature review from 1950-2016 addressing a similar question. A recent SLR addressing the same question covered the period from 2016-2022 (Massoels et al., 2023). The first following update of this SLR will focus on literature published since 1/1/2023. This SLR will be updated on demand.

2.1.1.2 Search strategy

The following databases will be searched: Web of Science™ and Medline/PubMed and the search terms will include three categories (Annex B.1.):

- Pathogens
- Vectors
- Field studies

2.1.1.3 Selection process

Title and abstract will be screened independently by two reviewers.

Inclusion:

- Publications written in English
- All species belonging to one of the four designated vector groups
- All methods able to detect pathogens accurately
- Studies in which pathogen presence in vectors in the field is investigated

Exclusion:

- Non-primary research publications (e.g., review publications)
- Pathogens not part of the pre-determined list provided in Annex A.1.

Disagreements regarding study eligibility will be reviewed and a consensus made. If needed, a third opinion will be sought.

The full texts of the resulting studies will then be screened independently for inclusion/exclusion based on the same criteria by the one reviewer. In addition, publications will then be excluded if:

- The full text of a publication with results is not accessible
- If there is no detection of the pathogen in any species, no records will be extracted, because they cannot be interpreted unambiguously
- Data are not presented numerically and it is not stated whether pathogen was detected or not
- Hosts were recently imported from other regions and possible vectors collected from them do therefore not represent the status of the species population originally living in the region

2.1.1.4 Data extraction

Data will be extracted by one reviewer according to the data template in Annex D.1. After data extraction, 5% of the data extracted from the papers shall be quality checked by another reviewer. Additionally, to entering the coordinates of the study site, the observation location will also be converted to the polygon levels used by VectorNet.

2.1.2 SLR 2: Systematic literature review on vector competence of 36 vector-borne diseases

Within this systematic literature review we aim to answer the following research questions:

1. Which arthropod species can become infected with a given pathogen after oral feeding (in vitro or in vivo), i.e., vector competence studies?
2. Which arthropod species can transmit a given pathogen biologically?

2.1.2.1 Eligibility criteria

Pathogens
The vector-borne pathogens included in this review are listed in Annex A.1.

Vectors
Publications are included for species of the following vector groups:

- Mosquitoes
- Sand flies
- Biting midges
- Ticks

All species belonging to one of the four vector groups are eligible for inclusion. Species outside of these four groups were excluded.

Outcome
Results on any valid test method for the detection of one of the 36 pathogens listed in Annex A.1. in arthropods are eligible for inclusion:

- Test result for detecting pathogens from arthropod body parts (whole body, legs, salivary glands/saliva, head and thorax for insects, and the idiosoma for ticks) exposed to one of the 36 pathogens listed in Annex A.1. in laboratory conditions, OR

- 'Positive' test results detecting nucleic acid or pathogens in susceptible hosts infected in laboratory conditions after exposure to infectious vectors, OR
- Transmission rates and transmission efficiency.

Temporal delineation

Braks et al. (2017) conducted a systematic literature review from 1950-2016 addressing a similar question. A recent SLR addressing the same question covered the period from 2016-2022 (Massoels et al., 2023). The first following update of this SLR will focus on literature published since 1/1/2023. This SLR will be updated on demand.

2.1.2.2 Search strategy

Relevant publications will be sought for using Web of Science (Core collection & Medline) and search terms will comprise of three categories (Annex B.1).

- Pathogens
- Vectors
- Vector competence studies

The VectorNet Group Leaders (VGL's) will be consulted to provide additional publications of importance which are not included in our primary search result.

2.1.2.3 Selection process

Title and abstract will be screened independently by two reviewers.

Inclusion:

- Publications written in English
- All species belonging to one of the four designated vector groups
- All methods that are able to accurately detect pathogens
- Studies in which vector competence in a laboratory environment was investigated
- Vector competence studies in which laboratory strains of host animals were used

Exclusion:

- Non-primary research publications (e.g., review publications).
- Pathogens not part of the pre-determined list provided in Annex A.1.

If both reviewers choose to include (or exclude) a publication, no further discussion will be needed. Disagreements regarding study eligibility will be reviewed and a consensus decision will be made. If needed, a third opinion will be sought.

The full texts of the resulting studies will then be screened independently for inclusion/exclusion based on the same criteria by the one reviewer. In addition, publications will then be excluded if:

- The full text of a publication is not available
- Data are not presented numerically and cannot be extracted according to our data template

- Host infection studies in which hosts are not representative of their wild counterparts (e.g., studies on laboratory mice strains)
- Studies on vector competence in which there is no mention of transmission rates or the transmission efficiency and it is not possible to calculate them based on the available data

2.1.2.4 Data extraction

Data will be extracted according to the data template presented in Annex E.1. After data extraction, 5% of the data extracted from the papers shall be quality checked by another reviewer. This database has two components: (1) vector competence studies and (2) host infection studies.

The following criteria will be applied to data extraction:

- For each assay conducted in a vector competence study, we will include data from the minimum extrinsic incubation period for data on 'positive' results, as we are most interested in the earliest possible time at which pathogen transmission becomes possible. For data on 'negative' results we will only include data from the maximum extrinsic incubation period tested in the study.
- For *Leishmania infantum*, we will only include records when metacyclic promastigotes, the infectious stage of the parasite in the sand fly vector, will be detected. (After ingestion, amastigotes become metacyclic promastigotes in the thoracic midgut and then move to the proboscis, from which they are transmitted).
- Species will be flagged in case they occur in the VectorNet database (Annex C) and also when they are on the VectorNet priority species list (Annex C).
- Additionally, to adding the coordinates in the database, the observation location will be converted to the polygon levels used by VectorNet.

2.1.2.5 Determining the vector status

We will determine the vector status based on the data collected in SLR 1 and SLR 2. The vector status will be determined as following:

- **'Potential'** vector, if the pathogen was detected in the field collected arthropods OR if vector competence or host infection studies concluded that the species was vector competent under laboratory conditions.
- **'Highly likely'** vector, if both the pathogen was detected in the field collected arthropods AND if vector competence or host infection studies concluded that the species was competent under laboratory conditions.

2.2 SLR on the vector status of potential vector status of tick species for tick borne encephalitis virus (TBEV) and *Borrelia burgdorferi* s.l. complex

2.2.1 SLR 1: Systematic literature review on pathogen detection in ticks collected in the field

Within this systematic literature review we aim to answer the following research questions:

1. In which tick species have TBEV and *B. burgdorferi* s.l. complex been found in the field, in the VectorNet area? Data related to this research question will be extracted in step 1 (by November 2025)
2. What are the minimum infection rates (MIR) or prevalence of tick vectors for TBEV and *B. burgdorferi* s.l. complex? Data related to this research question will be extracted in step 2 (by October 2026)

2.2.1.1 Eligibility criteria

Pathogens

The details of the two tick-borne pathogens causing diseases of veterinary importance, included in this review, are listed in Annex A.2. For the full list of selected vector-borne pathogens of the EFSA-Animal Disease profiles see (Massoels et al., 2023).

Vectors

Publications are included for species of the following vector groups:

- Ticks

Arthropod species outside of this group will be included only if deemed relevant.

Outcome

Results from any valid test method for the detection of one of the pathogens listed in Annex A.2. in ticks collected in the field are eligible for inclusion:

- Test results detecting VBD's' pathogens from individual and/or pooled samples
- Reported MIR or prevalence

Temporal delineation

For the present work, which is the first SLR specifically targeting these two disease agents, the review will cover the period from 1 January 2016 to 31 December 2024.

2.2.1.2 Search strategy

The following databases will be searched: Web of Science™ and Medline/PubMed and the search terms will include three categories (Annex B.2.):

- Pathogens
- Vectors
- Field studies

The search will be carried out as a separate process from the search described in SLR 2 (see below).

2.2.1.3 Selection process

Title and abstract will be screened independently by two reviewers.

Inclusion:

- Publications written in English
- All methods able to detect pathogens accurately
- Studies in which pathogen presence in ticks in the field is investigated
- Ticks collected within the VectorNet area

Exclusion:

- Non-primary research publications (e.g., review publications)
- Pathogens not part of the pre-determined list provided in Annex A.2.

Disagreements regarding study eligibility will be reviewed and a consensus made. If needed, a third opinion will be sought.

The full texts of the resulting studies will then be screened independently for inclusion/exclusion based on the same criteria by one reviewer.

In addition, publications will be excluded if:

- The full text of a publication with results is not accessible
- The publication is not written in English
- No pathogens have been detected in any tick species
- Data are not presented numerically, and it is not stated whether pathogen was detected or not
- Ticks collected outside the VectorNet area or with no clear geographical information

2.2.1.4 Data extraction

Data will be extracted by one reviewer according to the data template in Annex D.2. During step 1 (by November 2025), only information relevant to the fields "First Author", "Title", "Year", "Country", "LifeStage", "VectorGroup", "VectorSpecies", "Host", "Positive/Negative", "VBD_Agent", "VBD_Agent_subtype", "VBD_AS_Full", "Notes", will be completed. The other information will be extracted during step 2 (by October 2026). After data extraction, 5% of the data extracted from the papers shall be quality checked by another reviewer.

