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Protocol of the systematic literature review for the distribution of priority vector species within the VectorNet geographical area

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Abstract

Within the context of VectorNet, the European Centre for Disease Prevention and Control (ECDC) and the European Food Safety Authority (EFSA) publish regularly updated vector distribution maps, which are informed by a comprehensive review of the literature, data from the VectorNet Entomological Network, and relevant reports. This protocol focuses on the systematic collection of data derived from peer-reviewed publications. The primary objective of this living systematic literature review (SLR) is to gather information regarding the presence, abundance, and seasonal patterns of targeted vector species, including mosquitoes, sand flies, biting midges, and ticks, within the geographical scope defined by VectorNet. Studies will be identified through searches in Web of Science™ and Medline/PubMed. Eligible studies will be screened and analysed for methodological rigor and relevance. The review will provide rigorous data that will be integrated in the VectorNet distribution maps.

Keywords: vector distribution, vector presence, vector absence, vector seasonality, vector abundance, vector-borne diseases

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Summary

Within the context of VectorNet, the European Centre for Disease Prevention and Control (ECDC) and the European Food Safety Authority (EFSA) publish regularly updated vector distribution maps, which are informed by a comprehensive review of the literature, data from the VectorNet Entomological Network, and relevant reports.

This protocol outlines the process for conducting a living systematic literature review (SLR) to track the distribution and seasonal patterns of vector species, including mosquitoes, sand flies, biting midges, and ticks, within the geographical scope defined by the VectorNet project. This SLR specifically focuses on extracting data related to the presence, abundance, and seasonality of these targeted vector species.

The SLR is designed to provide a rigorous, transparent methodology for systematically collecting and reviewing relevant literature. It will be regularly updated to incorporate new data, ensuring its relevance and accuracy. Each vector group (mosquitoes, sand flies, biting midges, and ticks) will carry out its own independent SLR following the same overarching protocol. Specific details about the species included, search terms, and identification methods for each vector group are provided in the accompanying annexes. The SLR aims to answer key research questions about the documented presence, abundance, and seasonal patterns of these species in the VectorNet geographical area.

The protocol specifies clear eligibility criteria for publications, which must focus on the priority vector species listed for each vector group. The SLR process also details the search strategy, which involves querying databases such as Web of Science and PubMed using specific search terms and Boolean operators. The search terms are tailored to each vector group, accounting for synonyms, abbreviations, and spelling variations. The search will focus on studies conducted within the geographical area defined by VectorNet.

After data extraction, the information will be incorporated into the VectorNet database for further processing and mapping.

In summary, this living SLR aims to systematically compile and update information on the distribution of vector species within the VectorNet area. By continuously integrating new data, it will support ongoing efforts to monitor and understand vector-borne disease risks across Europe.

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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

Within the context of VectorNet, the European Centre for Disease Prevention and Control (ECDC) and the European Food Safety Authority (EFSA) publish regularly updated vector distribution maps (European Centre for Disease Prevention and Control, 2024; European Food Safety Authority, 2024), which are informed by a comprehensive review of the literature, data from the VectorNet Entomological Network, and relevant reports.

This protocol focuses on the systematic collection of data derived from peer-reviewed publications. The primary objective of this living systematic literature review (SLR) is to gather information regarding the presence, abundance, and seasonal patterns of targeted vector species from four vector groups, i.e. including mosquitoes, sand flies, biting midges, and ticks, within the geographical scope defined by VectorNet.

The SLR will adhere to the established standards of systematic reviews, ensuring a rigorous and transparent methodology. To maintain the relevance and accuracy of the findings, the SLR will be updated repeatedly, allowing for the incorporation of new data and insights.

Each vector group involved in this review will conduct its SLR independently, following the overarching protocol. Specific criteria for each vector group, including details on the species considered, relevant search terms, and identification methods, are clearly outlined in the accompanying annexes: Annex A specifies the species included, Annex B details the search terms employed, and Annex C describes the identification methods utilised.

