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TECHNICAL REPORT

Organisation of vector surveillance and control in Europe

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ECDC TECHNICAL REPORT

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Abbreviations

CCHF	Crimean-Congo haemorrhagic fever
ECDC	European Centre for Disease Prevention and Control
EEA	European Economic Area
EFSA	European Food Safety Authority
EU	European Union
UK	United Kingdom
VEN	VectorNet Entomological Network

Executive summary

In recent decades, Europe has faced changes in the epidemiological situation of vector-borne diseases. Vector surveillance and control are key in the prevention of vector-borne disease transmission, and their organisation can be complex due to the many stakeholders involved. This report provides an overview of how vector surveillance and control is organised in European Union/European Economic Area (EU/EEA) countries, EU enlargement policy countries, European Neighbourhood Policy partner countries and the UK, and highlights challenges and opportunities.

In 2020, a questionnaire was sent to the VectorNet Entomological Network (VEN) members of 28 EU/EEA countries, seven EU enlargement policy countries, 14 European Neighbourhood Policy partner countries and the United Kingdom (UK). In total, 43 out of 50 targeted countries completed and returned questionnaires, resulting in an 86% response rate. Vector surveillance and control was most often implemented in the context of mosquitoes and mosquito-borne diseases. The presence of a mosquito-vector, in the absence of autochthonous transmission, was a trigger to implement control measures in 87% of the countries. Tick surveillance was implemented in 33 of the 43 responding countries, whereas tick control was limited to 12 countries and implemented most often in non-EU/EEA countries. Absence of tick control in countries is probably related to the lack of reliable vector control methods and strategies, as indicated by 18 countries. Sand fly surveillance and control measures were implemented by 17 and seven countries, respectively. Biting midge surveillance was more often implemented in EU/EEA countries (62%) compared to EU enlargement policy countries, European Neighbourhood Policy partner countries and the UK (47%).

The most prominent limiting factor for implementing vector surveillance and control mentioned by the respondents was the lack of funding and trained professionals. Responses to this questionnaire also pointed to the fact that many different stakeholders are involved in vector surveillance and control, making coordination and collaboration a necessary element for success. Most of the active vector surveillance was classified as 'limited in time' and this holds for all vector groups. We believe that the development of long-term sustainable vector surveillance would require, but also offer, the opportunity to build a durable entomological capacity of e.g. trained professionals. It was often mentioned that the various roles and responsibilities in vector control are not clearly defined. This complicates the development of control procedures, guidelines and frameworks.

The changing epidemiological situation in EU/EEA countries, EU enlargement policy countries, European Neighbourhood Policy partner countries and the UK poses a challenge to vector surveillance control practices. Countries that are not familiar with vector surveillance and control have to build up their expertise and experience. Further, the currently available control methods might be insufficient to cope with the changing epidemiological situation and innovative control tools and methods might be needed in the future.

Key points to consider for the future relate to:

- sharing experience and expertise among countries;
- improving coordination and collaboration, among the many involved stakeholders;
- developing a long-term perspective for sustainable vector surveillance and control at national and international level;
- developing guidance on vector control;
- advocating for funds for research on innovative vector control methods and tools to be able to cope with the future challenges of vector-borne diseases;

As limited financial and human resources were frequently specified as bottlenecks for surveillance and control activities, the public health benefits of these activities should be clearly demonstrated to (political) decision makers, as well as the differences in environmental and financial costs of the different control methods.

Background

In recent decades, EU/EEA countries, EU enlargement policy countries, European Neighbourhood Policy partner countries and the UK have been confronted with a changing epidemiology of vector-borne diseases. Autochthonous transmission of some vector-borne diseases, previously absent from many of these countries, has been observed. Local vector-borne transmission of malaria has been reported in Greece and France [1, 2] and local cases of dengue, chikungunya virus disease and Zika virus disease occurred in the EU/EEA [3-6]. Further, West Nile virus infection is no longer restricted to the Mediterranean region and Central Europe, as it has spread northward, with recent incursions into the Netherlands and Germany [7]. Lyme borreliosis, tick-borne encephalitis and Crimean-Congo haemorrhagic fever (CCHF) are endemic in Europe. For example, CCHF was known to be endemic in the Balkan region, but in 2016, the first autochthonous human case of the disease was reported in Spain [8]. Leishmaniasis was known to exist in the Mediterranean region, but this disease is considered an emerging problem in Europe connected with the spread of the sand fly vector [9]. The viral vector-borne disease bluetongue affects domestic and wild ruminants such as sheep, goats, cattle and deer. Europe has seen several incursions of the virus in recent decades, while in 2016, the bluetongue virus-8 strain caused the largest outbreak in Europe with high economic consequences [10]. Schmallenberg disease, caused by the Schmallenberg virus (genus *Orthobunyavirus*, Bunyaviridae family), primarily affects ruminant species such as cattle, sheep and goat. It emerged in North-Western Europe in 2011 and spread widely across Europe. The virus is transmitted by various *Culicoides* biting midges [11].

A prerequisite for autochthonous vector-borne transmission is the presence of an efficient vector. In many cases, vector control is pivotal to prevent transmission of vector-borne disease [12]. To mitigate the impact of vector-borne diseases, a comprehensive approach to vector control is needed [13]. It requires specific organisation and expertise, including a thorough understanding of the biology of the vectors and of the transmission cycles, and a detailed knowledge on the ample options of vector control methods and tools. Collaboration between several disciplines and responsible health and environmental authorities are needed for effective surveillance, adequate risk assessment, early detection, communication about, response to, and control of vectors and the pathogens they transmit [13].

This report aims to provide an overview of how vector surveillance and control is organised in EU/EEA countries, EU enlargement policy countries, European Neighbourhood Policy partner countries and the UK, of which legal frameworks for vector surveillance and control are in place, of who is responsible for making decisions about and who is responsible for implementing the vector surveillance and control.

Methods

Survey

General overview of the questionnaire

The information on the organisation of surveillance and control was collected through an online questionnaire implemented in EUSurvey (https://ec.europa.eu/eusurvey/home/welcome) (Annex 1). The questionnaire addressed four different vector groups (i.e. mosquitoes, ticks, sand flies and biting midges) and was divided into six parts (see Annex 1 for details):

- PART 1 asked for details of the respondent;
- PART 2 asked for the epidemiological situation of selected vector-borne diseases in the country;
- PART 3 covered the organisation of vector surveillance in the countries addressing following topics;
  - Whether vector surveillance is implemented;
  - Who is responsible and who implements;
  - Operational overview of the vector surveillance.
- PART 4 covered the organisation of vector control in the countries addressing following aspects:
  - Whether vector control is implemented;
  - Who is responsible and who implements;
  - Operational overview.
- PART 5 asked about 'One Health' collaboration between the public, veterinary and environmental sectors related to vector surveillance and control in the country.
- PART 6 consisted of an open question where in response, additional information on the organisation of vector surveillance and control could be provided as where challenges or opportunities related to the implementation of vector surveillance and control could be mentioned.

The respondent and target countries

In the fall of 2020, this questionnaire was sent to the VEN members of 28 EU/EEA countries, seven EU enlargement policy countries, 14 European Neighbourhood Policy partner countries and the UK; accordingly, UK data are included in this report. The online questionnaire was not sent to Israel, Liechtenstein, and Lithuania, because these countries did not have a VEN member at the time of the study. The VEN members were asked to complete this questionnaire with input from the national focal points of ECDC's Emerging and Vector-borne diseases network and the national focal points of European Food Safety Authority (EFSA) or the 'Country contacts' for the European Neighbourhood Policy partner countries. The national focal points are the officially nominated contact points of ECDC and EFSA in the EU/EEA countries. The VEN members could also ask for input from other parties.

Terms and framework

Levels of organisation

We considered three organisational levels in the organisation of vector surveillance and control:

- Policy making;
- Decision-making, planning and evaluation;
- Operational execution.

For the level of 'policy making' we sought to identify the Ministry responsible for vector surveillance or control, i.e. the Ministry that has the overall responsibility and oversight of vector surveillance. For level 2 we looked for the organisation or agency that is responsible for designing, planning and evaluation of the surveillance or control plan. Such a plan identifies 'what, when, and where' needs to be done related to vector surveillance or control. For the third level, operational execution, we asked for the organisation or agency that carries out the day-to-day vector surveillance or control activities.

Definitions

Table 1 provides an overview of the definitions that are applied throughout this questionnaire and the report.

Table 1. The definitions used in the questionnaire and report

Term	Definition
Vector	An arthropod capable of transmitting a pathogen.
Vector surveillance	Continuous, systematic collection, analysis and interpretation of vector-specific data that can be used in planning, implementing and evaluating public or veterinary health practice.
Vector control	Measures of any kind against pathogen-transmitting arthropods (vectors), intended to limit their presence or abundance or their ability to transmit the pathogen.
Active vector surveillance	A system employing staff members to visit surveillance sites and collect (often on a regular basis) information on vector-specific data.
Passive vector surveillance	A system by which the responsible authority/agency receives vector-specific data from all potential sources. Citizen science is considered as passive surveillance.
Animals of veterinary importance	Animals of either economical or personal importance, such as livestock or companion animals, often living in close proximity to humans.
Wildlife	Undomesticated animal species and abandoned/feral dogs.

Assessment of the epidemiological situation of selected vector-borne diseases in a target country

To contextualise the information collected through this questionnaire, we asked the respondents to provide the contexts of a number of selected vector-borne diseases according to the framework developed by Braks et al. [14]. This framework refers to a simplified scheme of six different contexts according to the current presence or absence of the disease, the pathogen and the vector in their country (Table 2).

Table 2. Definition of the six contexts

Context	Status	Definition
1a	Local transmission	Autochthonous cases in human and/or animals of veterinary importance occurred every year over the last five years (2016–2020).
1b	Local transmission	Autochthonous case(s) in human and/or animals of veterinary importance occurred sporadically i.e. a single event or multiple events occurring during up to four years of local transmission out of the last five years (2016–2020).
2	Pathogen and vector are present	See under context 3 and 4 for definitions.
3	Vector is present	A vector is considered present when an arthropod species capable of transmitting a certain vector-borne pathogen is indigenous; or when an exotic vector species is established.
4	Pathogen is present	We consider a pathogen to be present when it is circulating among indigenous vectors and non-human (wildlife) hosts and, when it is regularly introduced by vectors, reservoir hosts or humans. When a pathogen circulates in animal populations of veterinary importance (e.g. cattle or pets), this is considered local transmission and therefore 1a or 1b.
5	None of the above	

The following diseases were included:

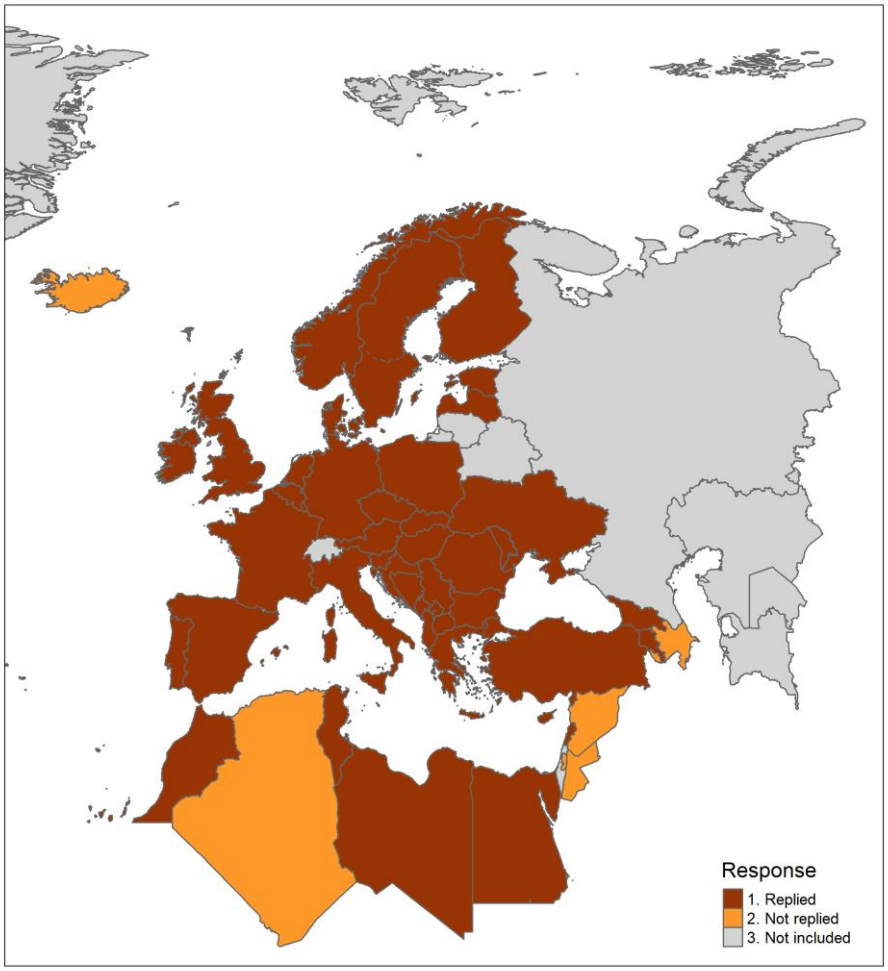
- Diseases of public health importance:
  - West Nile virus infection in humans;
  - Dengue, chikungunya virus disease or Zika virus disease;
  - Lyme borreliosis;
  - Tick-borne encephalitis;
  - Crimean-Congo haemorrhagic fever;
  - Leishmaniasis in humans.
- Diseases of veterinary importance:
  - West Nile virus infection in horses;
  - Leishmaniasis in dogs;
  - Bluetongue;
  - Schmallenberg disease

Results

Participating countries

In total, 43 of 50 questionnaires were completed and returned resulting in an 86% response rate (Figure 1). Twenty six of the 28 EU/EEA countries, all seven EU enlargement policy countries, nine of the 14 European Neighbourhood Policy partner countries and the UK replied to the questionnaire.