2.2.2 SLR 2: Systematic literature review on vector competence of TBEV and *B. burgdorferi* s.l. complex.

Within this systematic literature review we aim to answer the following research questions:

1. Which tick species can become infected with a given pathogen after oral feeding (in vitro or in vivo), i.e., vector competence studies?

2. Which tick species can transmit a given pathogen biologically?

2.2.2.1 Eligibility criteria

Pathogens
The tick-borne pathogens included in this review are listed in Annex A.2.

Vectors
Publications are included for species of the following vector groups:

- Ticks

Arthropod species outside of this group are excluded.

Outcome
Results on any valid test method for the detection of one of the pathogens listed in Annex A.2. in ticks are eligible for inclusion:

- Test results for detecting pathogens from ticks' body parts (whole body, legs, salivary glands/saliva, and the idiosoma for ticks) exposed to one of the pathogens listed in Annex A.2. in laboratory conditions, OR
- 'Positive' test results detecting nucleic acid or pathogens in susceptible hosts infected in laboratory conditions after exposure to infectious ticks, OR
- Prevalence and/or transmission rates

Temporal delineation
For the present work, which is the first SLR specifically targeting these two pathogens, the review will cover the period from 1 January 2016 to 31 December 2024.

2.2.2.2 Search strategy

Relevant publications will be sought for using Web of Science™ and Medline/PubMed and search terms will comprise of three categories (Annex B.2.).

- Pathogens
- Vectors
- Vector competence studies

The search will be carried out as a separate process from the search described in SRL 1 (see above). If needed, the VectorNet Group Leaders (VGL's) will be consulted to provide additional publications of importance which are not included in our primary search result.

2.2.2.3 Selection process

Title and abstract will be screened independently by two reviewers.

Inclusion:

- Publications written in English
- All methods that are able to accurately detect pathogens

- Studies in which tick competence in a laboratory environment was investigated
- Studies focusing on the transmission of the pathogens between competent hosts and ticks

Exclusion:

- Non-primary research publications (e.g., review publications)
- Pathogens not part of the pre-determined list provided in Annex A.2.

If both reviewers choose to include (or exclude) a publication, no further discussion will be needed. Disagreements regarding study eligibility will be reviewed and a consensus decision will be made. If needed, a third opinion will be sought.

The full texts of the resulting studies will then be screened independently for inclusion/exclusion based on the same criteria by the one reviewer. In addition, publications will then be excluded if:

- The full text of a publication is not available
- Publication not available in English
- Data are not presented numerically and cannot be extracted according to our data template
- Studies on vector competence in which there is no mention of prevalence or MIR or transmission rates or the transmission efficiency and it is not possible to calculate them based on the available data

2.2.2.4 Data extraction

Data will be extracted by one reviewer according to the data template in Annex E.2. After data extraction, 5% of the data extracted from the papers shall be quality checked by another reviewer.

The following criteria will be applied to data extraction:

- For each assay conducted in a vector competence study, we will only include data from the minimum extrinsic incubation period, as we are most interested in the earliest possible time at which pathogen transmission becomes possible.
- Species will be flagged in case they occur in the VectorNet database (Annex C) and also when they are on the VectorNet priority species list (Annex C).
- Data related to experiments evaluating the transmission efficiency to hosts that are not representative of their wild counterparts (e.g., studies on laboratory mice strains) will not be extracted.

2.2.2.5 Determining the vector status

We will determine the vector status based on the data collected in SLR 1 and SLR 2. The vector status will be determined as following:

- **'Potential'** vector, if the pathogen was detected in the field collected ticks OR if vector competence or host infection studies concluded that the tick species was vector competent under laboratory conditions.
- **'Highly likely'** vector, if both the pathogen was detected in the field collected ticks AND if vector competence or host infection studies concluded that the tick species was competent under laboratory conditions.

2.3 Narrative review on mechanical transmission of selected pathogens

Within this narrative review we aim to answer the following research questions:

- Which arthropod species have been implicated as potential mechanical vectors of *C. burnetii*, EIAV, LSDV, *T. evansi*, *T. vivax*, and *B. besnoiti*?
- What type of evidence supports the implication of each vector species (experimental proof, pathogen detection on arthropods, epidemiological associations, circumstantial reports)?
- What is the strength of evidence for the involvement of each arthropod group in the mechanical transmission of these pathogens?

2.3.1 Eligibility criteria

Pathogens

The pathogens included in this review are the six agents listed in Annex A.3: *Coxiella burnetii*, equine infectious anaemia virus, lumpy skin disease virus, *Trypanosoma evansi*, *Trypanosoma vivax*, and *Besnoitia besnoiti*.

Vectors

Publications will be included for biting, hematophagous insect species belonging to the following groups, which are known or suspected to play a role in mechanical transmission:

- Tabanidae
- *Stomoxys* spp.
- *Haematobia* spp.
- *Haematobosca* spp.
- *Simulium* spp.
- Hippoboscidae
- *Culicoides* spp.

Arthropod species outside of these groups (including non-biting hematophagous flies, responsible rather for mechanical transport but not defined as transmission) will be excluded.

Outcome

Eligible outcomes include results from studies providing evidence compatible with **mechanical transmission**, namely:

- Demonstration of pathogen transmission to a susceptible host following interrupted feeding or contaminated mouthparts
- Detection of pathogens on or in blood-feeding arthropods in a way consistent with mechanical carriage (e.g. on mouthparts, in regurgitated blood, or on external body surfaces)
- Epidemiological or outbreak data associating arthropod activity with pathogen spread

Studies dealing exclusively with **biological transmission** or passive environmental contamination (without blood-feeding involvement) will be excluded.

Because pathogens involved in mechanical transmission typically survive only briefly on or in insect mouthparts, evidence will be considered valid only if compatible with the short time frame of transmission (minutes to hours after feeding, exceptionally longer in cases involving regurgitation).

Temporal delineation

No temporal restrictions will be applied, as both historical and recent studies are relevant for understanding mechanical transmission. The review will therefore cover publications from the earliest available records up to the date of completion.

2.3.2 Search strategy

The following databases will be searched: Web of Science™ and Medline/PubMed. Search terms will include three categories (see Annex B.3):

- **Pathogens**: names and synonyms of *Coxiella burnetii*, equine infectious anaemia virus, lumpy skin disease virus, *Trypanosoma evansi*, *Trypanosoma vivax*, and *Besnoitia besnoitia*
- **Vectors**: names (including common names) of the arthropod taxa listed under Section 2.3.1
- **Transmission terms**: "mechanical transmission", "mechanical vector", "passive transmission", "interrupted feeding"

Searches will be run in parallel across databases, and studies will be flagged according to the type of evidence they provide (experimental, epidemiological, field detection) to prevent duplication during screening.

2.3.3 Selection process

Inclusion:

- Publications written in English (non-English accepted if abstract/translation is available)
- Studies addressing one or more of the six pathogens
- Arthropod species belonging to the eligible groups listed in Section 2.3.1
- Experimental, field, or epidemiological data relevant to mechanical transmission
- Vector species is present in the VectorNet geographical area

Exclusion:

- Non-primary research publications (e.g. reviews, commentaries)
- Studies focused exclusively on biological transmission
- Pathogens not included in Annex A.3.
- Publications without accessible full text
- Reports lacking sufficient methodological detail to allow interpretation
- Vector species is not present in the VectorNet geographical area

The list of questions to be used for screening is shown in Annex G.

2.3.4 Data extraction

Data will be extracted using a predefined template (Annex F). The following variables will be recorded:

- Pathogen species
- Arthropod species
- Geographic origin of the study (Country)
- Type of study:
  - Experimental
    - Pathogen transmission tested under controlled laboratory or semi-field conditions.
    - Arthropods deliberately exposed to infected hosts or artificial blood meals.
    - Assessment of pathogen carriage (e.g. mouthparts, regurgitation) and subsequent transmission to susceptible hosts.
    - Includes vector competence trials, even if the outcome is negative.
  - Field
    - Arthropods collected in natural setting.
    - Pathogen detection in insects.
    - Outcome (presence/absence) or prevalence of pathogen in vector specimens.
    - No deliberate manipulation, no transmission test.
  - Epidemiological
    - Conducted at population/outbreak level (not just detection).
    - Data link disease occurrence in animals with vector density, activity, or distribution, using measurable indicators.
    - Uses one or more of the following approaches:
      - Temporal correlation (e.g., peaks of disease cases align with seasonal peaks in tabanids)
      - Spatial correlation (e.g., higher LSDV incidence in areas with higher stable fly abundance).
      - Analytical models (risk factors, regression, odds ratios linking disease incidence to vector exposure).
- Type of evidence
  - Confirmed transmission
    - Evidence that a pathogen was successfully transmitted by an arthropod to a susceptible host.
    - Must be direct demonstration under experimental or natural conditions.
    - Criteria:
      - Experimental infection: arthropods fed on an infected host or blood meal, then on a naïve host, which became infected.
      - Outbreak observation: detection of pathogen in vectors + verified transmission events to animals (very rare but sometimes documented).
  - Pathogen detection
    - Pathogen (or its DNA/RNA/antigen) identified in or on arthropods.
    - Collected in the field (no manipulation), or after experimental exposure without proof of onward transmission.