2 Methodologies

2.1 SLR: Systematic literature review for the distribution of vector species within the VectorNet geographical area

The living systematic literature review (SLR) of the geographic distribution of the priority vector species will follow the basic standard protocol of a SLR.

The **aim** of this living SLR is to identify information on the presence and abundance or seasonality of target vector species of **mosquitoes, sand flies, biting midges and ticks** in the VectorNet geographical area. The SLR will be updated on demand.

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

1. What is the documented presence or absence of the priority vector species in the VectorNet Geographical Area?
2. What is the documented abundance or seasonality of the priority vector species in the VectorNet Geographical Area?

2.1.1 Eligibility criteria

2.1.1.1 Population

Publications are included for the priority vector species listed in **Annex A** for each vector group:

- Table A.1: Mosquitoes species included
- Table A.2: Sand flies species included
- Table A.3: Biting midges species included
- Table A.4: Ticks species included

2.1.1.2 Outcomes of interest

1. Presence or absence of a priority vector species at a specific location (area or point location) within the VectorNet geographical area.
2. Abundance or seasonality of a priority vector species at a specific location (area or point location) within the VectorNet geographical area.

2.1.1.3 Working definitions

A vector species is **present** at a specific location (area or point location) within the VectorNet geographical area if at least one specimen was detected during a given period (day(s), week(s), month(s), season) in the study.

A vector species is **absent** at a specific location within the VectorNet geographical area (area or point location) when zero specimens were detected during a given period for a given collection effort using appropriate collection methods. A separate inference process may be applied wherein species that could be caught by a specific method, but have not been recorded or reported as absent, will be assigned a zero value, provided the sampled is judged sufficient (see below).

The **observed abundance** of a vector species at a specific location (area or point location) within the VectorNet geographical area is the maximum number of specimens detected during a given period (day(s), week(s), month(s), season) for a given collection effort.

The **observed seasonality** of a vector species at a specific location (area or point location) within the VectorNet geographical area is a series of observed abundance records at different time points over a given vector season. These should include at least the first, maximum and last abundance records.

2.1.1.4 Settings

Any field evidence for the above outcomes.

2.1.1.5 Temporal delineation

The current VectorNet database is updated until 31/07/2023. The first following update of the SLR will cover the period 01/08/2023 – 31/12/2024. This SLR will be updated on demand.

2.1.1.6 Geographical delineation

The target area is the VectorNet geographical area (see **Annex B**, Table B.1). If geographical coordinates are not provided, papers will still be included if they contain a clear indication of either the location, municipality or parent administrative unit (NUTS 3 or GAUL 2 levels) or maps where the species was detected.

2.1.1.7 Study designs

Any study design can be included (longitudinal, cross-sectional, case study, outbreak investigation, etc.) but the vector species identification method needs to be appropriate (see **Annex C** for vector group specific identification methods).

In case a species is newly reported in a country or an admin unit, we will verify the identification process only when there are some doubts about species identification. In such case, without a good photo, an expert double check, or complementary methods (i.e., in the case of mosquitoes, morphology and molecular) the occurrence will be excluded.

No restriction on language, but the article can be excluded further in the process if translation is not feasible and/or unavailable.

To keep the SLR workload feasible, studies for which datasets are available either on the GBIF VectorNet Portal, published as data papers, or provided directly by the data providers shall be excluded from this SLR to avoid repetition and allow inclusion of non-aggregated data directly into the VectorNet database.

2.1.2 Search strategy

The following databases will be searched: Web of Science™ and Medline/PubMed.

For each vector group, specific combinations of search terms will be applied. The use of Boolean operators (AND, OR, NOT), truncation ($) and wildcard (*) symbols will ensure that search terms account for synonyms, abbreviations and spelling variants, enhancing thus the sensitivity of the search strategy.