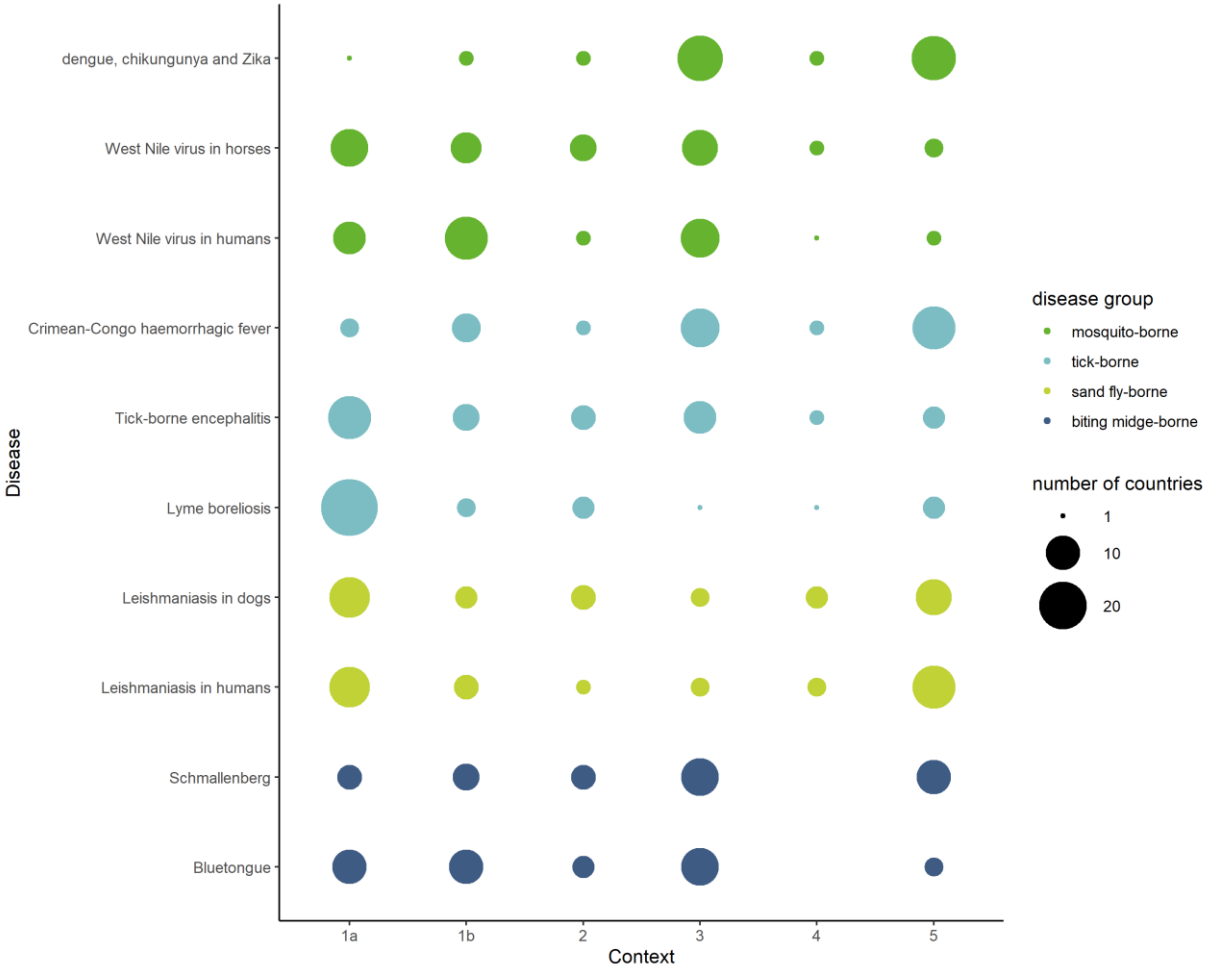
Figure 1. Overview of the respondent countries



The epidemiological context of the selected vector-borne diseases

Twenty-seven countries are currently confronted with local transmission of pathogens transmitted by mosquitoes (context 1a or 1b). This primarily refers to West Nile virus infection (Figure 2, Table 3, Annex 2, Figure 9). In the preceding five years, local transmission of arboviruses transmitted by exotic Aedes species was reported by three countries (France, Italy and Spain). In addition to these three countries with local transmission, 20 countries reported the presence of exotic Aedes vector species. Thirty-two countries reported local transmission of Lyme borreliosis and tick-borne encephalitis is transmitted locally in 22 countries. CCHF is much more localised, with 10 countries reporting the disease being transmitted (context 1a or 1b) and 15 countries reporting the presence of the tick vector without local transmission. Leishmaniasis is a disease of the Mediterranean countries where it is reported both in humans and dogs. Sixteen countries reported the absence of sand fly vectors. Finally, local bluetongue and Schmallenberg virus transmission are reported from 20 and 11 countries respectively. Additionally, 14 countries reported the presence of the vectors of bluetongue and Schmallenberg without local transmission (Figure 2, Annex 2, Figure 9).

Figure 2. Overview of the epidemiological context of the selected vector-borne diseases.



The size of the bubble represents the number of countries

Table 3. Other vector-borne diseases that trigger vector surveillance and control that were not included in the epidemiological context-section of the questionnaire, mentioned by respondents

Vector group	Disease	Countries
Mosquitoes	Rift Valley fever	Egypt, Morocco
	Malaria and import malaria	Armenia, France, Greece, Bulgaria, Morocco
	Usutu virus infection	Italy, Croatia, UK
	Dirofilariasis	Latvia
Ticks	Rickettsiosis	Tunisia, Portugal, Spain, Libya
	Anaplasmosis	Spain, Ireland, Kosovo*
	Babesiosis	Denmark, Spain, Latvia, Ireland
	Theileriosis	Spain
	Ehrlichiosis in dogs	Cyprus
	Hyalomma-borne pathogens	Denmark
Sand flies	Toscana virus	Tunisia, Portugal
	Sand fly fever	Libya
Biting midges	African horse sickness	Morocco
Other	Tularaemia	Portugal, Armenia
	Plague	Armenia
	Lumpy skin disease	Montenegro

**This designation is without prejudice to positions on status, and in line with UNSCR 1244/99 and the ICJ Opinion on the Kosovo Declaration of Independence*

Organisation of vector surveillance

Is vector surveillance implemented?

Over the period 2016–2020, surveillance of mosquitoes and ticks was implemented in most countries (in 37 and 33 of the 43 respondent countries, respectively), whereas the surveillance of sand flies was limited to 17 countries. Surveillance of biting midges was implemented in 24 countries in the same period (Figure 3). The percentage of countries that implement surveillance of a specific vector group (except for biting midges) is similar between EU/EEA countries and the group of EU enlargement policy countries, European Neighbourhood Policy partner countries and the UK (Table 4).

Figure 3. Overview of the countries that implement vector surveillance in the period 2016–2020

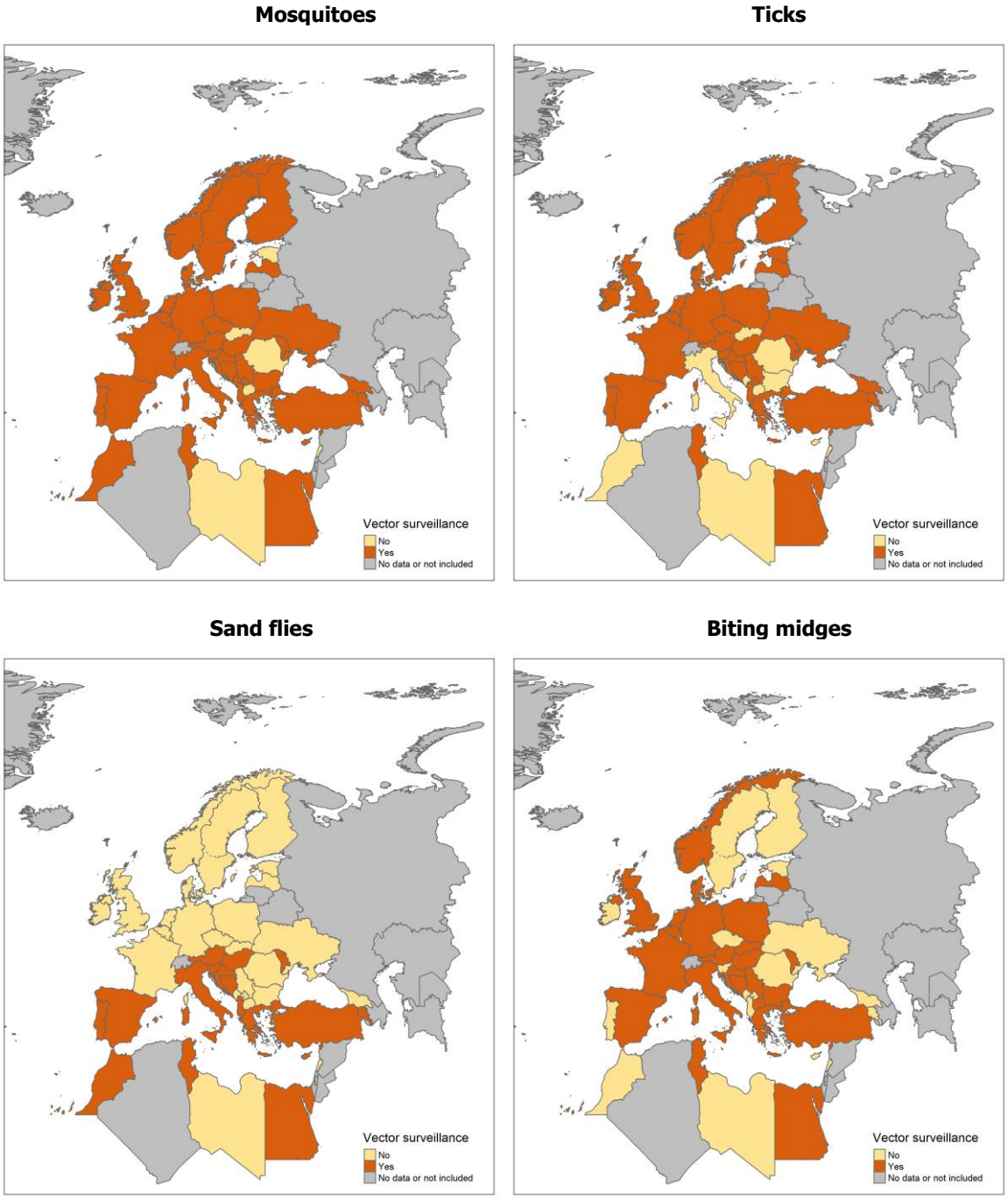


Table 4. Number and percentage of countries implementing vector surveillance by vector group

Country group	n	Mosquitoes	Ticks	Sand flies	Biting midges
EU/EEA countries	26	23 (88%)	21 (81%)	9 (35%)	16 (62%)
EU enlargement policy countries, European Neighbourhood Policy partner countries and the UK	17	14 (82%)	12 (71%)	8 (47%)	8 (47%)

Almost 90% of the countries that are confronted with local transmission of a mosquito-borne disease of public or veterinary health importance implement vector surveillance. Likewise, 85% of the countries experiencing autochthonous tick-borne disease transmission (context 1a and 1b) perform vector surveillance. These percentages reduce to 71% and 62% for biting midge-borne and sand fly-borne diseases, respectively (Table 5). The presence of a mosquito vector triggers vector surveillance in 87% of countries. For the other vector groups, the presence of the vector triggers surveillance in about 50% of countries (Table 5).

Table 5. Number and percentage of countries implementing vector surveillance by context within the four disease groups

Vector group	Disease group*	Context**		
		1a and 1b	2 and 3	4 and 5
Mosquitoes	Mosquito-borne diseases	24/27 (89%)	13/15 (87%)	0/1
Ticks	Tick-borne diseases	29/34 (85%)	4/8 (50%)	0/1
Sand flies	Sand fly-borne diseases	13/21 (62%)	3/6 (50%)	1/16 (6%)
Biting midges	Biting midge-borne diseases	17/24 (71%)	6/14 (43%)	0/1

***Note**. *Mosquito-borne diseases based on the contexts of West Nile virus infection, dengue, chikungunya virus disease or Zika virus disease in humans, West Nile virus infection in horses; Tick-borne diseases based on: Lyme borreliosis, tick-borne encephalitis, Crimean-Congo haemorrhagic fever; Sand fly-borne diseases: leishmaniasis in humans, leishmaniasis in dogs; Biting midge-borne diseases: bluetongue, Schmallenberg disease.*
***The contexts were grouped into: (1) contexts 1a and 1b representing a situation with local transmission; (2) contexts 2 and 3 referring to a situation where the vector is present; and (3) contexts 4 and 5 reflecting a situation where the vector is absent.*

Of the six countries that did not perform any mosquito surveillance, all indicated a lack of resources as a reason. Likewise, most of the countries stated lack of resources as reason for not implementing tick, sand fly or biting midge surveillance. Another important reason for the absence of vector surveillance was the fact that the vector-borne diseases transmitted by the specific vector groups at the time of the survey are not a public or veterinary health problem or priority. Also, the absence of a legal framework was often mentioned as a reason for not implementing vector surveillance (Annex 3). Libya mentioned that the insecure situation in the country prevented the implementation of vector surveillance.

Countries that did implement vector surveillance did so because the vector-borne diseases transmitted by the specific vector groups are a public or veterinary health problem or priority; because the information contributes to response and control of vector-borne disease; and because it is important for the assessment of the introduction and spread of invasive vector species. The latter reason was mentioned by 30 countries implementing mosquito surveillance and was also mentioned as a reason for tick (n=13), sand fly (n= 5) and biting midges (n=7) surveillance. A legal obligation was also mentioned as reason for the implementation of vector surveillance (Annex 3).