        - Criteria:
            - PCR, microscopy, culture, or immunoassays confirm presence of pathogen in arthropod specimens.
            - No evidence of successful transmission to a new host.
    - Outbreak association
        - Epidemiological link between disease occurrence in animals and arthropod activity/density.
        - Based on field/outbreak data, often supported by statistics.
        - Criteria:
            - Disease incidence peaks coincide with seasonal peaks in vector abundance.
            - Geographic overlap between outbreaks and vector distribution.
            - Statistical associations (e.g. odds ratios, regression) showing risk increases with vector exposure.
    - Circumstantial
        - Indirect or anecdotal evidence suggesting possible vector involvement.
        - No pathogen detection or confirmed transmission, and no rigorous epidemiological analysis.
        - Criteria:
            - Reports of high vector presence during outbreaks without quantitative data.
            - Historical descriptions or case reports speculating on vector roles.
            - Inference by exclusion ("no ticks present, therefore flies may be responsible").
- Strength of evidence
    - Strong
        - Based on confirmed transmission under controlled experimental conditions or very well-documented field transmission events.
        - Replicated in more than one study or supported by consistent findings across independent settings.
        - Pathogen detection in vectors aligns with epidemiological data and/or transmission experiments.
    - Moderate
        - Based on pathogen detection in vectors (field or lab) and/or epidemiological association with outbreaks, but without direct transmission proof.
        - Evidence is suggestive but not definitive:
        - Pathogen DNA/RNA found on/in arthropods.
        - Outbreak incidence correlates with vector activity, but causality not directly demonstrated.
        - Multiple reports exist, but findings may vary across regions or methods.
    - Weak
        - Based only on circumstantial observations or isolated pathogen detections without corroboration.
        - Single reports, anecdotal accounts, or speculative associations without rigorous methodology.
        - Evidence not replicated, or contradictory findings exist.

2.3.5 Determining the vector status

The assignation vector status for each arthropod species will be based on the classification framework described in Section 2.3.4.

1. **Confirmed mechanical vector**: species for which direct transmission has been experimentally demonstrated, or exceptionally, unequivocal natural transmission has been observed.
2. **Suspected mechanical vector**: species without experimental proof but supported by pathogen detection in field-caught specimens and/or epidemiological associations with outbreaks.
3. **Speculative mechanical vector**: species mentioned only in circumstantial reports, or supported by weak, non-replicated evidence.

2.3.6 Pathogen–vector matrix

A synthesis table will be produced listing all arthropod species investigated for each of the six pathogens. Each species will be assigned a vector status (confirmed, suspected, speculative) along with an indication of the type and strength of supporting evidence.

References

Baldacchino, F., Muenworn, V., Desquesnes, M., Desoli, F., Charoenviriyaphap, T., Duvallet, G. (2013). Transmission of pathogens by Stomoxys flies (Diptera, Muscidae): a review. Parasite; 20:26. doi: 10.1051/parasite/2013026. Epub 2013 Aug 29. PMID: 23985165; PMCID: PMC3756335.

Baldacchino, F., Desquesnes, M., Mihok, S., Foil, L.D., Duvallet, G., Jittapalapong, S. (2014). Tabanids: neglected subjects of research, but important vectors of disease agents! Infect Genet Evol.; 28:596-615. doi: 10.1016/j.meegid.2014.03.029. Epub 2014 Apr 13. PMID: 24727644.

Baldacchino, F., Desquesnes, M., Duvallet, G., Lysyk, T., Mihok, S. (2018). Veterinary importance and integrated management of Brachycera flies in dairy farms. In: Garros C, Bouyer J, Takken W, Smallegange RC, editors. Pests and vector-borne diseases in the livestock industry – Ecology and control of vector-borne diseases. Volume 5. Wageningen: Wageningen Academic Publishers; p. 85-108. doi: 10.3920/978-90-8686-863-6_3.

Braks, M., Mancini, G., de Swart, M., & Goffredo, M. (2017). Risk of vector-borne diseases for the EU: Entomological aspects: Part 2. doi:10.2903/sp.efsa.2017.EN-1184

EFSA (European Food Safety Authority). (2023). EFSA-Animal disease profiles. Available online: https://animal-diseases.efsa.europa.eu

Massoels, B., Bottu, T., Vanslembrouck, A., Kramer, I., & Van Bortel, W. (2023). Systematic literature review on the vector status of potential vector species of 36 vector-borne pathogens. *EFSA Supporting Publication*, 2023, EN-8484.

WHO, 1967. Arboviruses and human disease. World Health Organization Technical Report Series, 369.

WHO, 2020. Vector-borne diseases. Available online: https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases

Glossary

Vector-borne disease	Vector group
Dissemination rate	$\frac{\text{Number of specimens infected in the legs/wings}}{\text{Number of specimens infected in the midgut}}$ x 100
Host infection study	Laboratory studies in which biological transmission cycles between suspected vectors and hosts are to be proven.
Infection rate	$\frac{\text{Number of specimens infected in the midgut}}{\text{Total number of specimens tested}}$ x 100
Infected vector study	Laboratory study investigating whether the pathogen can be found in the salivary glands or saliva of the arthropod after taking an infected (artificial) blood meal. For biting midges, tests using the heads were also considered.
Minimum infection rate	Minimum infection rate for a given mosquito species is the number of positive pools, assuming only one positive mosquito per pool, divided by the total number of mosquitoes tested. MIR is usually expressed as the number infected/1000 tested.
Transmission efficiency	$\frac{\text{Number of specimens with infected saliva(ry glands)}}{\text{Total number of specimens tested}}$ x 100
Transmission rate	$\frac{\text{Number of specimens with infected saliva(ry glands)}}{\text{Number of specimens with infected legs or wings}}$ x 100
Vector	An arthropod capable of transmitting a pathogen.
Vector-borne disease	A pathogen with is transmitted from one host to another through the spreading by vectors.
Vector competence study	Laboratory study in which the vector competence of a species is tested for i.e. the capability to get infected by and transmit a pathogen.

Abbreviations

Abbreviation	Explanation
DR	Dissemination rate
EIA	Equine infectious anaemia
EIAV	Equine infectious anaemia virus
ELISA	Enzyme-linked immuno sorbent assay
HI	Host infection
IR	Infection rate
LDS	Lumpy skin disease
LSDV	Lumpy skin disease virus
MIR	Minimum infection rate
PCR	Polymerase chain reaction
SLR	Systematic literature review
TE	Transmission efficiency
TR	Transmission rate
VBD	Vector-borne disease
VC	Vector competence
VGL	VectorNet Group Leader
VN	VectorNet
WHO	World Health Organization

Annex A – List of the selected vector-borne pathogens

A.1. List of the 36 selected vector-borne pathogens of the EFSA animal disease profiles

Abbreviation	Species	Isolate/virus name	Family	Genus	OIE_notifiable
AHFV	Alkhurma haemorrhagic fever virus	Alkhurma haemorrhagic fever virus	Flaviviridae	Flavivirus	No
AHSV	African horse sickness virus	African horse sickness virus	Reoviridae	Orbivirus	Yes
AINOV	Aino virus	Aino virus	Bunyaviridae	Orthobunyavirus	No
AKAV	Akabane virus	Akabane virus	Bunyaviridae	Orthobunyavirus	No
ASFV	African swine fever virus	African swine fever virus	Asfarviridae	Asfivirus	Yes
BEFV	Bovine ephemeral fever virus	Bovine ephemeral fever virus	Rhabdoviridae	Ephemerovirus	No
BHAV	Bhanja virus	Bhanja virus	Bunyaviridae	unassigned	No
BTV	Bluetongue virus	Bluetongue virus	Reoviridae	Orbivirus	Yes
CCHFV	Crimean-Congo haemorrhagic fever virus	Crimean Congo haemorrhagic fever virus	Bunyaviridae	Nairovirus	Yes
CVV	Bunyamwera virus	Cache Valley virus	Bunyaviridae	Orthobunyavirus	No
EEEV	Eastern equine encephalitis virus	Eastern equine encephalomyelitis virus	Togaviridae	Alphavirus	Yes
EEV	Equine encephalosis virus	Equine encephalosis virus	Reoviridae	Orbivirus	No
EHDV/IBAV	Epizootic hemorrhagic disease virus	Epizootic haemorrhagic disease virus, Ibaraki virus	Reoviridae	Orbivirus	Yes
GETV	Getah virus	Getah virus	Togaviridae	Alphavirus	No
HJV	Highlands J virus	Highland J virus	Togaviridae	Alphavirus	No
JEV	Japanese encephalitis virus	Japanese encephalitis virus	Flaviviridae	Flavivirus	Yes
KASV	Palyam virus	Kasba virus	Reoviridae	Orbivirus	No
KOTV	Kotonkan virus	Kotonkan virus	Rhabdoviridae	unassigned	No
MDV	Main drain virus	Main drain virus	Bunyaviridae	Orthobunyavirus	No