The search strings will be a combination of the following elements (see **Annex B** for details):

1. Data type (Annex B, Table B.1)
2. Geography (Annex B, Table B.1)
3. Vector species specific for each vector group (Annex B, Table B.2)

2.1.3 Selection process

Title and abstract will be screened by two reviewers independently using a screening check list developed according to the eligibility criteria defined above and implemented in Distiller®, provided in **Annex D**, Table D.1. If the information contained in the title or abstract is not relevant for the research objectives (any of the eligibility criteria is not met), the article will not be selected for full text assessment. This first level of screening will be performed independently by two reviewers. Conflicts will be resolved by the two reviewers. If no agreement is reached a third person will be consulted.

The full text of selected studies will be screened by one reviewer using a screening checklist developed according to the eligibility criteria defined above and implemented in Distiller®, provided in **Annex D**, Table D.2.

2.1.4 Data extraction

Data extraction will be done by one person from studies that have passed screening for relevance, applying a quality assurance process and recorded in the data table in **Annex E** (Table E.1).

The following types of data will be extracted from studies:

- **Presence** data
- **Abundance** data will be extracted when available i.e., if the number of collected specimens and the corresponding sampling effort (value and units) are clearly indicated, allowing the computation of a number per unit of sampling effort. **Seasonality** will be determined based on observed abundance records at different time points over a given vector season, when feasible
- **Absences** will be recorded in two ways:
  - Recorded from zeros extracted directly from the publication or dataset. These will be treated in the same way as any other recorded abundance values.
  - Inferred "not reported" tags for species that were not reported in the results, but which should have been caught by the sample methods used if they were present. These inferences need not be entered in the database, as they can be calculated automatically. A judgement will, however, be made, as to whether the publication is suitable to be included within the automatic "not reported" inference process, and the reference will be tagged accordingly in data extraction phase. The criteria for inclusion are available in the D2.6.1 report "*Algorithm for automated generation of absence data at point locations*".

Data extraction will be done according to the data extraction table provided in **Annex E** (Table E.1) so that it complies with the VectorNet database requirements.

2.1.5 Outputs

Data will be entered in an Excel® data file template (cf. VectorNet2) and incorporated into the VectorNet database for further processing and mapping.

2.1.6 Quality

By fulfilling the eligibility criteria, only data generated through studies using appropriate methods for vector identifications will be included and the quality assessment on the study design and vector identification is embedded in the eligibility screening of the studies, before data extraction. Before data extraction, training will be organised by the SLR coordinator to make sure all the eligibility criteria are interpreted and addressed in the same way across the different reviewers and vector groups.

After data extraction, 1% of the data extracted from the papers shall be quality checked by VGLs. When the quality is found insufficient, additional training sessions shall be organised until the data are extracted in a consistent way by all the reviewers.

References

European Centre for Disease Prevention and Control. (2024). *Surveillance and updates for disease vectors*. European Centre for Disease Prevention and Control. https://www.ecdc.europa.eu/en/disease-vectors/surveillance-and-disease-data

European Food Safety Authority. (2024). *Disease orofiles*. European Food Safety Authority. https://animal-diseases.efsa.europa.eu/

Abbreviations

Abbreviation	Explanation
SLR	Systematic literature review
VGL	VectorNet Group Leader
VN	VectorNet
WHO	World Health Organization

Annex A – List of the species included for each specific vector group

Table A.1 – MOSQUITOES: priority species included

Mosquitoes, native	Mosquitoes, invasive
Aedes detritus/Aedes coluzzii	Aedes aegypti
Aedes caspius	Aedes albopictus
Aedes vexans, Aedes arabiensis	Aedes atropalpus
Aedes sticticus	
Anopheles plumbeus	Aedes japonicus
Anopheles maculipennis s.l. and members of the species complex: Anopheles atroparvus, Anopheles labranchiae, Anopheles maculipennis s.s., Anopheles sacharovi, Anopheles messeae	Aedes koreicus
Anopheles claviger	
Anopheles superpictus	
Coquillettidia richiardii	
Culex antennatus	
Culex modestus	
Culex perexiguus / Culex univittatus	
Culex pipiens	
Culex theileri	
Culex torrentium	
Culex tritaeniorhynchus	
Culiseta annulata	