Of those countries implementing mosquito surveillance (n=37), 23 referred to legal frameworks. Fourteen countries mentioned a specific legislation on vector surveillance. In 12 countries, mosquito surveillance is embedded in a legal framework on disease surveillance. Of these 23 countries, 13 countries referred to two or three different legal frameworks. Of the 33 countries implementing tick surveillance, 13 referred to a legal context in which the surveillance is done. For sand flies and biting midge surveillance, this was 8 out of 17 and 14 out of 24 countries, respectively. For tick and sand fly surveillance, most countries referred to a legal framework on disease surveillance. In nine countries, there is a specific legislation for surveillance of biting midges (Annex 3). In the Netherlands, a specific legislation is present on Lucky Bamboo as part of the Commodities Act Decree. France referred to a specific European regulation for biting midges surveillance.

Who is responsible and implements vector surveillance?

The Ministry responsible for vector surveillance, i.e. the Ministry that has the overall responsibility and oversight of vector surveillance, is strongly linked with the actual public or veterinary health problem. Hence, in many countries, the Ministry of Health is responsible for the surveillance of vectors that transmit pathogen of human importance. Likewise, in many countries, the Ministry of Agriculture oversees the surveillance of vectors responsible for pathogen transmission of animal importance. In Belgium, Georgia, Libya, Turkey and Tunisia, the Ministry of Environment is also responsible for surveillance. In Belgium the, the Ministry of Environment is the only one responsible. In Georgia, for example, the Ministries of Agriculture and Environment share the responsibility of surveillance related to WNV in horses, leishmaniasis in dogs and bluetongue (Annex 3, Figure 10, Annex 6).

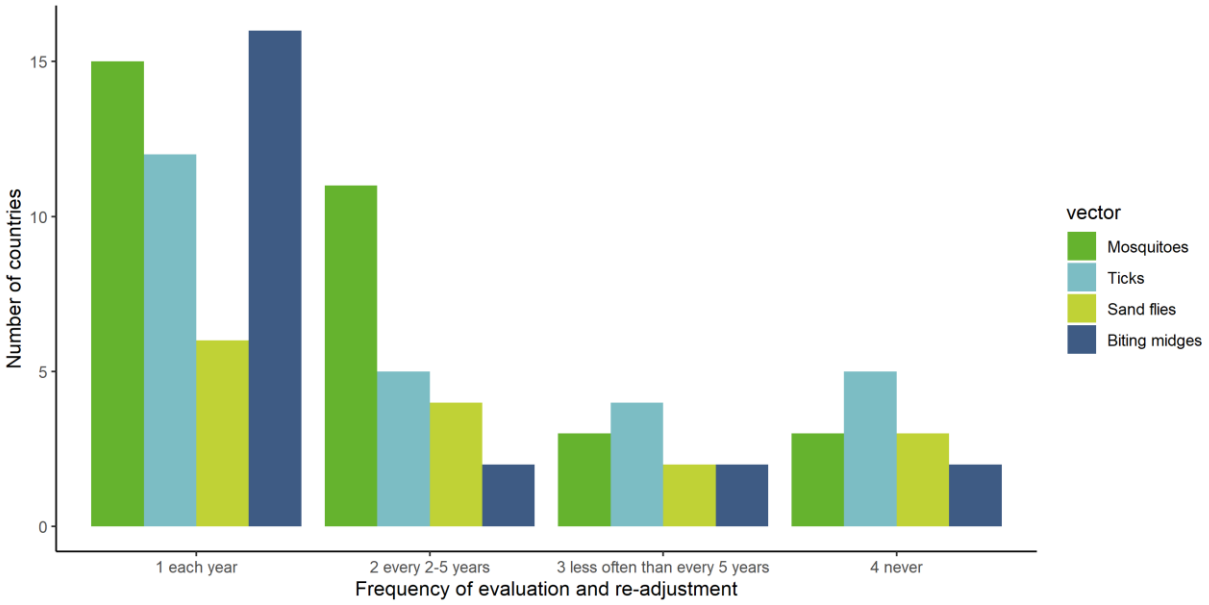
Other responsible authorities or agencies mentioned by different countries are: collaboration between the National Institutes of Public Health, the Public Health Institute Ostrava, the Czech Academy of Sciences and the Regional Stations of Hygiene (Czechia); regional authorities and municipalities (Greece); Provincial Secretariat of Health (Serbia), municipalities (Sweden); the French Agency for Food, Environmental and Occupational Health and Safety (ANSES); the National Center for Disease Control and Public Health (Georgia) and the Ministry of Education and Science and Technology; the University of Pristina and the department of Veterinary Medicine (Kosovo[i])

[i] This designation is not without prejudice on status, and in line with UNSCR 1244/99 and the ICJ Opinion on the Kosovo Declaration of Independence

In most countries, the surveillance plan is designed by public or veterinary health agencies, or scientific or academic institutes. Although for biting midges, a working group within a Ministry was mentioned by eight countries. In general, the same agencies responsible for the design are also responsible for the evaluation and possible re-adjustment of the vector surveillance plan. In most countries, the surveillance plan for the different vector groups is designed at national level.

This does not mean that the plan targets the entire country: a plan can be designed at national level, but target only specific areas such as points of entry of exotic vector species are surveyed or risk areas for vector-borne diseases. In Greece, regional authorities and municipal authorities design their mosquito surveillance programme in collaboration with regions or private contractors. In Sweden, the design of vector plans is the responsibility of the municipalities (Annex 3, Annex 6). In most countries, the evaluation and re-adjustments of the surveillance plans is regularly done (Figure 4).

Figure 4. Number of countries implementing vector surveillance that evaluate and re-adjust their surveillance plan



The execution of vector surveillance is mostly done by scientific institutions, or public/veterinary health agencies. Only a limited number of countries have a dedicated agency for the execution of surveillance. In four countries, mosquito surveillance is executed by private companies (Annex 3, Annex 6).

Operational overview of vector surveillance

For all vector groups, active surveillance is the primary type of surveillance. Passive surveillance is mostly implemented in the context of mosquito and tick vectors (Annex 3). Active surveillance is most commonly implemented country-wide for mosquitoes and biting midges, whereas the active surveillance of ticks and sand flies most often focuses on selected parts of the country. The main reason for implementing focused surveillance is linked to the focal nature of vector-borne disease, which is especially the case for tick-borne diseases (Table 6). The lack of human and financial resources and capacity is the main organisational reason mentioned by the respondents for limiting the implementation of surveillance to selected parts of the countries. This holds for all vector groups, but was most often mentioned in relation to mosquito and tick surveillance (Table 6).

Table 6. Number of times a reason for the implementation of vector surveillance in parts of the country was mentioned (summary of 30 answers to the open question)

Reason	Mosquitoes	Ticks	Sand flies	Biting midges
Epidemiological or vector-related				
Only in parts where vector-borne disease is endemic, where there is a risk of outbreaks	4	9	5	2
Distribution of the vector species is limited, so only focused surveillance	3	3	3	1
Focuses on presence and risk for hosts	0	0	0	2
At points of entry for vector or pathogen	3	0	0	0
To evaluate control programme	1	0	0	0
Organisational or resource-related				
Limited or lack of resources (both financially and human) or capacity	5	7	3	2
Done as research projects	1	5	1	1
Decision is sub-national (such as regions, communes) level	1	2	0	0
Surveillance targets the findings of citizen science	1	1	0	0
To complement citizen science	0	0	0	1

Most of the active vector surveillance is classified as 'limited in time' and this holds for all vector groups, despite 20 countries having an active mosquito surveillance plan that is embedded in a long-term strategy of disease risk assessment and control. Similar results were reported for passive surveillance (Annex 3, Annex 6).

The three most important aims linked to mosquito and tick surveillance are the assessment of the introduction of exotic vector species, outbreak investigation, and the assessment of the place and/or time of transmission risk. The latter was most often mentioned related to sand fly surveillance. For biting midges, the assessment of the vector-free period is important in 16 countries (Table 7). Norway mentioned that the overall aim of mosquito and biting midge surveillance was the increase of general knowledge of vectors after a long period of absence of any study on these vector groups.

In line with these objectives, most countries focus their mosquito and biting midge surveillance activities on the surveillance of vector presence, vector abundance and seasonality. For ticks and sand flies, the three most important activities are vector presence, seasonality and vector infection rate. Few countries look at vector behavioural traits (Annex 3, Annex 6). One country mentioned vector modelling, habitat suitability and impact of climate change on vectors as important activities.

Table 7. Number of countries indicating the aims of the vector surveillance.

Assessment of	Mosquitoes	Ticks	Sand flies	Biting midges
Introduction of exotic vector species	32	18	5	8
Outbreak investigation	23	17	9	15
Place and/or time of transmission risk	26	20	12	14
Vector-free period	15	11	7	16
Vector control interventions quality or efficiency	14	3	4	3
Other	4	2	0	1

Multiple answers per country were possible

Organisation of vector control

Is vector control implemented?

Over the period 2016–2020, mosquito control was implemented in 31 of the 43 countries. Twelve countries implemented tick control, seven sand fly control and nine biting midge control (Figure 5). In general, vector control is more often implemented in EU enlargement policy countries, European Neighbourhood Policy partner countries and the UK compared to EU/EEA countries. This is even more pronounced for tick, sand fly, and biting midge control (Table 8).

Figure 5. Overview of countries that implemented vector control, 2016–2020

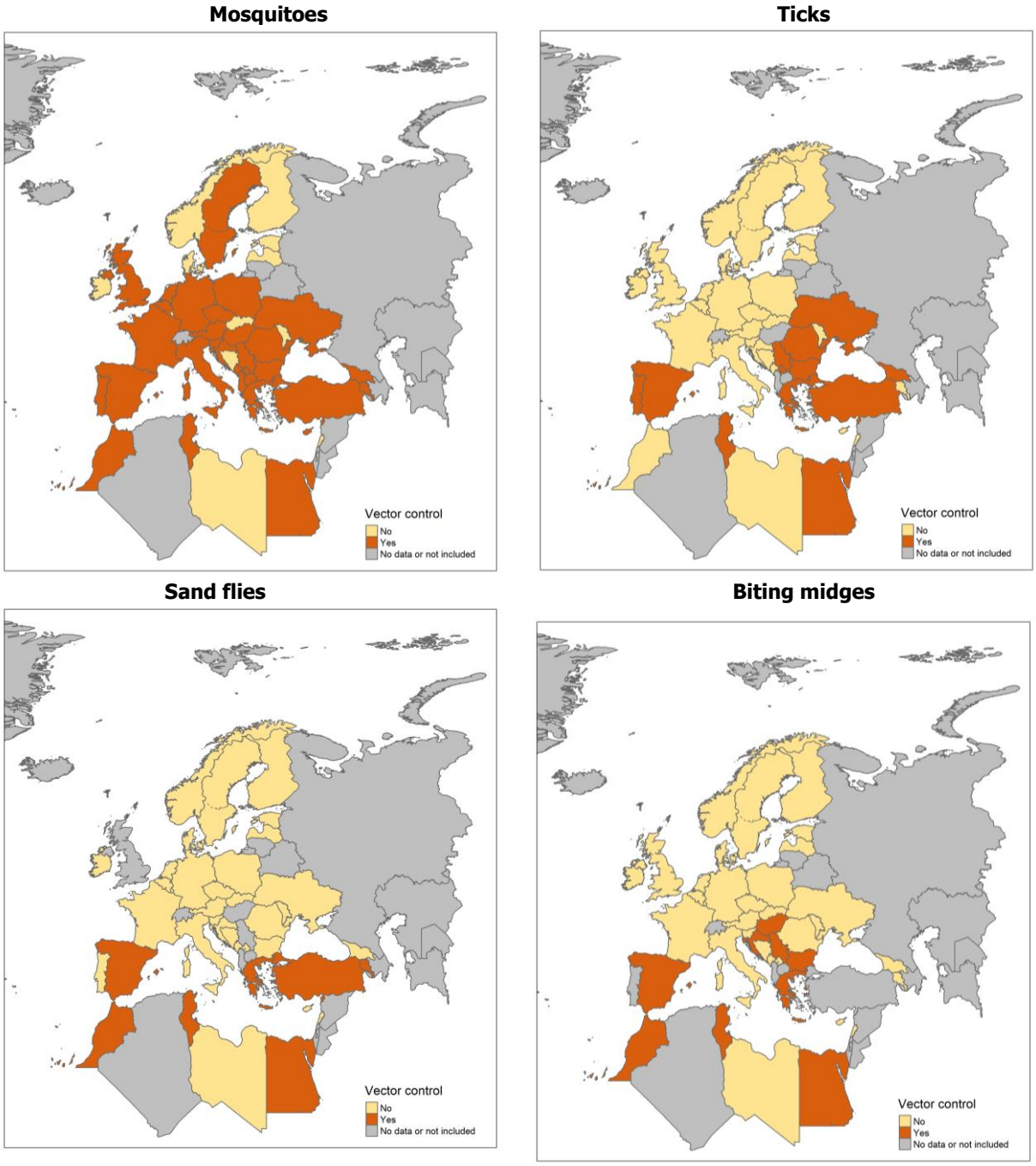


Table 8. Number and percentage of countries implementing vector control by vector group

Country group	n	Mosquitoes	Ticks	Sand flies	Biting midges
EU/EEA countries	26	18 (69%)	5 (19%)	2 (8%)	5 (19%)
EU enlargement policy countries, European Neighbourhood Policy partner countries and the UK	17	13 (76%)	7 (41%)	5 (29%)	4 (24%)

More than 90% of countries that are confronted with local transmission of mosquito-borne diseases (context 1a and 1b) perform vector control. This is around 30% for tick, sand fly and biting midge control (Table 9). The presence of an exotic mosquito vector triggers vector control in 40% of the countries (Table 9).

