FRAMEWORK ESTABLISHING RECOMMANDATIONS FOR THE SURVEILLANCE OF EXOTIC MOSQUITOES IN BELGIUM[i]

[i] As agreed on January 2014 by the Interministerial Conference on the Environment enlarged to Public Health.

Fact sheet #1: Entomological surveillance[ii]

1 Global objective

The addressed entomological surveillance aims at collecting information on mosquito vector species in order the assess risk for public health (PH) and support decision making to prevent/reduce/control this risk. However, as mosquitoes may also transmit pathogens to both livestock and wild fauna and as some invasive mosquito species (IMS) may outcompete native species, information collected by such surveillance could support protection of animal health (AH) and biodiversity.

As a result of increasing travel and trade, exotic mosquito species (EMS) are more and more frequently introduced into new territories, and, whereas some EMS populations remain localised, others show to be invasive and spread over large territories of Europe. When these are potential vectors and/or invasive, they generate additional risk compared to native mosquitoes. Indeed, some IMS have already shown to act as vectors of chikungunya and dengue under southern European conditions and have a potential to transmit a number of pathogens. Native mosquitoes are not considered efficient for these pathogens, but they are vectors of others, such as West Nile virus (WNV) (Table 1, page 6). Concerning the impact of IMS on biodiversity (native mosquitoes and other fauna), there are to date only few data available. One study in the US shows some displacement of native species as a result of competition with *Aedes japonicus* in rock pools.

2 Current situation in Belgium

To date (October 2013), the mosquito fauna present in Belgium does not poses any threat to human and/or animal health, although it is difficult to predict emerging threats. Depending on the (changing) situations, and when exotic or native species become a threat, appropriate surveillance and control actions should be undertaken.

Mosquito vector species currently occurring in Belgium

A country-wide survey conducted from 2007 to 2010 (MODIRISK) has showed the occurrence of two exotic and 23 indigenous mosquito species in Belgium (Table 1). In July 2013, *Aedes albopictus* was detected from a second hand tyre trade in Vrasene, the same site where it was already observed in 2000. According to the literature, at least 7 more indigenous species have been observed at some occasion, but because of their scarcity, they might not represent any risk to PH or AH in Belgium.

Two EMS are locally established: *Aedes japonicus* in Hamois, Province of Namur, at least since 2002, and *Aedes koreicus* in Maasmechelen, Limburg, at least since 2008. A first effort to eliminate Ae. japonicus started in 2012 during ExoSurv project. In 2013 an exhaustive community based control project was carried out from April till November with positive first results. In addition, *Aedes albopictus* was found at one occasion in Beveren, Oost-Vlaanderen, in 2000, but has subsequently not been observed again.

Although it is recognised that both exotic and a number of native mosquito species show some ability to transmit pathogens (Table 1a-c), most species are currently not considered as a threat. The vectorial capacity of a mosquito population is not easy to assess as it depends of many factors. Firstly, the mosquito has to be able to host the virus (vector competence, genetically determined) and to feed on receptive hosts to become infected and to transmit infection later on (host preferences). In addition, the mosquito population must show some level of abundance and longevity to engender a transmission cycle. Finally, this is also dependent to local environmental and climatic conditions which impact e.g. the mosquito-host contact rate and the speed of virus reproduction in the mosquito (extrinsic incubation period).

[ii] *Fact-sheet set up by AVIA-GIS (Francis Schaffner & Veerle Versteirt) on behalf of the Federal Public Service Public Health, Food Chain Safety and Environment (DG Environment).*

The potential vector role of Belgian mosquitoes is summarized in Table 1 (page 6) for pathogens with relevance to PH and AH, which show to circulate in Europe or to be introduced into Europe. Species which could engender a threat to biodiversity are (1) those who can transmit a pathogen that severely affects wild fauna (e.g. WN or Usutu viruses), and (2) EMS that can outcompete native mosquitoes in natural larval habitats. Both EMS established in Belgium have not shown to be invasive to date. It can therefore be stated that on the basis of current scientific knowledge, the risk to biodiversity is quite low in Belgium. However, considering the behaviour of these EMS in other European countries, it is not excluded that they become invasive in the future.