Table A.2 – SAND FLIES: priority species included

Sand flies
Phlebotomus alexandri
Phlebotomus ariasi
Phlebotomus balcanicus
Phlebotomus halepensis
Phlebotomus longiductus
Phlebotomus kandelakii
Phlebotomus mascittii

Sand flies
Phlebotomus neglectus
Phlebotomus papatasi
Phlebotomus perfiliewi
Phlebotomus perniciosus
Phlebotomus sergenti
Phlebotomus simici
Phlebotomus similis
Phlebotomus tobbi

Table A.3 – BITING MIDGES: priority species included

Biting midges
Culicoides imicola
Culicoides dewulfi
Culicoides chiopterus
Culicoides obsoletus s.l./Culicoides scoticus and members of this assemblage: Culicoides scoticus and Culicoides obsoletus s.l., which includes Culicoides obsoletus s.s., Culicoides montanus, and other cryptic 'molecular forms'.
Culicoides punctatus s.l.
Culicoides newsteadi s.l.
Culicoides pulicaris s.l./Culicoides lupicaris and members of this assemblage Culicoides pulicaris s.l. and Culicoides lupicaris
Culicoides kingi

Table A.4 – TICKS: priority species included

Ticks
Dermacentor reticulatus
Hyalomma marginatum
Hyalomma lusitanicum
Ixodes ricinus
Ixodes persulcatus
Ornithodoros erraticus
Rhipicephalus sanguineus

Annex B – Search terms

The different search domains are combined with an AND.

Table B.2: Search terms common to all vector groups

Category	Search terms
Data type	distribution OR presence OR occurrence OR report* OR spread OR dispers* OR detect* OR abundance OR densit* OR number OR absence OR surv* OR monitoring OR introduc* OR intercept* OR first OR emergence OR expansion OR vector
Geography	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 Ukrayina 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*"

Table B.2: Vector group specific search terms

Category	Search terms
Mosquitoes	(aedes OR stegomyia OR ochlerotatus OR hulecoeteomyia OR georgecraigus OR anopheles OR coquillettidia OR culex OR culiseta OR mosquito OR culicidae) AND (aegypti OR albopict* OR atropalpus OR caspius OR detritus OR coluzzii OR sticticus OR japonic* OR koreic* OR vexans OR arabiensis OR atroparvus OR claviger OR labranchiae OR maculipennis OR messeae OR plumbeus OR sacharovi OR superpictus OR richiardii OR antennatus OR modestus OR perexiguus OR pipiens OR theileri OR torrentium OR tritaeniorhynchus OR univittatus OR annulata)
Sand flies	(phlebotomus OR sandflies OR "sand flies" OR leishmania) AND (ALL(alexandri OR ariasi OR neglectus OR mascittii OR papatasi OR perniciosus OR perfiliewi OR tobbi OR sergenti OR similis))
Biting midges	(Culicoides) AND (ALL(imicola OR dewulfi OR chiopterus OR obsoletus OR scoticus OR punctatus OR newsteadi OR pulicaris OR lupicaris OR kingi))
Ticks	(ixodes OR dermacentor OR rhipicephalus OR hyalomma or OR ornithodoros) AND (ricinus OR persulcatus OR reticulatus OR sanguineus OR marginatum OR erraticus OR lusitanicum)

Annex C – Vector group specific identification methods

Appropriate identification methods for each vector group:

1) Mosquitoes:
   a) Electrophoresis
   b) Maldi-tof MS
   c) Morphological
   d) PCR
   e) PCR DNA Barcoding
   f) PCR RFLP
   g) qPCR