Table 9. Number and percentage of countries implementing vector control by context within the four disease groups

Vector group	Disease group*	Context**		
		1a and 1b	2 and 3	4 and 5
Mosquitoes	Mosquito-borne diseases	25/27 (93%)	6/15 (40%)	0/1
Ticks	Tick-borne diseases	11/34 (32%)	1/8 (13%)	0/17
Sand Flies	Sand fly-borne diseases	7/21 (33%)	0/6	0/16
Biting midges***	Biting midge-borne diseases	8/24 (33%)	1/14 (7%)	0/1

**Mosquito-borne diseases based on the contexts of West Nile virus infection in humans, West Nile virus infection in horses, dengue, chikungunya virus disease or Zika virus disease; Tick-borne diseases based on: Lyme borreliosis, tick-borne encephalitis, Crimean-Congo haemorrhagic fever; Sand fly-borne diseases: leishmaniasis in humans, leishmaniasis in dogs; Biting midge-borne diseases: bluetongue, Schmallenberg disease.*
***The contexts were grouped into: (1) contexts 1a and 1b representing a situation with local transmission; (2) contexts 2 and 3 referring to a situation where the vector is present; and (3) contexts 4 and 5 reflecting a situation where the vector is absent.*
****Four countries with missing information on disease context. These countries do not implement vector control.*

The three most important reasons for the absence of vector control were:

- the absence of reliable vector control options;
- the absence of a legal framework within which control can be organised;
- a lack of resources.

The latter was mentioned most often in relation to mosquito, sand fly and biting midge control. For the absence of tick control, countries most often referred to the absence of reliable vector control options (Annex 4). Belgium mentioned that the recent development of a control plan stopped due to the COVID-19 pandemic. In the UK, tick control is performed as a private initiative by farmers and pet owners, and in Denmark, there has never been any mosquito control, hence the country has no experience with control. The most mentioned reasons for implementing vector control are that the vector potentially transmits pathogens of public or veterinary importance and that control contributes to the response to and control of vector-borne diseases. Three countries (Czechia, Poland and Sweden) also indicated the importance of mosquito control to mitigate nuisance. In the context of mosquito control, France, Hungary, Morocco, the Netherlands, Turkey and the UK have a legal framework that regulates the 'right to enter private property'. Three countries (Croatia, France and the Netherlands) have a regulation on tyre companies, and Austria and the Netherlands refer to specific regulations on the import of goods. In Greece, the Ministry of Health recommends vector control and public awareness campaigns for control in private areas.

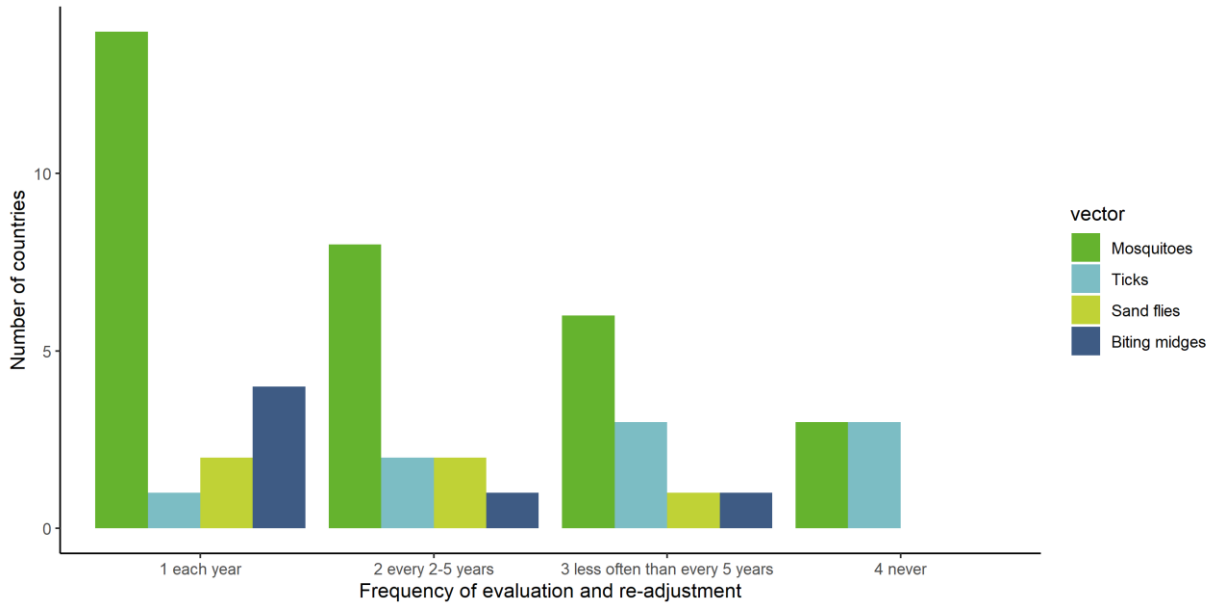
Who is responsible and implements vector control?

In line with the situation regarding vector surveillance, in most countries for which information is available, the Ministry of Health is responsible for the control of vectors that can transmit pathogens of human importance. Likewise, the Ministry of Agriculture oversees the control of vectors responsible for pathogen transmission of animal importance (Annex 4, Figure 11, Annex 6). Other responsible entities mentioned by the countries are:

- In **Greece**, regional authorities (Regional General Directorates of Public Health) and municipal authorities are responsible for mosquito control programmes in the field (regions and municipalities are partially funded and supervised by the Ministry of Interior). The Ministry of Health publishes a circular regarding vector control (on an annual basis) enforcing regional and local authorities to conduct integrated mosquito control programmes. The Ministry of Rural Development and Food is responsible for the biocides authorisations. There is an intersectoral National 'Committee for the Prevention and Management of Tropical Diseases' of the Ministry of Health, which addresses public health policy on vector-borne diseases management, and consults on emergency response vector control treatments.
- In **Lebanon**, vector control in the context of WNV, dengue, chikungunya virus disease and Zika virus disease, and leishmaniasis is done at the municipality level.
- In **Serbia**, vector control is a responsibility of the Ministry of State and Local Administration at National level and the Provincial Secretariat for Urban Planning and environment protection (primarily WNV, but also Lyme borreliosis and tick-borne encephalitis).
- In **Sweden**, the Environmental and Health Protection Boards in the municipalities are responsible for control of vectors.
- In the **UK**, **Montenegro** and **Turkey**, local authority or municipalities are responsible for vector control.
- In **Morocco,** it is the Ministry of Interior (WNV and leishmaniasis), in **Georgia** the National Centre for Disease Control and Public Health (WNV, and dengue, chikungunya virus disease and Zika virus disease) and in **France** the Ministry of the Interior at subnational level is responsible in cases of large outbreaks of dengue, chikungunya virus disease or Zika virus disease in close collaboration with 'Agences régionales de santé' (Health Regional Agency, which are representative of the Ministry of Health at subnational level).

The design of mosquito and tick control plans is in most countries is the responsibility of public or veterinary health agencies as well as working groups within or between ministries (Annex 4, Annex 6). Regarding sand fly and biting midge control, most countries refer to working groups within a Ministry for the design of the control plan. The same organisation responsible for the design is generally also responsible for the evaluation and possible re-adjustment of the control plan. The readjustments are done regularly (i.e. each year or every two to five years) for all vector groups except ticks (Figure 6).

Figure 6. Number of countries implementing vector control that evaluate and readjust their vector control plan



In about half of the countries, mosquito and sand fly control is designed at sub-national level (mosquitoes: 23/31; sand flies: 4/7). Tick control is more often designed at sub-national level (9/12) whereas for biting midges, this is the opposite (3/9). In about half of the countries, vector control (except for biting midges) is limited in time (Annex 4).

The execution of mosquito control is most often done by private companies (in 17 countries), but public or veterinary health agencies play an important role in the execution of mosquito control. Tick control is often executed by private companies, whereas biting midge control is more often executed by public or veterinary health agencies (Annex 4).

Operational overview of vector control

The reported 'aim and scope of vector control' is tabulated in Table 10. Control of ticks and biting midges focuses very much on the control of local transmission or outbreaks. Reducing nuisance is also an important aim in mosquito and tick control. Different types of control methods are implemented and used. For the control of immature stages of mosquitoes, both biocidal and non-biocidal interventions are applied. Adult mosquito control is primarily based on the application of biocides (Table 11).

Table 10. Number of countries indicating the aims of the vector control. Multiple answers per country were possible

Aim or scope	Mosquitoes	Ticks	Sand flies	Biting midges
Nuisance control	23	7	2	1
Prevent introduction and establishment of exotic vector species	16	1	1	1
Lower the likelihood of local transmission	21	10	5	7
Outbreak control	18	5	6	9

Table 11. Number of countries indicating the types of vector control implemented. Multiple answers per country were possible

Aim or scope	Mosquitoes	Ticks	Sand flies	Biting midges
Targeting immature stages using biocides	25	6	1	0
Targeting immature stages using non-biocidal intervention	19	1	1	0
Targeting the vector by treating the animal host	3	7	3	5
Targeting adults using biocides	21	6	5	5
Targeting adults using non-biocidal intervention	4	3	2	2
Environmental management	15	3	3	2
Targeting adult stages using innovative methods	2	1	1	0
Formalised social mobilisation programme	6	1	2	2
Other	3	0	0	O

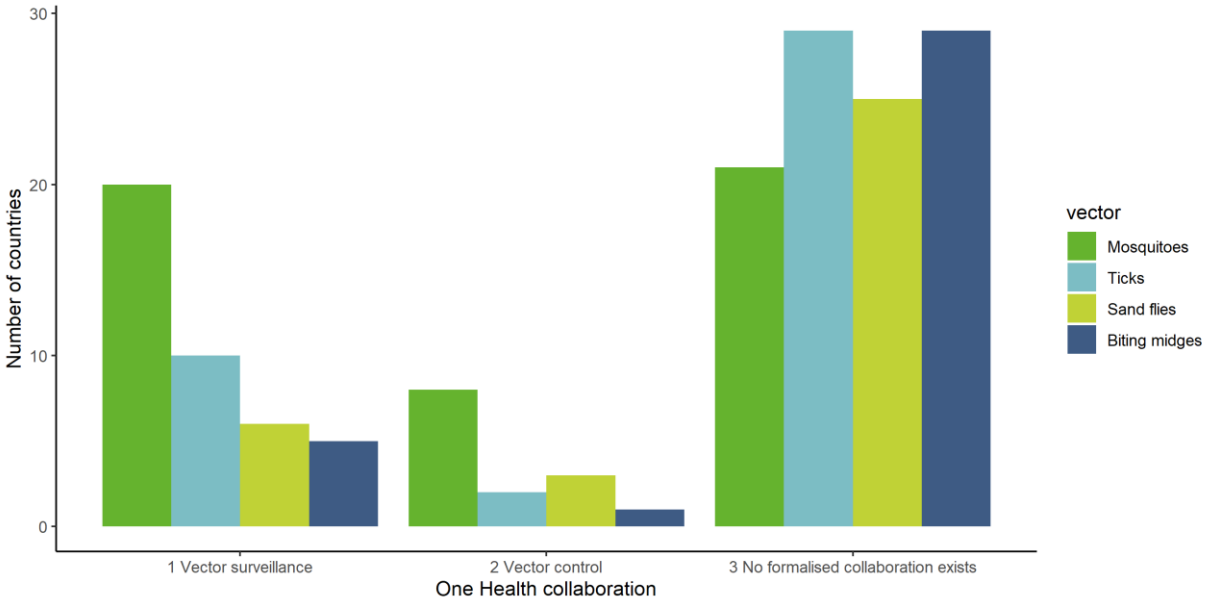
'One Health' aspect of vector surveillance and control

The formal intersectoral collaboration between public and veterinary health sectors is more often present for vector surveillance than for vector control. Comparing among the vector groups, more formalised collaboration is present in the context of mosquito surveillance and control (Figure 7). The formal collaboration with the environmental sector is most often absent for all vector groups (Annex 5). In Belgium, the collaboration between the Ministry of Health and the Ministry of Environment is formalised through an inter-ministerial working group called NEHAP. In Italy, there is an Intersectoral Technical Committee for vector-borne diseases, coordinated by the Ministry of Health. In Denmark, veterinary preparedness is operated by a consortium (of the University of Copenhagen and the State Serum Institute).

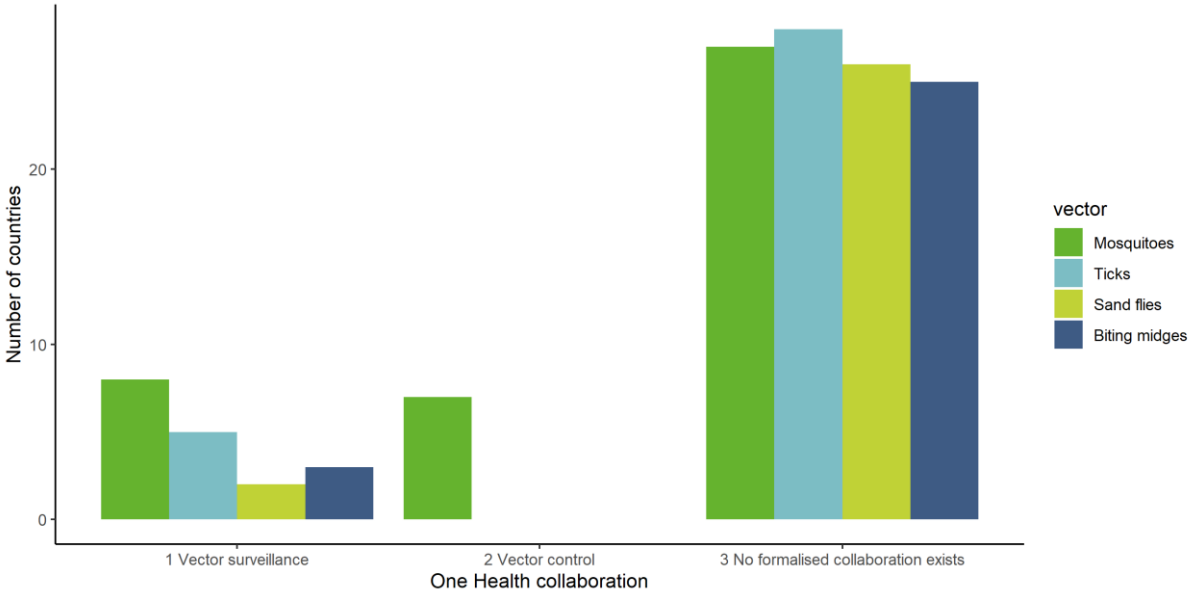
Where collaboration is present between the public and veterinary sectors, it is most often in the areas of data sharing and communication, and to a lesser extent in data analysis, vector surveillance design and data collection. The collaboration with the environmental sector most often concerns biocide regulation.