Species likely to be introduced in Belgium

-The Asian tiger mosquito *Aedes albopictus* is one of the worst worldwide invaders and is currently rapidly spreading in most of the southern-European countries. Since its first introductions into Europe (Albania 1979, Italy 1990), it has been reported from at least 20 European countries. Several models predicting climate suitability for its establishment in Europe highlight the possible expansion of the species into more northern latitudes, including most part of the Benelux. Suitability may even increase for Benelux in the future, according to several climate change scenarios. This EMS is competent for transmitting a number of pathogens, and was the vector of chikungunya and dengue in the recent outbreaks in southern Europe. The finding in Belgium and the recent introduction events reported in the Netherlands (from USA, via used tyre trade) and in Germany (from southern Europe, via ground transportation) show the high probability for this species to be introduced again in Belgium and maybe establish.

This, together with predicted climate suitability and vectorial competence, plead for the surveillance of this species and for a rapid implementation of elimination/control measures. Once established, the only option is to monitor the population density and control the population to minimise outbreak risks and scale.

-The American rock pool mosquito *Aedes atropalpus* is native from North American and has been occasionally introduced into Italy (1996), France (2003, 2005) and the Netherlands (2008-2010) via the commercial transport of used tyres. In the Netherlands, the species has been found to colonize surroundings of the introduction site, showing its ability to establish and spread under north-European climatic conditions. Indeed, models suggest climate suitability for its establishment and spread in northern European countries. Although its importance as a vector of infectious diseases is still not clear, the propensity of this species to feed on a range of hosts (including humans), and studies demonstrating its competence to transmit WNV in the laboratory and to be infected in nature suggest that this species has the potential to become involved in WNV transmission.

-The yellow fever mosquito *Aedes aegypti* is another IMS that has colonized almost all tropical regions worldwide, subsequently to its transport by shipments. The species was well established in the whole Mediterranean basin until the 1950's, where it was responsible of large yellow fever and dengue outbreaks. Although the mosquito was introduced in ports of northern France and UK, where it transmitted efficiently yellow fever during summer months, it did not succeed to establish permanently in temperate climate. Indeed, models show that only parts of southern Europe are suitable to its establishment.

However, possibilities of introduction via the used tyre trade, as shown in the Netherlands in 2010, plead for active surveillance and prompt elimination to avoid any risk of pathogen importation and transmission.

Risk of spread of *Aedes japonicus* and *Aedes koreicus* within Belgium

-The Asian rock pool mosquito *Aedes japonicus* has successfully invaded the USA and has shown to be invasive over large areas of central Europe (e.g. Germany, Switzerland). To date in Belgium, *Ae. japonicus* is established in a focus limited in size (around 5 km^2) but its occurrence outside this zone cannot be completely ruled out yet. It is generally assumed that most exotic species need a lag period to adapt to its new environment, during which it remains at low density. The genetic fingerprint and diversity of the species probably plays an important role in the adaptation process. Studies on the genetic structure of *Ae. japonicus* in the USA and Belgium reveal that in both countries probably multiple introductions occurred, although in the latter case this still needs further research. Seeing its recent expansion in Switzerland and Germany, it seems unlikely that the species could not spread in Belgium. However, ecological aspects (e.g. availability of breeding sites) and genetic

richness could be currently the major limiting factors. Arrival of the species in Belgium from bordering Germany and further spread within the country cannot be excluded.

Although the role of Ae. japonicus in the transmission of pathogens under natural conditions is unclear, its abundance in urbanized areas and its tendency to bite humans together with its high competence to transmit WN, dengue, Japanese encephalitis, and La Crosse viruses in the laboratory plead for a surveillance and control of this mosquito.