2) Culicoides:
   a) Maldi-tof MS
   b) Morphological
   c) PCR
   d) PCR DNA Barcoding
   e) qPCR

3) Ticks:
   a) Maldi-tof MS
   b) Morphological
   c) PCR
   d) PCR DNA Barcoding
   e) PCR RFLP
   f) qPCR

4) Sand flies:
   a) Maldi-tof MS
   b) Morphological
   c) PCR
   d) PCR RFLP
   e) qPCR

Annex D – Eligibility screening forms implemented in Distiller®

Table D.1 – Level 1 screening (title and abstract)

Question	Answer	Action
1. Is the article reporting the detection (catch and identification, can include zero) of at least one of the priority species on the list in the VectorNet geographical area?	Yes	Include
	No	Exclude
	Not sure	Include

Table D.2 – Level 2 screening (full text)

Question	Answer	Action
1. Is the article reporting the detection of at least one of the priority species on the list in the VectorNet geographical area?	Yes	Include
	No	Exclude
	Not sure	Include
2. Are there useful locations provided in the paper (either the administrative unit NUTS 3 or GAUL 2 levels, geo-coordinates, a location from which a NUTS 3 or GAUL 2 can be inferred...)?	Yes	Include
	No	Exclude
	Not sure	Include
3. Is at least one of the species identification methods accepted? (list ID method/species combination)	Yes	Include
	No	Exclude
	Not sure	Include
4. Is at least one of the detected species reported in a country or an admin unit where it is not yet known nor expected?	No	Include
	Yes	Next question
4.1 Is there enough information (publication of a full description of individuals including pictures, results of molecular assay provided) to assume the of the newly detected species in the area identification is correct?	Yes	Include
	No	Next question
4.1.1 Ask the author for a specimen/picture. Is the identification correct?	Yes	Include
	No	Exclude
	No reply from author	Exclude

Annex E – Data extraction template

Table E.1 – Data extraction template

Field name	Data type	Description	Required	Lookup
occurrenceID	Integer	SourceID, Identification number	Yes	No
Family	Text	Vector group	Yes	Yes
scientificName	Text	Vector species name (GBIF)	Yes	Yes
verbatimIdentification	Text	Vector species name	Yes	Yes
country	Text	Country name	Yes	Yes
higherGeographyID	Text	Administrative Unit Code, validated against list in worksheet LocationCodes/Country	Yes	Yes
locality	Text	Administrative Unit Name, calculated from previous column using worksheet CodesVLOOKUP	Yes	Yes
decimalLongitude	Decimal	Longitude in decimal degrees	No	No
decimalLatitude	Decimal	Longitude in decimal degrees	No	No
locationAccordingTo	Text	GPS, Centroid etc.		
lifeStage	Text	Life stage of the species	Yes	Yes
sex	Text	Sex of the species	Yes	Yes
individualCount	Integer	Number of caught vectors	Yes	Yes
verbatimSiteNames	Text	Collection place	Yes	No
EventDate	Date	Format: YYYY-MM-DD/YYYY-MM-DD; start/end date	Yes	No
samplingProtocol	Text	Method used to collect the species	Yes	Yes
sampleSizeValue	Integer	Collection effort	Yes	No
associatedTaxa	Text	Vector Host Species	Yes	Yes
identificationRemarks	Text	Method used for vector species identification	Yes	Yes
eventRemarks	Text	Whether sample site was sheltered or not	No	Yes
OccurrenceStatus	Text	Reported distribution status: Present, Absent, Anticipated Absent, Introduced, Unknown, No Data	No	Yes
Source	Text	SourceType	No	Yes
bibliographicCitation	Text	PublicationTitle		
relationshipRemarks	Text	NotesFromDataExpert	No	No
identifiedByID	Text	Data expert name and surname for each row	No	No
Submitter email (first row only)	Text		No	No
AbsenceValid	Text	Zeros not reported but suitable for inference, zeros not reported and not suitable for inference	Yes	Yes