Figure 7. Number of countries with a formalised 'One Health' collaboration in the area of vector surveillance or control

A. Collaboration between public and veterinary health sectors



B. Collaboration between the health sectors (public and veterinary health) and the environmental sector



Challenges related to vector surveillance and control

Table 12 and Table 13 provide an overview of the challenges respondents listed in relation to vector surveillance and control in their country. Lack of financial resources is most often mentioned related to vector surveillance. The second most important challenge is related to the lack and need of trained staff and human resources. The lack of adequate human resources was also identified as a specific challenge related to vector control. The development of multisectoral collaboration in the context of vector surveillance and the operationalisation of this collaboration was mentioned by five countries as a specific challenge related to vector surveillance. For vector control, the countries identified the need for the development of guidance, principles and targets for control.

Table 12. Overview of number of countries indicating a specific challenge related to vector surveillance (summary of 24 answers to the open question)

Category	Topic	Number	Comment
Resources	Lack of funding	9	
	Lack and need of trained staff and human resources	8	
Responsibilities	Absence/need for dedicated agency for vector surveillance	2	This would help to further develop and maintain expertise in the country
	Low awareness among authorities	3	
	Lack of clarity about competencies (who is responsible for what)	1	
Coordination and collaboration	Lack of (national) coordination	1	
	Need for development of multisectoral collaboration and operationalise this collaboration	5	Specifically mentioned is the further development of guidelines and framework for 'One Health' approach
	Need for more communication between surveillance and control teams	1	
Operational considerations	Need for a long-term vector surveillance plan	2	
	Need for citizen science adapted to local context	2	
	Identification of critical points for surveillance	1	
	Development of early warning for vector-borne diseases outbreaks	1	
	Consider other vector groups (such as Simuliidae, soft ticks)	1	

Table 13. Overview of number of countries indicating a specific challenge related to vector control (summary of 19 answers to the open question)

Category	Topic	Number	Comment
Resources	Lack or insufficient funding to implement vector control	1	
	Lack of trained staff or human resources	5	
	Need to develop knowledge on vector control	1	
	Need to cope with changes related to entomological and epidemiological situation; expertise is not always available or adequate	3	e.g. challenges related to invasive species
Responsibilities	Need for long-term engagement by different stakeholders	1	
	Lack of clarity about competencies (Who is responsible for what?)	2	
	Need for international collaboration and support from ECDC, EFSA, World Health Organization	1	
Coordination and collaboration	Link between surveillance and control is not always adequate	1	
	Lack of collaboration between academic institutes and health institutes	1	
	Need for better national coordination	2	
	Need for improved community involvement	1	
	Development of intersectoral collaboration	3	
Legislation, Regulation	Limited flexibility of procurement and legislation	1	
	Limited number of biocides	1	
	Regulatory constraints that prevent areas from being treated	1	
Operational considerations	Need for vector control guidance/principles/targets	4	e.g. not always clear which control methods should be used in which situation e.g. need for clear criteria for action and defined strategies, develop plan
	Need for (better) evaluation of vector control interventions	4	
	Need for innovative vector control means, tool and strategies	1	The current available control methods might not be adequate in the future
	Possible problem of insecticide resistance	1	

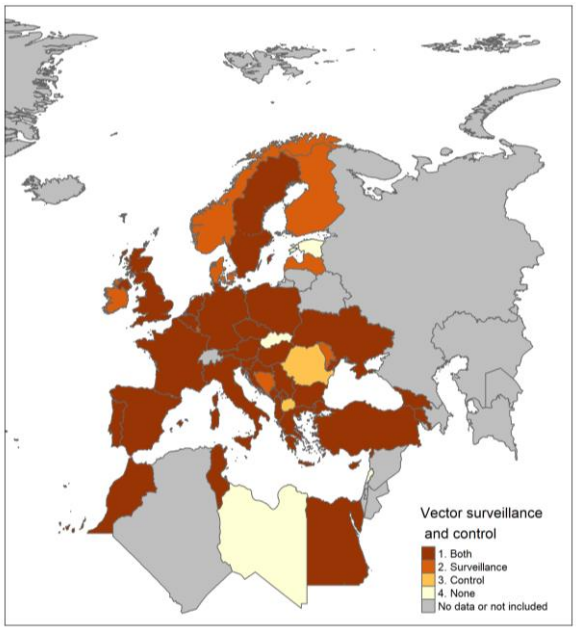
Discussion

Vector surveillance and control are most often implemented in the context of mosquitoes and mosquito-borne diseases in the EU/EEA countries, EU enlargement policy countries, European Neighbourhood Policy partner countries and the UK (Figure 8). The presence of vector mosquitoes, (even) in the absence of autochthonous transmission is a reason for implementing control in 87% of the countries. This is especially important in the context of invasive mosquito control, where timely detection and implementation of vector control can slow down the establishment of exotic mosquito species [15]. Tick surveillance is implemented in most countries (n=33/43), whereas tick control is limited to 12 (mostly non-EU/EEA countries). The absence of tick control is probably related to the lack of reliable vector control methods and strategies, as indicated by 18 out of 31 countries that did not implement tick control. Other important reasons mentioned were the lack of a legal framework within which control can be organised, and the lack of resources. The control of diseases transmitted by *Ixodes ricinus* is primarily based on reducing exposure to tick bites by education and communication, rapid removal of ticks, and/or spot-on endectocides for pets. Various options are available to control ticks in the environment, but the evidence base for these control methods is not well established [16]. In public health, education and communication plays a key role in many strategies of tick control. In general, control of tick and tick-borne disease needs to take the complex ecological cycle of tick-borne diseases into account. This requires multidisciplinary and multisectoral approaches in the control of these diseases [17]. Sand fly surveillance and control is more limited in its geographical scope than surveillance and control for mosquitoes and ticks, which is related to the more southern distribution of sand flies and sand fly-borne diseases in Europe. Biting midge surveillance is more often implemented in EU/EEA countries (62%) compared to EU enlargement policy countries, European Neighbourhood Policy partner countries and the UK (47%), which is most probably a consequence of the specific EU/EEA regulation on biting midge surveillance [18]. Apart from lack of resources, lack of reliable vector control options and absence of legal frameworks were also important explanations for vector control not being implemented against sandflies and biting midges. Detailed information on vector surveillance efforts at subnational administrative unit level has recently been made available on ECDC's website [19-22]. Some discrepancies between the data presented in this report and the vector surveillance maps are apparent. The data in this report are based on the responses of the VEN using the definition provided in Table 1, whereas the surveillance maps also display efforts of scientific or research groups, independent from authorities, or agencies generating data to which the authorities might or might not have timely access. This points to an important challenge regarding vector surveillance where many actors are involved and legal frameworks are not always in place to integrate all data sources.

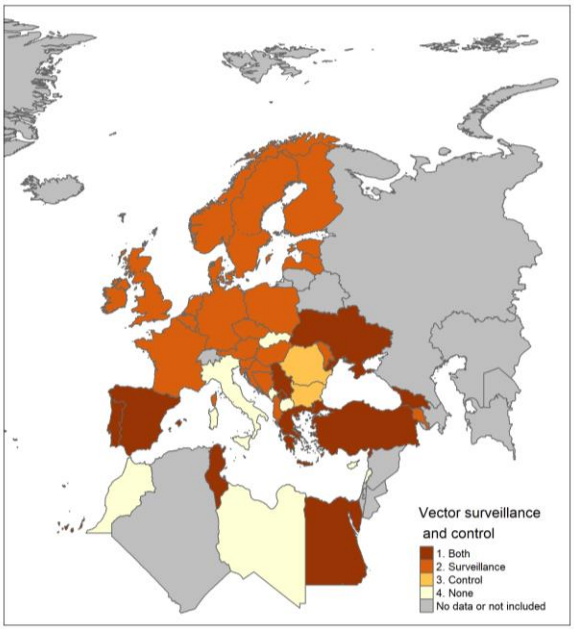
Annex 6 of this report provides a detailed overview of the ministries, agencies, institutions and organisations at the three organisational levels that were considered in the organisation of vector surveillance and control. Overall, in many countries, the Ministry of Health is responsible for the surveillance and control of vectors that transmit pathogens of human importance. Likewise, in many countries, the Ministry of Agriculture oversees the surveillance of vectors responsible for pathogen transmission of animal importance. In a few countries, this responsibility is shared among two or more ministries. Public or veterinary health agencies, or scientific or academic institutes are mainly responsible for decision-making, planning and evaluation for both vector surveillance and control. For implementation, apart from the above actors, private companies are also involved. This is mainly the case for activities related to mosquitoes. Interestingly, the design of vector surveillance is most often done at national level, whereas the design of vector control is often done at sub-national level. A plausible explanation is that surveillance requires more standardised methods for comparable results, while control needs to be more adopted to local conditions and resources.

Figure 8. Overview of the countries that implemented vector surveillance and control in period 2016–2020

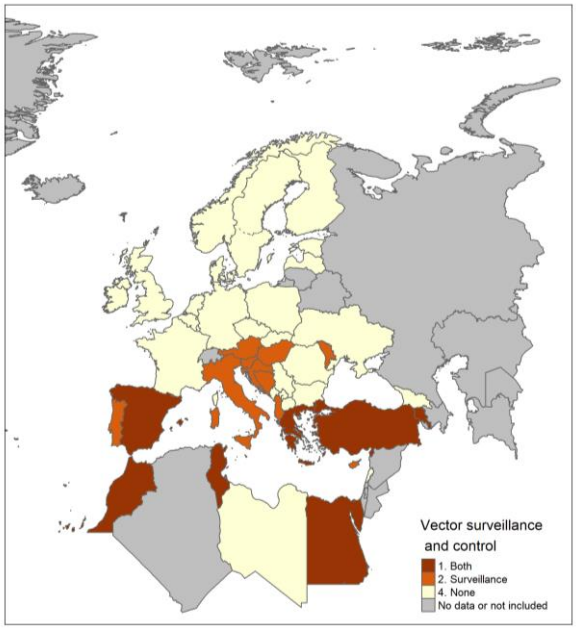
Mosquitoes



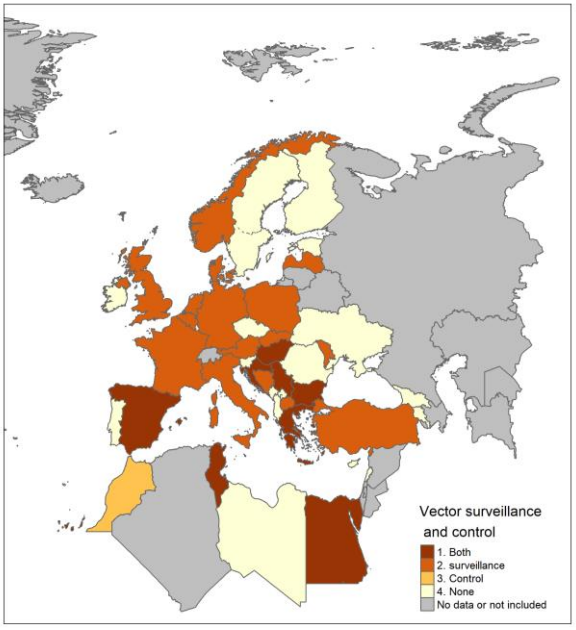
Ticks



Sand flies



Biting midges



The most prominent limiting factor for vector surveillance and control, mentioned by the respondents, is the lack of funding and trained professionals. The expertise that was mentioned to be lacking are the skills:

- to correctly identify vector species (e.g. mosquitoes and biting midges);
- to select the most appropriate surveillance sites and methods;
- to select the best control strategies taking into account the local situation and context. Several respondents mentioned the need for vector control guidance identifying the principles, targets and criteria for action.

A challenge mentioned by many countries was the lack of inter-governmental and inter-institutional cooperation. This being the collaboration between veterinary and/or public health institutions of both national and local authorities as well as the communication between vector surveillance and vector control operators. This questionnaire also pointed to the fact that many stakeholders are involved in vector surveillance and control making coordination and collaboration a key element for success. Governmental complexity and low awareness among policy makers was mentioned as some of the limiting factors in the sustained organisation and implementation of vector control and surveillance.

Most of the active vector surveillance is classified as 'limited in time' and this holds for all vector groups, despite 20 countries having an active mosquito surveillance plan that is embedded in a long-term strategy of disease risk assessment and control. We think however that the development of long-term sustainable vector surveillance would require but also offer the opportunity to build durable entomological capacity of e.g. trained professionals. Long-term vector surveillance will also provide more valuable data. To complement the active surveillance done by trained professionals, passive surveillance is implemented in many countries, primarily related to mosquito and tick surveillance, but also to sand flies and biting midges. The AIMSurv initiative [23] combines active and passive surveillance in multiple countries in Europe to survey invasive *Aedes* mosquitoes.