-The Korean mosquito *Aedes koreicus* has been reported outside its native range only from two places, in Belgium and northern Italy (2010). A comparison between climatic factors in Jeju-do from where the population originates and Belgium showed similar annual mean temperatures (9-11°C), winter temperatures, and freezing days and nights in 4 consecutive years (2004-2008), thus allowing winter survival of the species. In contrast, the seasonal pattern of relative humidity and precipitation in Belgium deviated strongly from that of Jeju-do. Low humidity may be a limiting factor for establishment and expansion of a mosquito population. However, an annual precipitation of 800 mm is recorded in Belgium, which is higher than the calculated yearly rainfall of 500 mm, needed to provide enough water to fill container breeding sites. The area of infestation still remains small (around 10 km^2), but considering its spread in Italy, it is not excluded that the species could establish over a larger area in Belgium. In its native range, *Ae. koreicus* is a human-biter, with a greater preference for human habitations than *Ae. japonicus*, but its vector role under natural conditions is unclear. The species does not show to be invasive in Belgium to date, but it spreads quite rapidly in northern Italy.

3 Implementation of a surveillance of exotic mosquitoes in Belgium

3.1 Objectives and risk scale

Considering the current context within and outside Belgium, objectives for the implementation of a surveillance plan of EMS in Belgium should focus at (1) surveying a selection of points of entry (PoE) at risk to early detect further introductions of EMS and support control measures to prevent EMS establishment (= scenario 1 of ECDC guidelines), (2) surveying EMS in and around the two known colonized foci to estimate abundance, detect further spread, and support elimination/control programmes (= scenario 2 of ECDC guidelines). Considering invasiveness and vector potential, targeted species might be (1) *Ae. albopictus*, (2) *Ae. japonicus*, (3) *Ae. koreicus*. Additional putative EMS (e.g. *Ae. aegypti*, *Ae. atropalpus*, *Ae. triseriatus*) which are also container-breeding mosquitoes will be detected by the same surveillance methods if introduced.

A risk scale which associates entomological indicators for EMS with PH/AH signals for MBD they can transmit is defined and described in Table 2.

'Active' refers to the presence of host-seeking adults mosquitoes (by opposition to immature stages only or overwintering females). 'Established' refers to a mosquito population that has been introduced and could reproduce and overwinter under local conditions. Abundance is based on numbers of eggs collected in ovitraps, but adult trapping can be performed alternatively, according to ECDC guidelines. 'Abundant' refers to ovitraps that show at least 50 eggs per week.

The risk scale may be defined for a certain geographical area. In case of risk levels 4 and 5, the whole country might be considered at least for alert and information, and maybe for some prevention measures (e.g. source reduction, mosquito bite prevention), whereas curative measures (e.g. larviciding, adulticiding) remain restricted to the outbreak area. Currently in Belgium, the risk level 2 applies to the regions of Hamois and Maasmechelen, were *Ae. japonicus* and *Ae. koreicus*, respectively, have established and are active, from May to October. Risk level 0 applies to the rest of the country, provided that surveillance is performed.

Table 2 – Risk scale according to entomological indicators for EMS and PH/AH signals for MBD they can transmit.

Risk level	Entomological criteria	MBD situation, recommended actions
0	EMS is absent.	Absence of local transmission of MBD. Surveillance of introductions and possible spread.
1	An EMS is reported in limited number and is active.	Absence of local transmission of MBD. Surveillance of further introductions and possible spread. Prevention of establishment and spread (source reduction, larviciding).
2	An EMS is established and active.	Absence of local transmission of MBD, presence of imported MBD cases. Attempt to eliminate, or at least block the spread. Intensification and extension of surveillance.
3	An EMS is abundant and active.	Absence of local transmission of MBD, presence of imported MBD cases. Large scale intervention to reduce the population density. Intensification of surveillance, including adult trapping. Public information for community participation in source reduction. Information of the local public health authorities.
4	An EMS has reached a critical density: average number of eggs per trap >200; complaints by residents.	Presence of cases of local transmission of MBD. Reduction of mosquito population around cases (adulticiding, larviciding). Surveillance of mosquito density, activity, and control measures efficiency.
5	An EMS has reached a critical density and generates MBD outbreaks.	Presence of local outbreak(s) of MBD. Information of international health authorities (ECDC). Information of local authorities. Prevention of the spread of the MBD by intensive control measures within given perimeters.