Abbreviation	Species	Isolate/virus name	Family	Genus	OIE_notifiable
MIDV	Middelburg virus	Middelburg virus	Togaviridae	Alphavirus	No
NSDV	Nairobi sheep disease virus	Nairobi sheep disease virus	Bunyaviridae	Nairovirus	Yes
PHSV	Peruvian horse sickness virus	Peruvian horse sickness virus	Reoviridae	Orbivirus	No
RVFV	Rift Valley fever virus	Rift Valley fever virus	Bunyaviridae	Phlebovirus	Yes
SBV	Schmallenberg virus	Schmallenberg virus	Bunyaviridae	Orthobunyavirus	Yes
SHUV	Shuni virus	Shuni virus	Bunyaviridae	Orthobunyavirus	No
SLEV	St. Louis encephalitis virus	St. Louis encephalitis virus	Flaviviridae	Flavivirus	No
THOV	Thogoto virus	Thogoto viruses	Orthomyxoviridae	Thogotovirus	No
VEEV	Venezuelan equine encephalitis virus	Venezuelan equine encephalomyelitis virus	Togaviridae	Alphavirus	Yes
VSAV	Vesicular stomatitis viruses	Vesicular stomatitis Alagoas virus	Rhabdoviridae	Vesiculovirus	Yes
VSIV		Vesicular stomatitis – Indiana virus			
VSNJV		Vesicular stomatitis – New Jersey virus			
WEEV	Western equine encephalitis virus	Equine encephalomyelitis (Western) virus	Togaviridae	Alphavirus	Yes
WNV	West Nile virus	West Nile Virus	Flaviviridae	Flavivirus	Yes
YUOV	Yunnan orbivirus	Yunnan virus	Reoviridae	Orbivirus	No
WSLV	Wesselsbron virus	Wesselsbron virus	Flaviviridae	Flavivirus	No
Cowdr	*Cowdria/ Ehrlichia ruminantium*	*Cowdria/ Ehrlichia ruminantium*	Rickettsiaceae	Ehrlichia	Yes
hepat	*Hepatozoon canis*	*Hepatozoon canis*	Hepatozoidae	Hepatozoidae	No
CanL	*Leishmania infantum*	*Leishmania infantum*	Trypanosomidae	Leishmania	Yes

A.2. List of the 2 selected vector-borne pathogens

Abbreviation	Pathogen name	Family	Genus	Species	OIE_notifiable
TBEV	Tick-borne encephalitis virus	Flaviviridae	Orthoflavivirus	Orthoflavivirus encephalitidis	No
Bbsl	*Borrelia burgdorferi* s.l. complex	Borreliaceae	Borreliella		No

A.3. List of the 6 selected vector-borne pathogens to be screened for potential mechanical transmission

Abbreviation	Species	Family	Genus	Host species
Q fever	*Coxiella burnetii*	Coxiellaceae	Coxiella	Various species, zoonotic
EIAV	Equine infectious anemia virus	Retroviridae	Lentivirus	Horses, donkeys and mules
LSDV	Lumpy skin disease virus	Poxiviridae	Capripoxvirus	Cattle and buffalo
Surra	*Trypanosoma evansi*	Trypanosomatidae	Trypanosoma	Camels, horses, cattle, buffalo, dogs and wildlife
Animal trypanosomosis	*Trupanosoma vivax*	Trypanosomatidae	Trypanosoma	Cattle, goats, sheep and horses
Bovine besnoitiosis	*Besonitia besnoiti*	Sarcocystidae	Besnoitia	Cattle

Annex B – Search terms

B.1. Search terms applied for SLR 1 and SLR 2 for the 36 vector-borne pathogens

DISEASES:

"african horse sickness" OR "african swine fever" OR "aino" OR "akabane" OR "alkhurma" OR "bovine ephemeral*" OR "bhanja" OR "bhanja bunya*" OR "bluetongue" OR "crimean congo" OR "crimean-congo" OR "cache valley" OR "bunyamwera" OR "thogoto*" OR "eastern equine encephal*" OR "equine encephalosis" OR "epizootic hemorrhagic" OR "epizootic haemorrhagic" OR "getah" OR "highland* j" OR "ibaraki" OR "japanese encephal*" OR "chuzan" OR "palyam" OR "kasba" OR "kotonkan" OR "main drain" OR "middelburg" OR "nairobi sheep disease" OR "ganjam" OR "peruvian horse sickness" OR "rift valley fever" OR "schmallenberg" OR "shuni" OR "*louis encephal*" OR "venezuelan equine encephal*" OR "western equine encephal*" OR "west nile" OR "wesselsbron" OR "yunnan *virus" OR "vesicular stomatit*" OR "alagoas" OR "indiana virus" OR "new jersey virus" OR "cocal virus" OR "hepatozoonosis" OR "hepatozoon canis" OR "hepatozoon americanum" OR "heartwater" OR "cowdri*" OR "ehrlichia ruminantium" OR "leishmani*

VECTORS:

"vector" OR "vectors" OR "vectorborne" OR "vector-borne" OR "disease vector*" OR "biting midges" OR "culicoid*" OR "ceratopogonidae" OR "mosquito" OR "mosquitoes" OR "mosquitos" OR "mosquitoborne" OR "mosquito-borne" OR "culicidae" OR "sandflies" OR "sand flies" OR "sandfly" OR "sand fly" OR "psychodidae" OR "phlebotomus" OR "phlebotominae" OR "tick" OR "ticks" OR "tickborne" OR "tick-borne" OR "ixodidae"

FIELD (SLR 1) STUDIES:

"virus surveillance*" OR "pathogen surveillance*" OR "virus detection*" OR "virus isolation*" OR "pathogen detection*" OR "pathogen isolation*" OR "MIR" OR "infection rate*" OR "infection proportion*" OR "maximum likelihood estimation" OR "maximal likelihood estimation*" OR "polymerase chain reaction*" OR "pcr" OR "RTpcr" OR "RT-pcr"

VECTOR COMPETENCE (SLR 2) STUDIES:

"vector competenc*" OR "extrinsic incubation period*" OR "transmission efficienc*" OR "dissemination rate*" OR "transmission rate*"

B.2. Search terms applied for SLR 1 and SLR 2 for ticks for TBEV and *Borrelia burgdorferi* s.l.

SLR 1:

DISEASES:

"tick borne encephal*" or "tick-borne encephal*" or "TBE" or "TBEV" or "Orthoflavivirus encephalitidis" or "lyme disease" or "lyme borrelliosis" or "borrelia burgdorferi" or "b. burgdorferi"

VECTORS:
"vector" OR "vectors" OR "vectorborne" OR "vector-borne" OR "disease vector*" OR "tick" OR "ticks" OR "tickborne" OR "tick-borne"

GEOGRAPHICAL INFORMATION:
Europe or "Mediterranean Basin" or "Mediterranean area" or Balkan* or Scandinavia or "Iberian peninsula" or Aland or Albania* or Andorra* or Austria* or Belgi* or Bosnia* or Herzegovina or Bulgaria* or Croatia* or Cyprus or "Czech Republic" or Denmark or Greenland or German* or Spain or Estonia* or Finland or "Faroe islands" or France or Corsica* or Greece or Gibraltar or Hungary or Iceland or Ireland or Italy or Sicil* or Sardinia* or Kosov* or Latvia* or Liechtenstein or Lithuania* or Luxembourg or Macedonia* or Fyrom or Malta or Monaco or Montenegr* or Netherlands or Norway or Poland or Portug* or Slovenia* or Romania* or "San Marino" or Serbia* or Slovakia* or Switzerland or Sweden or "United Kingdom" or "British Isles" or "Great Britain" or Wales or England or Scotland or Turk* or "Vatican city" or Svalbard or Israel or Palestine or Jordan or Lebanon or Syria or Morocco or Algeria* or Tunisia* or Libya* or Egypt* or "Western Sahara" or Armenia* or Azerba* or Belarus or Bielorussia or Georgia or Moldova* or Russia or Yugoslavia or Ukrain* or Ukrayn* or Russia* or USSR or SSSR or "Soviet Union" or Crimea* or Abkhazia* or Transnistria* or Ossetia* or British or Irish or Scottish or Welsh or "Channel Islands" or Jersey or Guernsey or Sark or French or Gibraltar or Greek or Italian or Spanish or Swiss or Transcaucasia* or Georgia* or Danish or Finnish or Norwegian or Baltic or Czech or Hungarian or Polish or Mediterranean or Sahara or Majorca or Majorca or Mallorca or Minorca or Ibiza or Azores or Canar* or Balearic* or "Member St*"