The active surveillance is implemented based on a standardised protocol implemented in the different countries [23] whilst the passive surveillance is citizen science based, implemented through the mobile phone app 'Mosquito Alert' [24]. A few countries indicated that the currently available citizen science platforms need to be adapted to their local context.

It was often mentioned that the different roles and responsibilities in vector control are not clearly defined. This complicates the development of control procedures, guidelines and frameworks. Further, the necessity to implement quality assurance and quality control of the control operations was highlighted by the respondents. This as well, depends heavily on inter-institutional communication and information and data sharing.

The changing epidemiological situation in EU/EEA countries, EU enlargement policy countries, European Neighbourhood Policy partner countries and the UK, with the continuing spread of exotic vector species and the emergence of vector-borne diseases that were absent in the (recent) past, poses another challenge to vector surveillance control practices. Countries that are not familiar with vector surveillance and control may have to build up their expertise and experience. Further, the currently available control methods might be insufficient to cope with these challenges and innovative control tools and methods might be needed in the future.

In response to increased vector-borne disease burden in the last decade, some countries like Greece and Italy gained experience in preparedness and response related to mosquito-borne diseases management and prevention. Less experienced countries can learn from these experiences. This questionnaire triggered some discussion in countries as they were filling it out and prompted, for example, a meeting in Finland between different stakeholders. This shows the potential interest and possible engagement in vector surveillance and control in the countries.

Conclusions and potential implications

This report provides and overview of the organisation of vector surveillance and control in the EU/EEA countries, EU enlargement policy countries, European Neighbourhood Policy partner countries and the UK, and highlights challenges and opportunities. The changing epidemiological situation of vector-borne diseases in Europe results in countries not being familiar with vector surveillance and control having to build up their expertise and experience. Also, the currently available control options might not be sufficient to cope with these new challenges. As indicated by one of the respondents 'vector surveillance and control needs a multi-disciplinary approach' and necessitates coordination and collaboration between the different organisational levels. Hence, the following key points need to be considered:

- Expertise and experience in vector surveillance and control varies widely among countries. Sharing expertise and experience among countries would be pivotal to develop the necessary expertise across EU/EEA countries, EU enlargement policy countries, European Neighbourhood Policy partner countries and the UK.
- Vector surveillance and control in the context of vector-borne diseases involve many stakeholders. Improving the coordination, beyond data sharing and communication, would improve the integration, sustainability and quality of vector surveillance and control.

- It would be of value to develop a long-term perspective for sustainable vector surveillance and control at national and international levels. This would aid the building and maintenance of capacity and expertise in countries and in Europe as a whole, and would improve the preparedness, response and resilience of countries to cope with vector-borne diseases.
- The development of guidance on vector control, including aspects of criteria for action, control strategies and organisational issues, would help countries to improve and implement vector control in a smart and targeted way.
- Given the currently limited number of available control options, and/or insufficient evidence about their reliability, research is needed on innovative vector control methods and tools to be able to cope with the future challenges of vector-borne diseases.
- Monitoring implemented on the initiative of research groups should be folded into national programmes and research teams should be strongly encouraged to send their data to the national authorities.
- As limited financial and human resources were frequently specified as bottlenecks for surveillance and control activities, the public health benefits of these activities should be clearly demonstrated to (political) decision makers, as well as the differences in environmental and financial costs of the different control methods.

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Annex 1. Questionnaire

PART 1. Name of respondent	
Would you like to be acknowledged in the report for responding to the questionnaire?	
	1.1. Name; 1.2. Country; 1.3. Email; 1.4. Affiliation; 1.5. Role/function within your organisation; 1.6. Who did you consult to complete this questionnaire? Please provide name, institution and role/function of the institution
PART 2. Epidemiological situation	
2.1.a Indicate in which context your country is situated related to these vector-borne diseases of public health importance over the last five years based on the scheme and definitions above. Only one context can be chosen per disease.	
	West Nile virus infection in humans; Dengue, chikungunya virus infection or Zika; Lyme borreliosis; Tick-borne encephalitis; Crimean-Congo Haemorrhagic fever; Leishmaniasis in humans
2.1.b Indicate in which context your country is situated related to these vector-borne diseases of veterinary health importance over the last five years based on the scheme and definitions above. Only one context can be chosen per disease.	
	West Nile virus infection in horses; Leishmaniasis in dogs; Bluetongue; Schmallenberg
2.2. Is there another vector-borne disease not mentioned in the tables above which is important in your country and that triggers vector surveillance or control?	
	Disease 1, Context 1; Disease 2, Context 2
PART 3. Questions about vector surveillance	
3.1. In the last 5 years (2016-2020), is any type of vector surveillance implemented in your country (regardless of where it is implemented, at national or sub-national level) for any of the following vector groups?	
	Mosquitoes; Ticks; Sand flies; Biting midges
3.2. If NOT, please specify the reason why vector surveillance is not implemented in your country. Multiple reasons per vector group are possible.	
	1. Vector-borne disease(s) transmitted by this vector group is NOT a public or veterinary health problem/priority in the country; 2. Vector surveillance does not contribute to response and control of vector-borne diseases; 3. There is no legal framework within which vector surveillance can be organised; 4. There is a lack of resources to implement vector surveillance; 5. Other (please specify - for each vector group)
3.3. If YES, please specify the reason why surveillance is implemented. Multiple reasons per vector group are possible.	
	1. Vector-borne diseases transmitted by this vector group are a public or veterinary health problem/priority in the country; 2. Vector surveillance informs response and control of vector-borne diseases; 3. Vector surveillance is needed to assess the introduction and spread of invasive vector species; 4. There is a legal obligation; 5. Other (please specify for each vector group)
3.4. If vector surveillance is implemented in a context of a legal framework, can you specify following. Multiple reasons per vector group are possible.	
	1. Related to the International Health Regulation of surveillance at points of entry; 2. Embedded in a legal framework on diseases surveillance in the country; 3. Based on a specific legislation on vector surveillance in the country; 4. Other (please specify, for each vector group)
3.5. Which ministry is responsible for vector surveillance? Here we ask the ministry that has the overall responsibility and oversight of vector surveillance and is legally bound to it. Multiple ministries per disease (group) are possible if the responsibility is joint. Organisational level 1 (Fig.1).	
	Please specify for each disease (West Nile virus infection in humans; Dengue, chikungunya virus infection or Zika; Lyme borreliosis; Tick-borne encephalitis; Crimean-Congo Haemorrhagic fever; Leishmaniasis in humans; West Nile virus infection in horses; Leishmaniasis in dogs; Bluetongue; Schmallenberg): Ministry of Health at national level; Ministry of Agriculture of national level; Ministry of Environment at national level; Ministry of Health at sub-national level; Ministry of Agriculture at sub-national level; Ministry of Environment at sub-national level; Other (please specify for each disease)
3.6. Who designs the actual vector surveillance plan? Here we ask for the organization/agency that is responsible for designing a plan on "what, when, and where" needs to be done related to vector surveillance. Organisational level 2 (Fig.1).	
	1. Dedicated agency; 2. Working group within a ministry; 3. Working group between ministries; 4. Public/Veterinary health agency; 5. Scientific/Academic institution; 6. Private company or organisation; 7. Other (please specify for each vector group)
3.7. Specify which organization/agency is responsible for designing of the actual vector surveillance plan by providing the name of the agency and their website. It can be more than one if e.g. the design of the actual vector surveillance plan is at sub-national level. If you believe further explanation is necessary you can provide an extra comment.	
	Mosquitoes: Name, website, Comment; Ticks: name, website, Comment; Sand flies: Name, website, Comment; Biting midges: name, website, Comment
3.8. Who is responsible for the evaluation and possible re-adjustments of the vector surveillance plan? Multiple answers per vector group are possible.	
	1. The same organisation/agency that develops the surveillance plan; 2. Other (Please specify for each vector group)
3.9. How often is the evaluation and re-adjustment of the surveillance plan done?	
	1. Each year; 2. Every 2 – 5 years; 3. Less often than every 5 years; 4. Never
3.10. Is the surveillance plan designed at national or at sub-national level? A plan can be designed at national level, but targeting only specific areas e.g. points of entry or areas at risk for vector-borne diseases, but; in that case you should check 'national'.	
	1. National; 2. Sub-national
3.11. If vector surveillance is implemented, who executes the vector surveillance in your country? Here we ask for the organisation or agency that carries out the day-to-day vector surveillance activities. Organisational level 3 (Fig.1).	
	1. Dedicated agency; 2. Public/Veterinary health agency; 3. Scientific/Academic institution; 4. Private company or organisation; 5. Other (please specify for each vector group)

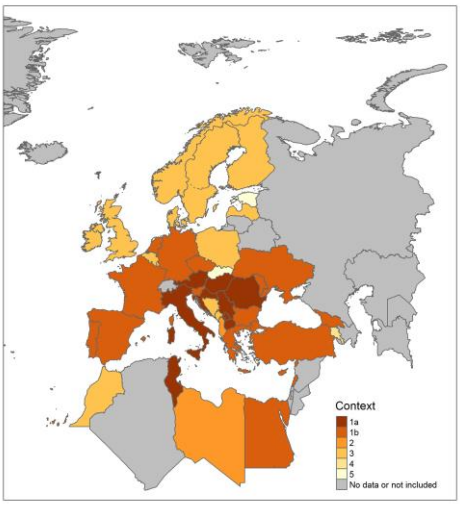
3.12. Specify which organizations/agencies are responsible for the execution of the vector surveillance. Provide their name and website. If you believe further explanation is necessary you can provide an extra comment.	
	Mosquitoes: Name, website, Comment; Ticks: name, website, Comment; Sand flies: Name, website, Comment; Biting midges: name, website, Comment
3.13. What type of vector surveillance is implemented in your country? See definition of active and passive surveillance above.	
	1. Active; 2. Passive
3.14. Where is vector surveillance implemented?	
	ACTIVE surveillance: 1. Country wide; 2. Certain parts of the country PASSIVE surveillance: 1. Country wide; 2. Certain parts of the country
3.15. If vector surveillance is implemented in certain parts of the country (active of passive), please specify why.	
	Mosquitoes; Ticks; Sand flies; Biting midges
3.16. How do you classify vector surveillance in your country?	
	ACTIVE surveillance: 1. Limited in time (e.g. project based); 2. Embedded in a long-term (>3 years) strategy of disease risk assessment and control PASSIVE surveillance: 1. Limited in time (e.g. project based); 2. Embedded in a long-term (>3 years) strategy of disease risk assessment and control
3.17. What do vector surveillance activities assess in your country? Multiple answers per vector group are possible	
	1. Vector presence; 2. Vector abundance; 3. Vector seasonality; 4. Vector infection rate; 5. Vector behavioural traits; 6. Other (please specify for each vector group)
3.18. What is the overall aim of vector surveillance in your country? Multiple answers per vector group are possible.	
	1. Introduction of exotic vector species; 2. Outbreaks and outbreak investigation; 3. Place and/or time of transmission risk; 4. Vector-free period; 5. Vector control interventions quality/efficiency; Other (please specify for each vector group)
PART 4. Questions about vector control	
4.1. In the last 5 years (2016–2020), is any type of vector control implemented in your country (regardless of where it is implemented, at national or sub-national level) for any of the following vector groups?	
	Mosquitoes; Ticks; Sand flies; Biting midges
4.2. If NOT, please specify the reason why vector control is not implemented in your country. Multiple answers per vector group are possible.	
	1. The vector species group is not present; 2. Vector-borne disease(s) transmitted by this vector group is not considered a public or veterinary health problem; 3. We don't have reliable vector control options for this vector group; 4. There is no legal framework within which control can be organised; 5. There is a lack of resources to implement vector control; 6. Other (please specify for each vector group)
4.3. If YES please specify the reason. Multiple answers per vector group are possible.	
	1. Vector-borne disease(s) transmitted by this vector group is a public and/or veterinary health problem; 2. Vector control contributes to the response and control of vector-borne diseases; 3. There is a legal obligation; 4. Other (please specify for each vector group)
4.4. If vector control is implemented, can you specify following.	
	1. Related to the International Health Regulation of surveillance and control at points of entry; 2. Embedded in a legal framework on diseases surveillance and control in the country; 3. Based on a specific legislation on vector control of the country; 4. Other (please specify for each vector group)
4.5. Does the legal framework provide certain tools or rights facilitating vector control? Multiple answers per vector group are possible.	
	1. The right to enter private property; 2. Tyre recycling regulation (e.g. storage regulations); 3. Importation regulations; 4. Other (please specify for each vector group)
4.6. Which ministry is responsible for vector control? Here we ask the ministry that has the overall responsibility and oversight of vector control and is legally bound to it. Multiple ministries per disease (group) are possible if the responsibility is joint. Organisational level 1 (Fig.1).	
	Please specify for each disease (West Nile virus infection in humans; Dengue, chikungunya virus infection or Zika; Lyme borreliosis; Tick-borne encephalitis; Crimean-Congo Haemorrhagic fever; Leishmaniasis in humans; West Nile virus infection in horses; Leishmaniasis in dogs; Bluetongue; Schmallenberg): Ministry of Health at national level; Ministry of Agriculture of national level; Ministry of Environment at national level; Ministry of Health at sub-national level; Ministry of Agriculture at sub-national level; Ministry of Environment at sub-national level; Other (please specify for each disease).
4.7. If vector control is implemented, who designs the actual control plan? Here we ask for the organization/agency that is responsible to design a plan on "what, when, and where" needs to be done regarding vector control. Organisational level 2 (Fig.1)	
	1. Dedicated agency mandated by law; 2. Working group within a ministry; 3. Working group between ministries; 4. Public/Veterinary health agency; 5. Scientific/Academic institution; 6. Private company or organisation; 7. Other (please specify for each vector group).
4.8. Specify which organisation/agency is responsible for the design of the vector control plan by providing the name of the agency and the website. If you believe further explanation is necessary you can provide an extra comment.	
	Mosquitoes: Name, website, Comment; Ticks: name, website, Comment; Sand flies: Name, website, Comment; Biting midges: name, website, Comment
4.9. Who is responsible for the evaluation and possible re-adjustments of the vector control plan?	
	1. The same organisation/agency that develops the control plan; 2. Other
4.10. If OTHER, please specify which organization/agency that is responsible for the evaluation and possible re-adjustments. Provide the name of the agency and their website. If you believe further explanation is necessary you can provide an extra comment.	
	Mosquitoes: Name, website, Comment; Ticks: name, website, Comment; Sand flies: Name, website, Comment; Biting midges: name, website, Comment
4.11. How often is the evaluation and re-adjustment of the vector control plan done?	