FIELD STUDIES:

"virus surveillance*" or "pathogen surveillance*" or "virus detection*" or "virus isolation*" or "pathogen detection*" or "pathogen isolation*" or "MIR" or "prevalence*" or "infection rate*" or "maximum likelihood estimation" or "polymerase chain reaction*" or "pcr" or "RTpcr" or "RT-pcr"

SLR 2:

DISEASES:
"tick borne encephal*" or "tick-borne encephal*" or "TBE" or "TBEV" or "Orthoflavivirus encephalitidis" or "lyme disease" or "lyme borrelliosis" or "borrelia burgdorferi" or "b. burgdorferi"

VECTORS:
"vector" OR "vectors" OR "vectorborne" OR "vector-borne" OR "disease vector*" OR "tick" OR "ticks" OR "tickborne" OR "tick-borne"

VECTOR COMPETENCE STUDIES:

"vector competen*" or "competen*" or "extrinsic incubation period*" or "transmission efficienc*" or "dissemination rate*" or "transmission rate*"

B.3. Search terms applied for narrative review on mechanical transmission of selected pathogens

The search strategy combines three groups of terms:

- **Pathogen(s)/Disease(s)** – names and synonyms of the six pathogens and diseases.
- **Vector(s)** – groups and species of blood-feeding flies relevant for mechanical transmission.
- **Transmission term(s)** – terms indicating mechanical or passive transmission.

(PATHOGEN terms) AND (VECTOR terms) AND (TRANSMISSION terms)

Pathogen(s)/Disease(s)

("Coxiella burnet*" OR "C. burnet*" OR "Q fever" OR "Q-fever" OR "Coxiellosis") OR ("equine infectious anaemia" OR "equine infectious anemia" OR "EIAV" OR "EIA") OR ("lumpy skin disease virus" OR "LSDV" OR "lumpy skin disease") OR ("Trypanosoma evansi" OR "T. evansi" OR "surra") OR ("Trypanosoma vivax" OR "T. vivax" OR "trypanosomosis" OR "trypanosomiasis") OR ("Besnoitia besnoiti" OR "B. besnoiti" OR "Besnoitia" OR "besnoitiosis" OR "besnoitiasis")

Vector(s)

("Tabanidae" OR "horse fly" OR "horsefly" OR "horse flies" OR "horseflies" OR "deer fly" OR "deerfly" OR "deerfly" OR "deerflies" OR "gad fly" OR "gad flies" OR "gad flies" OR "gadflies" OR "cleg fly" OR "cleg flies" OR "cleg flies" OR "clegflies") OR ("Stomoxys" OR "S. calcitrans" OR "stable fly" OR "stablefly" OR "stable flies" OR "stableflies") OR ("Haematobia" OR "H. irritans" OR "horn fly" OR "horn flies" OR "hornfly" OR "horn flies" OR "buffalo fly" OR "buffalo flies") OR ("Simulidae" OR "Simulium" OR "black fly" OR "black flies" OR "blackfly" OR "blackflies" OR "buffalo gnat" OR "buffalo gnats") OR ("Hippoboscidae" OR "Hippobosca" OR "H. equina" OR "forest fly" OR "forest flies" OR "horse louse fly" OR "horse louse flies" OR "horse ked" OR "horse keds" OR "louse fly" OR "louse flies" OR "louse-fly" OR "louse-flies" OR "keds" OR "ked" OR "Melophagus" OR "M. ovinus" OR "sheep ked" OR "sheep keds" OR "sheep louse fly" OR "sheep louse flies" OR "wingless fly" OR "wingless flies" OR "deer ked" OR "deer keds" OR "deer fly" OR "deer flies" OR "Lipoptena" OR "L. cervi" OR "moose fly" OR "moose flies" OR "elk fly" OR "elk flies" OR "deer louse fly" OR "deer louse flies") OR ("Ceratopogonidae" OR "Culicoides" OR "biting midge" OR "biting midges" OR "biting gnat" OR "biting gnats" OR "pinyon gnat" OR "pinyon gnats")

Transmission term(s)

"mechanical transmission", "mechanical vector", "passive transmission", "interrupted feeding"

Annex C – Overview of the species and genera included in the VectorNet database.

Vector group	Arthropod species	VN priority species
Biting midges	*Culicoides abchazicus*	No
Biting midges	*Culicoides achrayi*	No
Biting midges	*Culicoides achrayi/palidicornis*	No
Biting midges	*Culicoides alazanicus*	No
Biting midges	*Culicoides albicans*	No
Biting midges	*Culicoides albihalteratus*	No
Biting midges	*Culicoides algeriensis*	No
Biting midges	*Culicoides azerbajdzhanicus*	No
Biting midges	*Culicoides begueti*	No
Biting midges	*Culicoides boyi*	No
Biting midges	*Culicoides brunnicans*	No
Biting midges	*Culicoides bulbostylus*	No
Biting midges	*Culicoides bysta*	No
Biting midges	*Culicoides cameroni*	No
Biting midges	*Culicoides cataneii*	No
Biting midges	*Culicoides cataneii/gejgelensis*	No
Biting midges	*Culicoides caucoliberensis*	No
Biting midges	*Culicoides chiopterus*	Yes
Biting midges	*Culicoides circumscriptus*	No
Biting midges	*Culicoides clastrieri*	No
Biting midges	*Culicoides clintoni*	No
Biting midges	*Culicoides comosioculatus*	No
Biting midges	*Culicoides corsicus*	No
Biting midges	*Culicoides cubitalis*	No
Biting midges	*Culicoides deltus*	No
Biting midges	*Culicoides dendriticus*	No

Vector group	Arthropod species	VN priority species
Biting midges	*Culicoides derisor*	No
Biting midges	*Culicoides desertorum*	No
Biting midges	*Culicoides dewulfi*	Yes
Biting midges	*Culicoides duddingstoni*	No
Biting midges	*Culicoides dzhafarovi*	No
Biting midges	*Culicoides faghihi*	No
Biting midges	*Culicoides fagineus*	No
Biting midges	*Culicoides fagineus/impunctatus*	No
Biting midges	*Culicoides fagineus/subfagineus*	No
Biting midges	*Culicoides fascipennis*	No
Biting midges	*Culicoides festivipennis*	No
Biting midges	*Culicoides festivipennis/calstrieri*	No
Biting midges	*Culicoides flavipulicaris*	No
Biting midges	*Culicoides furcillatus*	No
Biting midges	*Culicoides gejgelensis*	No
Biting midges	*Culicoides gornostaevae*	No
Biting midges	*Culicoides griseidorsum*	No
Biting midges	*Culicoides grisescens s.l.*	No
Biting midges	*Culicoides grisescens s.l./deltus*	No
Biting midges	*Culicoides grisescens s.s.*	No
Biting midges	*Culicoides haranti*	No
Biting midges	*Culicoides heliophilus*	No
Biting midges	*Culicoides helveticus*	No
Biting midges	*Culicoides helveticus/stigma*	No
Biting midges	*Culicoides heteroclitus*	No
Biting midges	*Culicoides humeralis*	No
Biting midges	*Culicoides imicola*	Yes
Biting midges	*Culicoides impunctatus*	No
Biting midges	*Culicoides indistinctus*	No

Vector group	Arthropod species	VN priority species
Biting midges	*Culicoides jumineri*	No
Biting midges	*Culicoides jumineri/kurensis*	No
Biting midges	*Culicoides jurensis*	No
Biting midges	*Culicoides kibunensis*	No
Biting midges	*Culicoides kingi*	Yes
Biting midges	*Culicoides kurensis*	No
Biting midges	*Culicoides landauae*	No
Biting midges	*Culicoides langeroni*	No
Biting midges	*Culicoides longipennis*	No
Biting midges	*Culicoides lupicaris*	Yes
Biting midges	*Culicoides malevillei*	No
Biting midges	*Culicoides manchuriensis*	No
Biting midges	*Culicoides marcleti*	No
Biting midges	*Culicoides maritimus*	No
Biting midges	*Culicoides maritimus paucisensillatus*	No
Biting midges	*Culicoides minutissimus*	No
Biting midges	*Culicoides montanus*	No
Biting midges	*Culicoides newsteadi s.l.*	Yes
Biting midges	*Culicoides newsteadi s.s.*	No
Biting midges	*Culicoides nubeculosus*	No
Biting midges	*Culicoides obsoletus s.l.*	Yes
Biting midges	*Culicoides obsoletus s.l./scoticus*	No
Biting midges	*Culicoides obsoletus s.l./scoticus/chiopterus*	No
Biting midges	*Culicoides obsoletus s.l./scoticus/chiopterus/dewulfi*	No
Biting midges	*Culicoides obsoletus s.s.*	No
Biting midges	*Culicoides odiatus*	No
Biting midges	*Culicoides oxystoma*	No
Biting midges	*Culicoides pallidicornis*	No
Biting midges	*Culicoides pallidus*	No