	1. Each year; 2. Every 2 – 5 years; 3. Less often than every 5 years; 4. Never
4.12. Is the vector control plan designed at national or at sub-national level?	
	1. National; 2. Sub-national
4.13. How can you classify vector control in your country?	
	1. Limited in time (e.g. project based); 2. Embedded in a long-term strategy (> 3 years) of disease risk assessment and control
4.14. Who is in charge of the execution of the vector control in your country? Here we ask who carries out the day-to-day activities of vector control. Organisational level 3 (Fig.1).	
	1. Dedicated agency; 2. Public/Veterinary health agency; 3. Scientific/Academic institution; 4. Private company or organisation; 5. Other (please specify for each vector group)
4.15. Specify which organisation/agency is responsible for the execution of the vector control. Please provide the name of the organisation/agency and their website. Can be more than one if e.g. the execution of the vector control is at sub-national level. If you believe further explanation is necessary you can provide an extra comment.	
	Mosquitoes: Name, website, Comment; Ticks: name, website, Comment; Sand flies: Name, website, Comment; Biting midges: name, website, Comment
4.16. What type of vector control is implemented in your country? Multiple answers per vector group are possible.	
	1. Targeting immature stages using biocides (including Bti); 2. Targeting immature stages using non-biocidal intervention (such as source reduction and biological control); 3. Targeting the vector by treatment of the animal host (e.g. poor-on treatment, but also collars); 4. Targeting adults using biocides; 5. Targeting adults using non-biocidal intervention (such as mass trapping); 6. Environmental management; 7. Targeting adult stages using innovative methods such as SIT; 8. Formalised social mobilization program; 9. Other (please specify for each vector group)
4.17. What is the overall aim/scope of vector control in your country? Multiple answers per vector group are possible.	
	1. Nuisance control; 2. Prevent introduction and establishment of exotic vector species; 3. Lower the likelihood of local transmission; 4. Outbreak control; 5. Other (please specify for each vector group)
PART 5. Questions about One Health aspects of vector surveillance and control.	
5.1. Is there a formalised collaboration between public and veterinary health sector related to vector surveillance or vector control? Multiple answers per vector group are possible.	
	1. Vector surveillance; 2. Vector control; 3. No formalised collaboration exists
5.2. If yes, please specify the area(s) of collaboration for each vector group. Multiple answers per vector group are possible.	
	1. Vector surveillance design; 2. Vector control design; 3. Data collection; 4; Data sharing (e.g. on Pathogen circulation in hosts or surveillance data); 5. Data management or/and storage; 6. Data analysis and interpretation; 7. Communication; 8. Other (please specify for each vector group)
5.3. Is there a formalised collaboration between public/veterinary health sector and the environmental sector related to vector surveillance or vector control? Multiple answers per vector group are possible.	
	1. Vector surveillance; 2. Vector control; 3. No formalised collaboration exists
5.4. If a formalised collaboration exists, please specify the area(s) of collaboration for each vector group. Multiple answers per vector group are possible.	
	1. Land use planning; 2. Biocides regulation; 3. Other (please specify for each vector group)
PART 6. Space for general comments and challenges.	
6.1. Please provide any additional information that you think is important for us to understand the organisation of vector surveillance in your country.	
6.2. Please provide any additional information that you think is important for us to understand the organisation of vector control in your country.	
6.3. Please provide any information related to the challenges and opportunities about the organisation of vector surveillance in your country.	
6.4. Please provide any information related to the challenges and opportunities about the organisation of vector control in your country.	

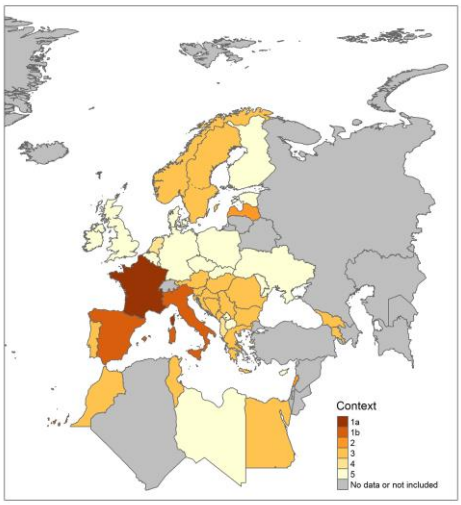
Annex 2. The epidemiological context of the selected vector-borne diseases

Figure 9. The epidemiological context of the selected vector-borne diseases

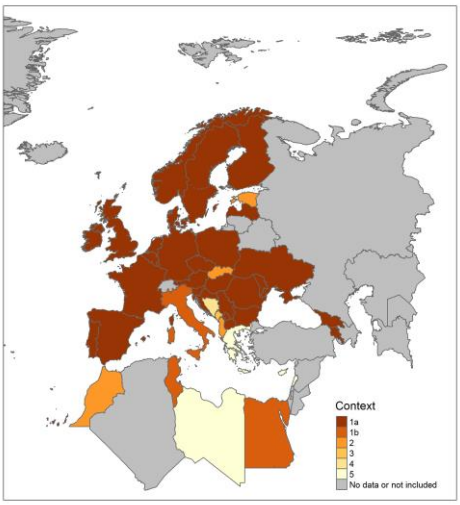
West Nile virus infection in humans



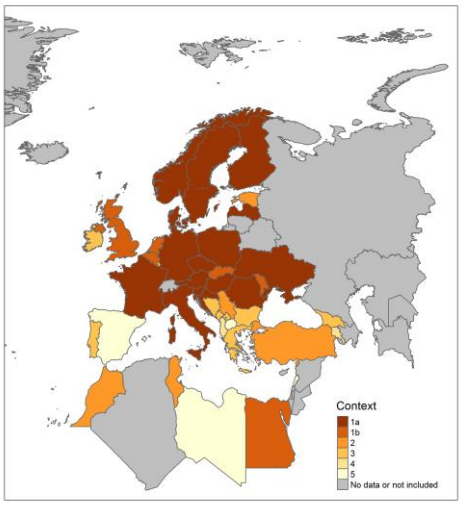
Dengue, chikungunya virus infection and Zika virus infections



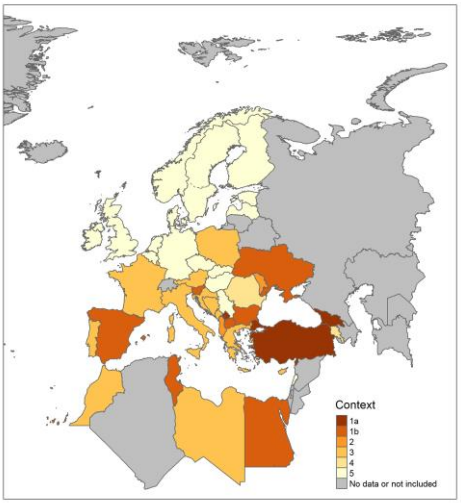
Lyme borreliosis



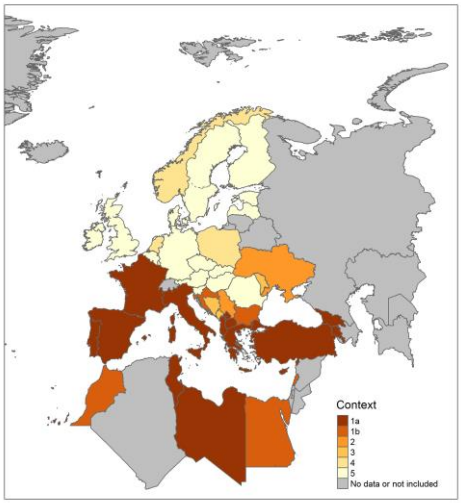
Tick-borne encephalitis



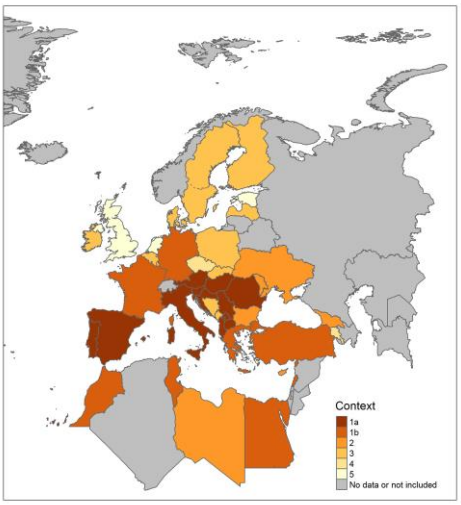
Crimean-Congo haemorrhagic fever



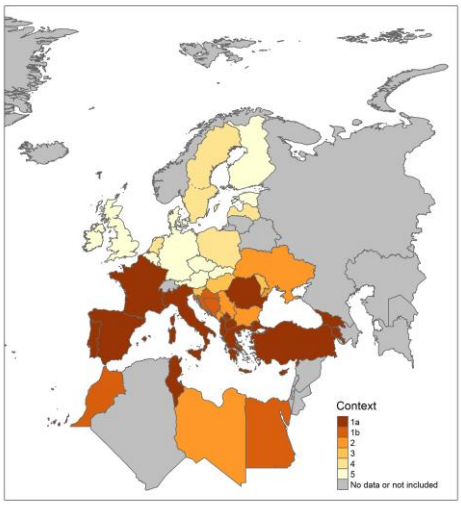
Leishmaniasis in humans



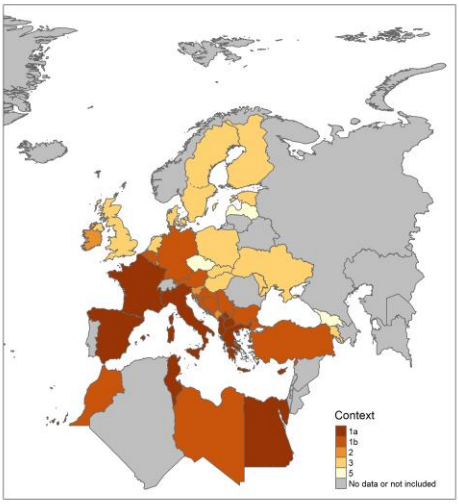
West Nile virus infection in horses



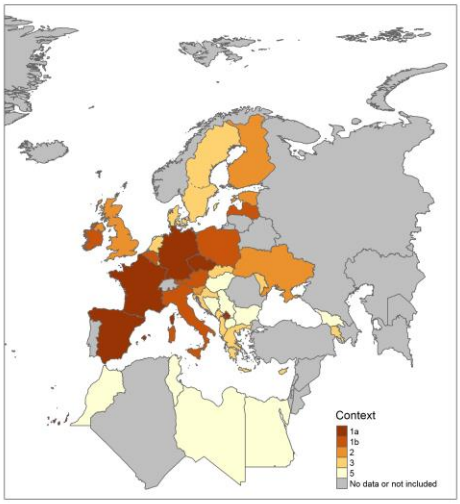
Leishmaniasis in dogs



Bluetongue



Schmallenberg



***Note**. Context: 1a. Local transmission every year over the last five years (2016–2020).; 1b. Sporadic local transmission i.e. single event or different events occurring during up to 4 years of local transmission out of the last five years; 2. Pathogen and vector are present; 3. Vector is present; 4. Pathogen is present; and 5. None of the above.*

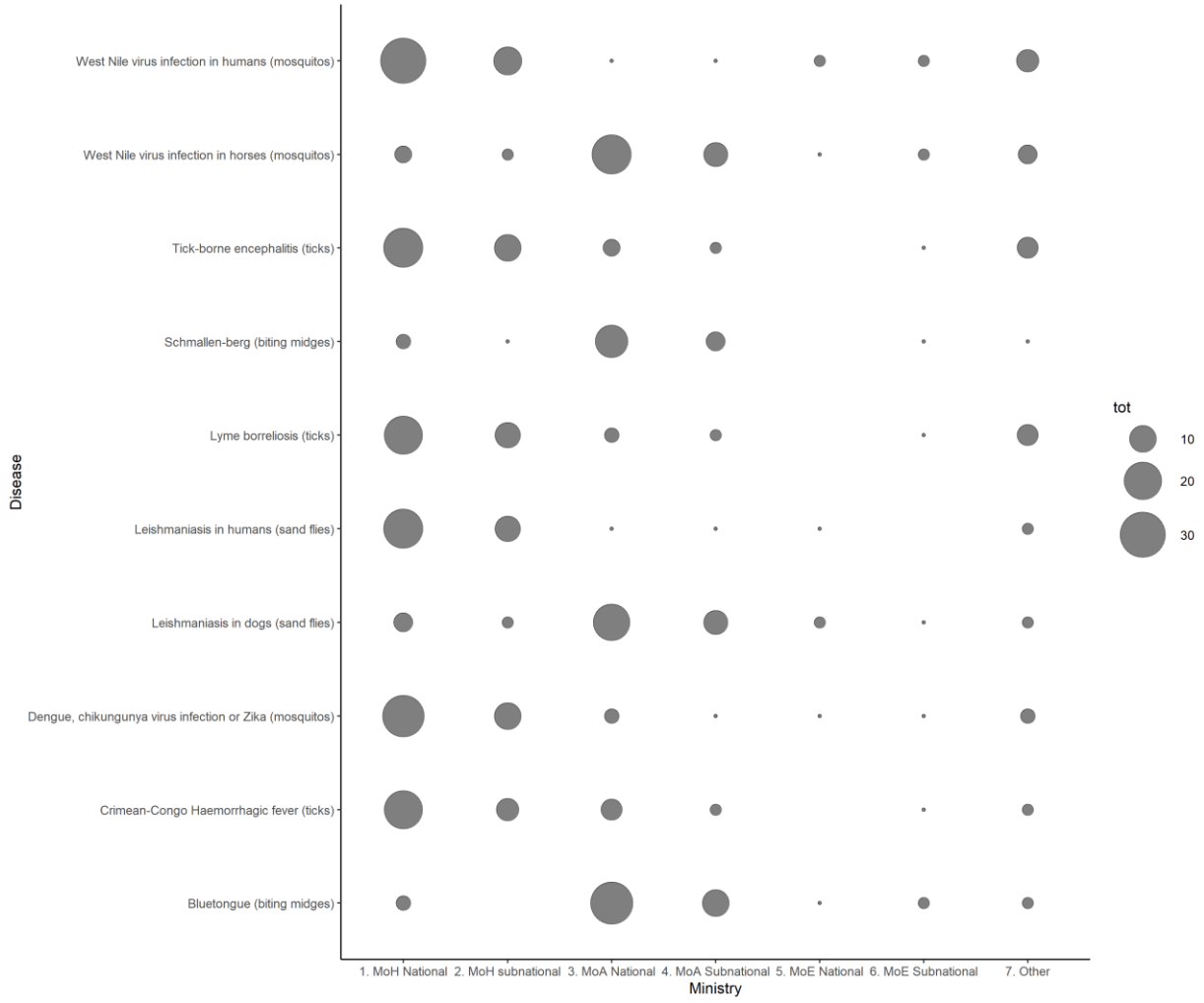
Annex 3. Detailed responses related to vector surveillance

Is vector surveillance implemented?