Vector group	Arthropod species	VN priority species
Biting midges	*Culicoides paolae*	No
Biting midges	*Culicoides paradisionensis*	No
Biting midges	*Culicoides paradoxalis*	No
Biting midges	*Culicoides parroti*	No
Biting midges	*Culicoides pictipennis*	No
Biting midges	*Culicoides picturatus*	No
Biting midges	*Culicoides poperinghensis*	No
Biting midges	*Culicoides pseudoheliophilus*	No
Biting midges	*Culicoides pseudolangeroni*	No
Biting midges	*Culicoides pseudopallidus*	No
Biting midges	*Culicoides pulicaris s.l.*	Yes
Biting midges	*Culicoides pulicaris s.l./lupicaris*	No
Biting midges	*Culicoides pumilus*	No
Biting midges	*Culicoides punctatus*	No
Biting midges	*Culicoides punctatus s.l.*	Yes
Biting midges	*Culicoides puncticollis*	No
Biting midges	*Culicoides puncticollis/nubeculosus*	No
Biting midges	*Culicoides ravus*	No
Biting midges	*Culicoides reconditus*	No
Biting midges	*Culicoides remmi*	No
Biting midges	*Culicoides riebi*	No
Biting midges	*Culicoides riethi*	No
Biting midges	*Culicoides riouxi*	No
Biting midges	*Culicoides rubeculosus*	No
Biting midges	*Culicoides saevanicus*	No
Biting midges	*Culicoides saevus*	No
Biting midges	*Culicoides sahariensis*	No
Biting midges	*Culicoides salinarius*	No
Biting midges	*Culicoides santonicus*	No

Vector group	Arthropod species	VN priority species
Biting midges	*Culicoides schultzei*	No
Biting midges	*Culicoides scoticus*	Yes
Biting midges	*Culicoides segnis*	No
Biting midges	*Culicoides seifadinei*	No
Biting midges	*Culicoides sejfadinei*	No
Biting midges	*Culicoides selandicus*	No
Biting midges	*Culicoides semimaculatus*	No
Biting midges	*Culicoides sergenti*	No
Biting midges	*Culicoides shaklawensis*	No
Biting midges	*Culicoides simulator*	No
Biting midges	*Culicoides slovacus*	No
Biting midges	*Culicoides sp.*	No
Biting midges	*Culicoides sphagnumensis*	No
Biting midges	*Culicoides stigma*	No
Biting midges	*Culicoides subfagineus*	No
Biting midges	*Culicoides subfasciipennis*	No
Biting midges	*Culicoides subfasciipennis/pallidicornis*	No
Biting midges	*Culicoides submaritimus*	No
Biting midges	*Culicoides tauricus*	No
Biting midges	*Culicoides truncorum*	No
Biting midges	*Culicoides univittatus*	No
Biting midges	*Culicoides vexans*	No
Biting midges	*Culicoides vidourlensis*	No
Mosquitoes	*Aedes aegypti*	Yes
Mosquitoes	*Aedes albopictus*	Yes
Mosquitoes	*Aedes annulipes*	No
Mosquitoes	*Aedes annulipes/cantans*	No
Mosquitoes	*Aedes atropalpus*	Yes
Mosquitoes	*Aedes behningi*	No

Vector group	Arthropod species	VN priority species
Mosquitoes	*Aedes berlandi*	No
Mosquitoes	*Aedes cantans*	No
Mosquitoes	*Aedes caspius*	Yes
Mosquitoes	*Aedes cataphylla*	No
Mosquitoes	*Aedes cinereus*	No
Mosquitoes	*Aedes cinereus/geminus*	No
Mosquitoes	*Aedes coluzzii*	Yes
Mosquitoes	*Aedes communis*	No
Mosquitoes	*Aedes cretinus*	No
Mosquitoes	*Aedes cyprius*	No
Mosquitoes	*Aedes detritus*	Yes
Mosquitoes	*Aedes detritus/coluzzii*	No
Mosquitoes	*Aedes diantaeus*	No
Mosquitoes	*Aedes dorsalis*	No
Mosquitoes	*Aedes eatoni*	No
Mosquitoes	*Aedes echinus*	No
Mosquitoes	*Aedes esoensis rossicus*	No
Mosquitoes	*Aedes euedes*	No
Mosquitoes	*Aedes excrucians*	No
Mosquitoes	*Aedes flavescens*	No
Mosquitoes	*Aedes geminus*	No
Mosquitoes	*Aedes geniculatus*	No
Mosquitoes	*Aedes gilcolladoi*	No
Mosquitoes	*Aedes hexodontus*	No
Mosquitoes	*Aedes hungaricus*	No
Mosquitoes	*Aedes impiger*	No
Mosquitoes	*Aedes intrudens*	No
Mosquitoes	*Aedes japonicus*	Yes
Mosquitoes	*Aedes koreicus*	Yes

Vector group	Arthropod species	VN priority species
Mosquitoes	*Aedes lepidonotus*	No
Mosquitoes	*Aedes leucomelas*	No
Mosquitoes	*Aedes mariae*	No
Mosquitoes	*Aedes nigrinus*	No
Mosquitoes	*Aedes nigripes*	No
Mosquitoes	*Aedes pheoniciae*	No
Mosquitoes	*Aedes pionips*	No
Mosquitoes	*Aedes pulcritarsis*	No
Mosquitoes	*Aedes pullatus*	No
Mosquitoes	*Aedes punctodes*	No
Mosquitoes	*Aedes punctor*	No
Mosquitoes	*Aedes quasirusticus*	No
Mosquitoes	*Aedes refiki*	No
Mosquitoes	*Aedes riparius*	No
Mosquitoes	*Aedes rusticus*	No
Mosquitoes	*Aedes sticticus*	No
Mosquitoes	*Aedes subdiversus*	No
Mosquitoes	*Aedes surcoufi*	No
Mosquitoes	*Aedes triseriatus*	No
Mosquitoes	*Aedes vexans arabiensis*	No
Mosquitoes	*Aedes vexans s.l.*	Yes
Mosquitoes	*Aedes vexans vexans*	Yes
Mosquitoes	*Aedes vittatus*	No
Mosquitoes	*Aedes zammitii*	No
Mosquitoes	*Anopheles albimanus*	No
Mosquitoes	*Anopheles algeriensis*	No
Mosquitoes	*Anopheles atroparvus*	Yes
Mosquitoes	*Anopheles beklemishevi*	No
Mosquitoes	*Anopheles cinereus*	No

Vector group	Arthropod species	VN priority species
Mosquitoes	*Anopheles claviger s.l.*	No
Mosquitoes	*Anopheles claviger s.s.*	Yes
Mosquitoes	*Anopheles daciae*	No
Mosquitoes	*Anopheles gambiae s.l.*	No
Mosquitoes	*Anopheles hyrcanus*	No
Mosquitoes	*Anopheles labranchiae*	Yes
Mosquitoes	*Anopheles maculipennis s.l.*	Yes
Mosquitoes	*Anopheles maculipennis s.s.*	Yes
Mosquitoes	*Anopheles marteri*	No
Mosquitoes	*Anopheles melanoon*	No
Mosquitoes	*Anopheles messeae*	Yes
Mosquitoes	*Anopheles multicolor*	No
Mosquitoes	*Anopheles petragnani*	No
Mosquitoes	*Anopheles plumbeus*	Yes
Mosquitoes	*Anopheles sacharovi*	Yes
Mosquitoes	*Anopheles sergentii s.l.*	No
Mosquitoes	*Anopheles subalpinus*	No
Mosquitoes	*Anopheles superpictus*	No
Mosquitoes	*Coquillettidia buxtoni*	No
Mosquitoes	*Coquillettidia richiardii*	Yes
Mosquitoes	*Culex antennatus*	No
Mosquitoes	*Culex brumpti*	No
Mosquitoes	*Culex deserticola*	No
Mosquitoes	*Culex europaeus*	No
Mosquitoes	*Culex hortensis hortensis*	No
Mosquitoes	*Culex hortensis maderensis*	No
Mosquitoes	*Culex impudicus*	No
Mosquitoes	*Culex laticinctus*	No
Mosquitoes	*Culex martinii*	No

Vector group	Arthropod species	VN priority species
Mosquitoes	*Culex mimeticus*	No
Mosquitoes	*Culex modestus*	Yes
Mosquitoes	*Culex perexiguus*	Yes
Mosquitoes	*Culex perexiguus/univittatus*	No
Mosquitoes	*Culex pipiens*	Yes
Mosquitoes	*Culex pipiens/torrentium*	No
Mosquitoes	*Culex pusillus*	No
Mosquitoes	*Culex territans*	No
Mosquitoes	*Culex theileri*	Yes
Mosquitoes	*Culex torrentium*	Yes
Mosquitoes	*Culex tritaeniorhynchus*	Yes
Mosquitoes	*Culex univittatus*	Yes
Mosquitoes	*Culex vishnui*	No
Mosquitoes	*Culiseta alaskaensis*	Yes
Mosquitoes	*Culiseta annulata*	No
Mosquitoes	*Culiseta bergrothi*	No
Mosquitoes	*Culiseta fumipennis*	No
Mosquitoes	*Culiseta glaphyroptera*	No
Mosquitoes	*Culiseta litorea*	No
Mosquitoes	*Culiseta longiareolata*	No
Mosquitoes	*Culiseta morsitans*	No
Mosquitoes	*Culiseta ochroptera*	No
Mosquitoes	*Culiseta subochrea*	No
Mosquitoes	*Orthopodomyia pulcripalpis*	No
Mosquitoes	*Uranotaenia unguiculata*	No
Sandflies	*Phlebotomus alexandri*	Yes
Sandflies	*Phlebotomus ariasi*	Yes
Sandflies	*Phlebotomus balcanicus*	No
Sandflies	*Phlebotomus caucasicus*	No

Vector group	Arthropod species	VN priority species
Sandflies	*Phlebotomus halepensis*	No
Sandflies	*Phlebotomus jacusieli*	No
Sandflies	*Phlebotomus kandelaki*	No
Sandflies	*Phlebotomus killicki*	No
Sandflies	*Phlebotomus langeroni*	Yes
Sandflies	*Phlebotomus longiductus*	No
Sandflies	*Phlebotomus major s.l.*	Yes
Sandflies	*Phlebotomus mascittii*	Yes
Sandflies	*Phlebotomus mongolensis*	No
Sandflies	*Phlebotomus neglectus*	Yes
Sandflies	*Phlebotomus papatasi*	Yes
Sandflies	*Phlebotomus perfiliewi*	Yes
Sandflies	*Phlebotomus perniciosus*	Yes
Sandflies	*Phlebotomus sergenti*	Yes
Sandflies	*Phlebotomus simici*	No
Sandflies	*Phlebotomus similis*	Yes
Sandflies	*Phlebotomus syriacus*	No
Sandflies	*Phlebotomus tobbi*	Yes
Sandflies	*Sergentomyia dentata*	No
Sandflies	*Sergentomyia minuta*	No
Ticks	*Amblyomma lepidum*	No
Ticks	*Argas persicus*	No
Ticks	*Boophilus annulatus*	No
Ticks	*Boophilus kohlsi*	No
Ticks	*Dermacentor marginatus*	No
Ticks	*Dermacentor reticulatus*	Yes
Ticks	*Dermacentor spp.*	No
Ticks	*Haemaphysalis concinna*	No
Ticks	*Haemaphysalis inermis*	No

Vector group	Arthropod species	VN priority species
Ticks	*Haemaphysalis parva*	No
Ticks	*Haemaphysalis punctata*	No
Ticks	*Haemaphysalis spp.*	No
Ticks	*Haemaphysalis sulcata*	No
Ticks	*Hyalomma aegyptium*	No
Ticks	*Hyalomma anatolicum*	No
Ticks	*Hyalomma dromedarii*	No
Ticks	*Hyalomma excavatum*	No
Ticks	*Hyalomma lusitanicum*	Yes
Ticks	*Hyalomma marginatum*	Yes
Ticks	*Hyalomma marginatum s.l.*	No
Ticks	*Hyalomma scupense*	No
Ticks	*Hyalomma spp.*	No
Ticks	*Ixodes acuminatus*	No
Ticks	*Ixodes arboricola*	No
Ticks	*Ixodes frontalis*	No
Ticks	*Ixodes gibbosus*	No
Ticks	*Ixodes hexagonus*	No
Ticks	*Ixodes persulcatus*	Yes
Ticks	*Ixodes redikorzevi*	No
Ticks	*Ixodes ricinus*	Yes
Ticks	*Ixodes rugicollis*	No
Ticks	*Ixodes spp.*	No
Ticks	*Ixodes trianguliceps*	No
Ticks	*Ixodes uriae*	No
Ticks	*Ixodes ventalloi*	No
Ticks	*Ornithodoros erraticus*	Yes
Ticks	*Ornithodoros savignyi*	No
Ticks	*Ornithodoros spp.*	No

Vector group	Arthropod species	VN priority species
Ticks	*Ornithodoros tholozani*	No
Ticks	*Rhipicephalus (Boophilus) annulatus*	No
Ticks	*Rhipicephalus (Boophilus) kohlsi*	No
Ticks	*Rhipicephalus bursa*	No
Ticks	*Rhipicephalus pulchellus*	No
Ticks	*Rhipicephalus pusillus*	No
Ticks	*Rhipicephalus sanguineus group*	No
Ticks	*Rhipicephalus sanguineus s.l.*	Yes
Ticks	*Rhipicephalus turanicus*	No

Annex D – Data extraction template (SLR1)

D.1. Data extraction template for the field database (SLR 1) for the 36 vector-borne pathogens

Variable	Explanation
ID	Assigned ID of the study
First_Author	First listed author of the study
Title	Title of the study
Year	Year of publication of the study
Country	Country where sampling of specimens took place
Region/State	Region where sampling of specimens took place
City/County	Precise location, if applicable, where sampling of specimens took place
Latitude	Latitude of coordinates of sampling location
Longitude	Longitude of coordinates of sampling location
Continent	Continent where sampling of specimens took place
Year_Start	First year of species sampling
Year_End	Last year of species sampling
Month_Start	First month of species sampling
Month_End	Last month of species sampling
Continuous_or_annually	Whether sampling happened continuously or not, referring to Month_Start and Month_End
SamplingMethod	Arthropod capture method
LifeStage	Life stage (and gender in case of adult vectors) of captured vectors: egg, larvae, nymph, adult, male, or female
VectorGroup	Ticks, Mosquitoes, Sandflies or Biting Midges
VectorSpecies	Species or species complex of the screened specimens; names have been corrected in case of taxonomically outdated species or groups
VectorSpeciesOld	Species or species complex of the screened specimens
fedStatus	Bloodfed status of specimens: unfed, fed, gravid or unclear
Host	Species of host animal on which the specimens were collected, if applicable
anMethCode	Pathogen screening method
MethodCategory	Category of pathogen screening method (e.g.: molecular, virus isolation)
NSpecimensTested	Amount of specimens screened for pathogens
NPoolsTested	Amount of specimens pools screened for pathogens

Variable	Explanation
Pool_size	Amount of specimens in tested pools
Positive/Negative	Absence or presence of relevant pathogens
NPoolspositive	Amount of pathogen-positive pools
VBD_Agent	Type of pathogen for which the specimens are screened (Virus, Bacteria or Protozoa)
VBD_Agent_subtype	Specific species of pathogen for which the specimens are screened
VBD_AS_Full	Full name of pathogen for which the specimens are screened
MIR	Minimum infection rate, calculated as the amount of pathogen-positive pools divided by amount of screened specimens, times 1000.
LCI_MIR	Lower confidence interval of minimum infection rate
UCI_MIR	Upper confidence interval of minimum infection rate
Vectornet_Region	Whether the vector sampling location falls within a Vectornet NUTS zone
Trap/Host	Whether the specimens are captured using a trapping method or sampled directly from a host
PrioritySpecies	Whether tested specimens belong to a VectorNet priority species
VectornetRegionSpecies	Whether tested species naturally occur in the VectorNet region
Vndatlocd	Data location ID of sampling location
Vnmaplocd	Map location ID of sampling location
Country_ISO	ISO 3166 code of country in which specimens are sampled

D.2. Data extraction template for the field database (SLR 1) for ticks for TBEV and *Borrelia burgdorferi* s.l.