Question	Reply	Surveillance	Mosquitoes	Ticks	Sand flies	Biting midges
3.2. Reasons why vector surveillance is not implemented	1 not priority	No	1	0	15	5
	2 not important for response	No	0	0	4	1
	3 no legal framework	No	4	6	10	6
	4 lack of resources	No	6	9	13	17
	5 other reason	No	1	2	4	3
3.3. Reasons why vector surveillance is implemented	1 yes priority	Yes	27	31	12	19
	2 yes important for response	Yes	26	18	9	16
	3 yes assess introduction and spread	Yes	30	13	5	7
	4 yes legal obligation	Yes	15	5	3	10
	5 other reason	Yes	8	5	2	5
3.4. The context of the legal framework of vector surveillance	1 Related to the International Health Regulations	Yes	12	2	3	2
	2 Embedded in a legal framework on disease surveillance	Yes	12	8	7	7
	3 Specific legislation on vector surveillance	Yes	14	5	4	9
	4 Other legal context	Yes	5	3	0	3

Who is responsible and implements?

Figure 10. Overview ministries responsible for vector surveillance



Question	Reply	Surveillance	Mosquitoes	Ticks	Sand flies	Biting midges
3.6. Who designs the actual vector surveillance plan?	1 dedicated agency	Yes	5	4	2	1
	2 working group within a ministry	Yes	8	3	4	9
	3 working group between ministries	Yes	9	4	6	5
	4 public/veterinary health agency	Yes	18	16	8	7
	5 scientific/academic institution	Yes	19	14	9	13
	6 private company or organisation	Yes	3	0	0	0
	7 other	Yes	4	3	2	3
3.8. Who readjusts the vector surveillance plan?	1 the same organisation readjusts	Yes	31	24	14	21
	2 other	Yes	1	1	1	2
3.9. How often is the evaluation and re-adjustment of the surveillance plan done?	1 each year	Yes	15	12	6	16
	2 every 2–5 years	Yes	11	5	4	2
	3 less often than every 5 years	Yes	3	4	2	2
	4 never	Yes	3	5	3	2
3.10. Is the surveillance plan designed at national or sub-national level?	1 at national level	Yes	28	17	10	18
	2 at sub-national level	Yes	8	10	4	2
3.11. Who executes vector surveillance?	1 dedicated agency	Yes	4	4	1	1
	2 public/veterinary health agency	Yes	17	13	10	11
	3 scientific/academic institution	Yes	21	15	8	15
	4 private company or organisation	Yes	6	0	0	0
	5 other	Yes	3	2	1	3

Operational overview

Question	Reply	Surveillance	Mosquitoes	Ticks	Sand flies	Biting midges
3.13. What type of vector surveillance is implemented?	1 active	Yes	36	27	14	20
	2 passive	Yes	15	17	3	4
3.14a. Where is ACTIVE surveillance implemented?	1 country wide	Yes	19	8	4	14
	2 in certain parts of the country	Yes	18	23	11	6
3.14b. Where is PASSIVE surveillance implemented?	1 country wide	Yes	13	12	0	1
	2 in certain parts of the country	Yes	8	10	6	4
3.16a. How do you classify your ACTIVE surveillance?	1 limited in time	Yes	20	20	11	12
	2 embedded in a long-term strategy of disease risk assessment and control	Yes	17	12	3	9
3.16b. How do you classify your PASSIVE surveillance?	1 limited in time	Yes	9	12	3	4
	2 embedded in a long-term strategy of disease risk assessment and control	Yes	10	10	0	0
3.17. What do vector surveillance activities assess?	1 vector presence	Yes	36	29	16	19
	2 vector abundance	Yes	24	20	10	16
	3 vector seasonality	Yes	33	22	13	18
	4 vector infection rate	Yes	19	21	11	6
	5 vector behavioural traits	Yes	7	5	5	1
	6 other	Yes	2	1	0	1

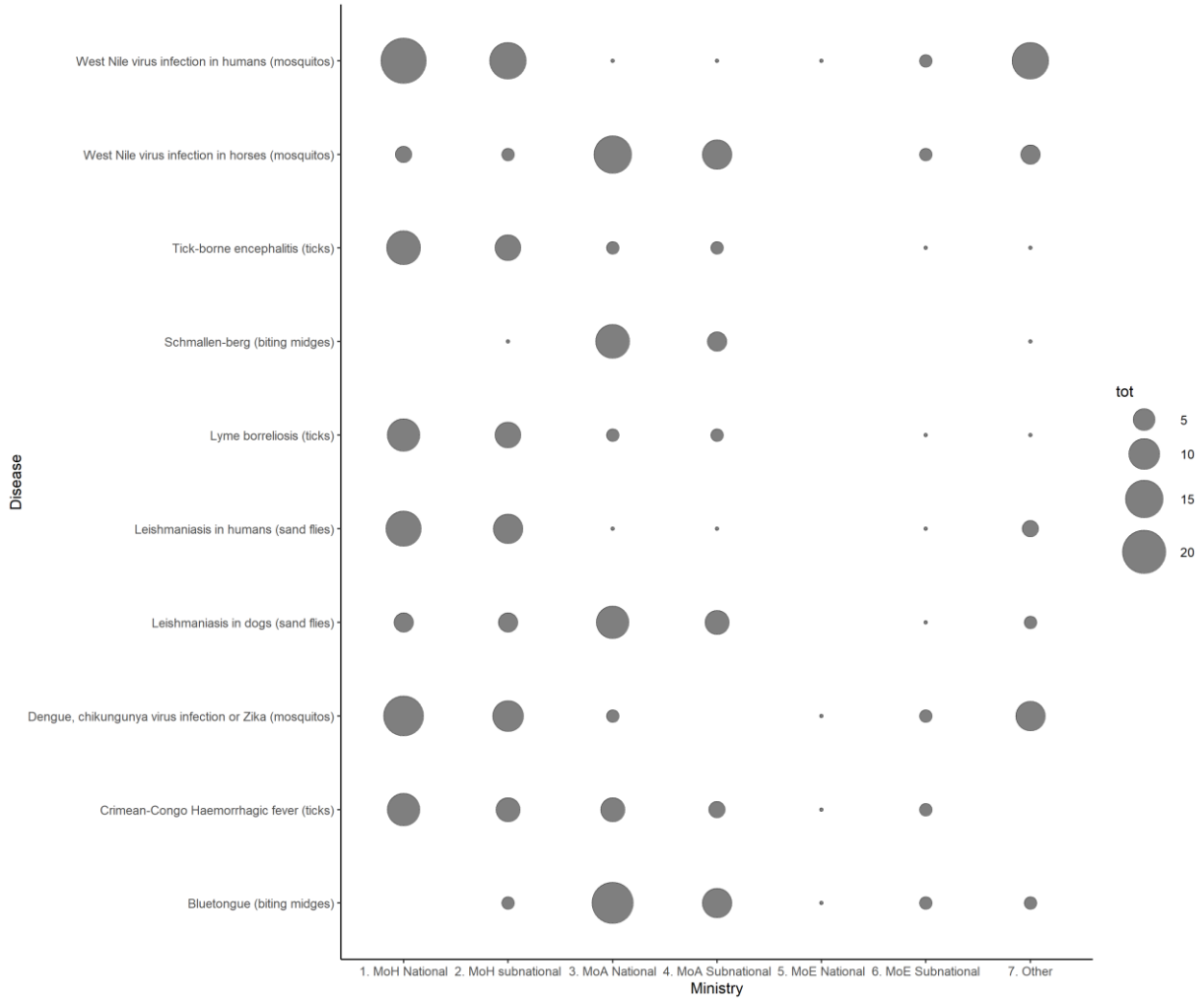
Annex 4. Detailed responses related to vector control

Is vector control implemented?

Question	Reply	Control	Mosquitoes	Ticks	Sand flies	Biting midges
4.2. Reasons why vector control is not implemented	1 vector species is not present	No	0	0	10	0
	2 not considered as public or veterinary health problem	No	3	1	7	5
	3 we don't have reliable vector control options for this group	No	3	18	12	16
	4 there is no legal framework within which control can be organised	No	7	11	13	12
	5 there is a lack of resources	No	9	16	17	17
	6 other reason	No	2	3	1	1
4.3. Reasons why vector control is implemented	1 it is a public or veterinary health problem	Yes	24	9	6	7
	2 contributes to the response and control of vector-borne diseases	Yes	24	9	6	6
	3 there is a legal obligation	Yes	13	2	1	6
	4 other reason	Yes	4	0	0	0
4.4. Specifications of the legal framework	1 related to the International Health Regulations	Yes	10	1	0	1
	2 embedded in a legal framework on disease surveillance and control	Yes	16	4	4	6
	3 based on a specific legislation on vector control	Yes	11	3	2	4
	4 other reason	Yes	7	1	0	1
4.5. Does the legal framework provide certain tools or rights facilitating vector control?	1 the right to enter private property	Yes	6	1	2	3
	2 tyre recycling regulation	Yes	3	0	0	0
	3 import regulations	Yes	2	0	0	2
	4 other reason	Yes	4	1	0	0

Who is responsible and implements?

Figure 11. Overview ministries responsible for vector control



Question	Reply	Control	Mosquitoes	Ticks	Sand flies	Biting midges
4.7. Who designs the actual vector control plan?	1 dedicated agency	Yes	5	2	3	0
	2 working group within a ministry	Yes	8	2	4	5
	3 working group between ministries	Yes	9	5	3	1
	4 public/veterinary health agency	Yes	12	5	1	3
	5 scientific/academic institution	Yes	6	3	2	3
	6 private company or organisation	Yes	7	2	0	0
	7 other	Yes	7	0	0	1
4.9. Who evaluates and readjusts vector control plan?	1 the same organisation readjusts	Yes	30	9	6	6
	2 other	Yes	2	0	0	0
4.11. How often is the evaluation and readjustment done?	1 each year	Yes	14	1	2	4
	2 every 2–5 years	Yes	8	2	2	1
	3 less often than every 5 years	Yes	6	3	1	1
	4 never	Yes	3	3	0	0
4.12. Is the control plan designed at national or sub-national level?	1 at national level	Yes	15	3	4	5
	2 at sub-national level	Yes	23	9	4	3
	1 limited in time	Yes	15	6	3	2

Question	Reply	Control	Mosquitoes	Ticks	Sand flies	Biting midges
4.13. How can you classify vector control in your country?	2 embedded in a long-term strategy of disease risk assessment and control	Yes	16	5	4	5
4.14. Who is in charge of the execution of the vector control plan?	1 dedicated agency	Yes	4	1	0	0
	2 public/veterinary health agency	Yes	13	5	5	6
	3 scientific/academic institution	Yes	2	0	0	1
	4 private company or organisation	Yes	17	7	3	4
	5 other	Yes	7	1	2	1

Annex 5. Detailed responses related to 'One Health' collaboration

Collaboration between public and veterinary health sectors

Question	Reply	Mosquitoes	Ticks	Sand flies	Biting midges
5.2. The areas of public health and veterinary health collaboration?	1 vector surveillance design	12	8	6	3
	2 vector control design	8	1	2	1
	3 data collection	13	9	6	5
	4 data sharing	19	11	7	4
	5 data management or/and storage	10	7	5	4
	6 data analysis and interpretation	11	8	5	4
	7 communication	19	12	7	6
	9 other	2	1	1	1

Collaboration between the health sectors (public/veterinary) and the environmental sector

Question	Reply	Mosquitoes	Ticks	Sand flies	Biting midges
5.4. The areas of public health and veterinary health collaboration?	1 land use planning	2	0	0	0
	2 biocides regulation	6	1	2	1
	3 other	4	2	1	1

Annex 6. Country information sheets

The country information sheets can be found here: https://external.ecdc.europa.eu/technicalreport/TRP-20210226_1623_VSC_Annex%206.html

PDF TQ-08-21-337-EN-N

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