Variable	Explanation
ID	Assigned ID of the study
First_Author	First listed author of the study
Title	Title of the study
Year	Year of publication of the study
Country	Country where sampling of specimens took place
Year_Start	First year of species sampling
Year_End	Last year of species sampling
Month_Start	First month of species sampling
Month_End	Last month of species sampling
continuous_or_annually	Whether sampling happened continuously or not, referring to Month_Start and Month_End

Variable	Explanation
SamplingMethod	Arthropod capture method
LifeStage	Life stage (and gender in case of adult vectors) of captured vectors: egg, larvae, nymph, adult, male, or female
VectorGroup	Ticks, Mosquitoes, Sandflies or Biting Midges
VectorSpecies	Species or species complex of the screened specimens; names have been corrected in case of taxonomically outdated species or groups
Host	Species of host animal on which the specimens were collected, if applicable
anMethCode	Pathogen screening method
MethodCategory	Category of pathogen screening method (e.g.: molecular, virus isolation)
NSpecimensTested	Amount of specimens screened for pathogens
NPoolsTested	Amount of specimens pools screened for pathogens
Pool_size	Amount of specimens in tested pools
Positive/Negative	Absence or presence of relevant pathogens
NPoolspositive	Amount of pathogen-positive pools
VBD_Agent	Type of pathogen for which the specimens are screened (Virus, Bacteria or Protozoa)
VBD_Agent_subtype	Specific species of pathogen for which the specimens are screened
VBD_AS_Full	Full name of pathogen for which the specimens are screened
MIR	Minimum infection rate, calculated as the amount of pathogen-positive pools divided by amount of screened specimens, times 100.
LCI_MIR	Lower confidence interval of minimum infection rate
UCI_MIR	Upper confidence interval of minimum infection rate
Prevalence	Prevalence of pathogen, calculated as the amount of pathogen-positive individuals divided by amount of screened specimens, times 100
LCI_Prevalence	Lower confidence interval of prevalence
UCI_Prevalence	Upper confidence interval of prevalence
Vectornet_Region	Whether the vector sampling location falls within a Vectornet NUTS zone
PrioritySpecies	Whether tested specimens belong to a VectorNet priority species
VectornetRegionSpecies	Whether tested species naturally occur in the VectorNet region
Vndatlocd	Data location ID of sampling location
Vnmaplocd	Map location ID of sampling location
Country_ISO	ISO 3166 code of country in which specimens are sampled
Notes	Notes

Annex E – Data extraction template (SLR 2)

E.1. Data extraction template for the laboratory database (SLR 2) for the 36 vector-borne pathogens

Variable	Explanation
ID	Assigned ID of the study
First_Author	First listed author of the study
Title	Title of the study
Year	Year of publication of the study
VBD_Agent	Type of pathogen for which the specimens are screened (Virus, Bacteria or Protozoa)
VBD_Agent_subtype	Specific species of pathogen for which the specimens are screened
VBD_AS_Full	Full name of pathogen for which the specimens are screened
VectorGroup	Ticks, Mosquitoes, Sandflies or Biting Midges
VectorSpecies	Species or species complex of the tested specimens; names have been corrected in case of taxonomically outdated species or groups
VectorSpeciesOld	Species or species complex of the tested specimens
LifeStage	Life stage (and sex in case of adult specimens) of tested specimens: egg, larvae, nymph, adult, male, or female
Source_of_vector_population	Origin colony of tested specimens, or sampling location in case of wild caught specimens
vector_population	Whether the tested specimens originated from a laboratory colony or wild caught populations
IR(%)	Infection rate in percentage, calculated as amount of infected specimens over total tested specimens
DR(%)	Dissemination rate in percentage, calculated as amount of specimens with a disseminated infection in legs or wings over amount of infected specimens
TR(%)	Transmission rate in percentage, calculated as amount of specimens with positive saliva samples over amount of specimens with a disseminated infection
Body_part_tested_TE	The body part tested for calculation of transmission efficiency
NSpecPositive_TE	Amount of specimens with a positive saliva sample (or other body part if applicable)
NSpecTested_TE	Total amount of tested specimens
Transmission_efficiency_(TE)_(%)	Transmission efficiency in percentage, calculated as amount of specimens with a positive saliva sample over total amount of tested specimens
Min_extrinsic_incubation_period	Number of days (after experimental infection) before the first infection was found in this population
Max_etrinsic_incubation_period	Maximum number of days (after experimental infection) used in the study to test the vector competence
anMethCode	Pathogen screening method

Variable	Explanation
NSpecExposedtoHOST	Amount of specimens exposed to host (in case of host infection study)
Host	Host species (in case of host infection study)
Nhost	Amount of host animals used
NInfectedHOST	Amount of infected hosts
ExpDuration	Total duration of host infection experiment
Type_of_study	Type of study: host infection study, salivary study or infected vector study
Positive/Negative	Absence or presence of transmissible infection
PrioritySpecies	Whether tested specimens belong to a VectorNet priority species
VectornetRegionSpecies	Whether tested species naturally occurs in the VectorNet region

E.2. Data extraction template for the laboratory database (SLR 2) for ticks for TBEV and *Borrelia burgdorferi* s.l.

Variable	Explanation
ID	Assigned ID of the study
First_Author	First listed author of the study
Title	Title of the study
Year	Year of publication of the study
VBD_Agent	Type of pathogen for which the specimens are screened (Virus, Bacteria or Protozoa)
VBD_Agent_subtype	Specific species of pathogen for which the specimens are screened
VBD_AS_Full	Full name of pathogen for which the specimens are screened
VectorGroup	Ticks, Mosquitoes, Sandflies or Biting Midges
VectorSpecies	Species or species complex of the tested specimens; names have been corrected in case of taxonomically outdated species or groups
LifeStage	Life stage (and sex in case of adult specimens) of tested specimens: egg, larvae, nymph, adult, male, or female
Source_of_vector_population	Origin colony of tested specimens, or sampling location in case of wild caught specimens
vector_population	Whether the tested specimens originated from a laboratory colony or wild caught populations
Body_part_tested	The body part tested for pathogen presence
TimeSpan	Duration (number)
TimeSpan_descr	Description of time span (e.g. days post infection, duration of tick attachment, incubation period)
NSpecPositive	Amount of positive specimens

Variable	Explanation
NSpecTested	Total amount of tested specimens
Prevalence	Prevalence of pathogen, calculated as the amount of pathogen-positive individuals divided by amount of screened specimens, times 100
LCI_Prevalence	Lower confidence interval of prevalence
UCI_Prevalence	Upper confidence interval of prevalence
Prev_descr	Additional details on prevalence
anMethCode	Pathogen screening method
NSpecExposedtoHOST	Amount of specimens exposed to host (in case of host infection study)
Host	Host species (in case of host infection study)
Nhost	Amount of host animals used
NInfectedHOST	Amount of infected hosts
ExpDuration	Total duration of host infection experiment
Type_of_study	Type of study: host infection study, salivary study or infected vector study
Notes	Additional details on type of study
Positive/Negative	Absence or presence of transmissible infection
PrioritySpecies	Whether tested specimens belong to a VectorNet priority species
VectornetRegionSpecies	Whether tested species naturally occurs in the VectorNet region

Annex F – Data extraction template for the field database for narrative review on mechanical transmission of selected pathogens

Variable	Explanation
ID	Assigned ID of the study
First_Author	First listed author of the study
Title	Title of the study
Year	Year of publication of the study
Country	Country where study took place
Region/State	Region where the study took place
City/County	Precise location, if applicable, where study took place
Latitude	Latitude of coordinates of study location
Longitude	Longitude of coordinates of study location
Continent	Continent where study took place
Pathogen	Species of the pathogen
Detection_method	e.g. PCR, microscopy, culture, immunoassay, serology, not applicable (if purely epidemiological)
Vector	Scientific (binomial) name of the arthropod species
Type_of_study	Experimental, Field, Epidemiological
Type_of_evidence	Confirmed transmission, Pathogen detection, Outbreak association, Circumstantial
Strength_of_evidence	Strong, Moderate, Weak

Annex G – Questions for screening forms for narrative review on mechanical transmission of selected species

TITLE / ABSTRACT SCREENING

Question 1
Is the article written in English (or with an English abstract/translation available)?

- Yes → Include
- No → Exclude

Question 2
Does the article address at least one of the six target pathogens (*Coxiella burnetii*, EIAV, LSDV, *Trypanosoma evansi*, *Trypanosoma vivax*, *Besnoitia besnoitia*)?

- Yes → Include
- No → Exclude
- Not sure → Include

Question 3
Does the article mention at least one eligible arthropod group (tabanids, *Stomoxys*, *Haematobia*, *Haematobosca*, mosquitoes, *Culicoides*, keds)?

- Yes → Include
- No → Exclude
- Not sure → Include

FULL TEXT SCREENING

Question 1
Is the article a primary research publication (not a review, commentary, opinion, letter)?

- Yes → Continue
- No → Exclude

Question 2
Does the article provide data relevant to mechanical transmission (experimental, field, or epidemiological evidence)?

- Yes → Continue
- No (focuses only on biological transmission, or irrelevant content) → Exclude
- Not sure → Include

Question 3
Is at least one of the six target pathogens included?

- Yes → Continue
- No → Exclude

Question 4
Is at least one eligible arthropod group included (see Section 2.3.1)?

- Yes → Continue
- No → Exclude

Question 5
Is the vector species reported as present within the VectorNet geographical area?

- Yes → Continue
- No → Exclude
- Not sure → Include

Question 6
Does the study provide sufficient methodological detail to allow interpretation (e.g., description of experimental design, detection method, or epidemiological analysis)?

- Yes → Include
- No → Exclude