3.2 Surveillance procedures

Table 3 – Sets of surveillance procedures defined according to the two objectives described above.

Surveillance aim and sites	Methods and traps	Density of traps	Frequency of trapping	Period of trapping
Introduction at points of entry				
Platforms of imported used tyres (based on risk scoring)	BG-Sentinel or MM HLC Larval search	1/5000m² 1 or 2 1/10 tyres	Bi-monthly Twice-yearly Twice-yearly	May-Oct Jul-Oct Jul-Oct
Shelters/greenhouses for imported cutting plants like Lucky bamboo	BG-Sentinel or MM HLC Larval search	1/5000m² 1 or 2 20 vessels	Bi-monthly Twice-yearly Twice-yearly	Apr-Nov Apr-Nov Apr-Nov
Commerce ports	Ovitraps	1/5000m²	Monthly	May-Oct
Forests and gardens in regions bordering Germany	Ovitraps Larval search	1/km² 20 vessels	Monthly Twice-yearly	May-Oct May-Oct
Main parking lots at country borders, highways originating from east and south	Ovitraps Larval search	1/2500m² 10 vessels	Monthly Twice-yearly	May-Oct May-Oct
Persistence/abundance in colonised area				
Inspection of colonised area	Ovitraps Larval search	1/5ha 40 vessels	Bi-monthly Bi-monthly	May-Oct May-Oct
Abundance and seasonal dynamics	BG-Sentinel or MM or gravid traps	4/site	Bi-monthly	May-Oct
Biting behaviour of *Ae. koreicus*	Baited traps, HLC	2/site	Monthly	Jun-Sep
Spread around colonised areas				
Inspections around colonised areas	Ovitraps	1/15ha	Monthly	May-Oct
In addition, where control measures are applied				
Quality and efficacy of control measures	Ovitraps	20/site	Before and after	

	BG-Sentinel, HLC	4/site	applications

More technical information can be found in ECDC guidelines. If autochthonous MBD cases suspected to be transmitted by IMS are reported, surveillance will be extended in the areas where transmission is supposed to have occurred. Information procedure (to central/local authorities) is defined to be activated if IMS is detected (see Fact sheet #10). Mosquito elimination/control is defined to be activated if IMS is detected (see Fact sheet #11).

3.3 Native species

Native mosquito species can act as vectors as well and in case of evidence of circulation of pathogens they can transmit (e.g. WNV), entomological surveillance should be extended to native vector species to support risk assessment. The proposed risk scaling could be applied as well to such a situation, but surveillance methods must be adapted to the focused mosquito species, e.g. using gravid traps to survey *Culex* species, using CO_2-baited traps to survey *Aedes* species in wetlands, using resting traps and larval sampling to survey *Anopheles* species in suburban areas and wetlands.

Guidelines for native species, edited by ECDC, will be available in 2014 and can then be integrated in this factsheet as well.

Table 1a – Overview of the exotic species recently observed in Belgium or which are likely to be introduced into Belgium with information on their biology and vectorial capacity.

Selected pathogens have relevance to PH and AH, and are known to circulate in Europe, or to show intense activity in other parts of the world with evidence of introduction into Europe.

Mosquito species	Occurrence in Belgium	Current global distribution	Batai virus	Chikungunya virus	Dengue virus	Inkoo virus	Japanese encephalitis virus	Lednice virus	Rift Valley fever virus	Sindbis virus	Tahyna virus	Usutu virus	West Nile virus	Yellow Fever virus	*Plasmodium* sp. (H. malaria)	*Dirofilaria* sp.	*Setaria* sp.	*Francisella tularensis*	Myxomatosis pox virus	Host preferences
Exotic species, already established																				
Aedes (Fin.) japonicus japonicus	R	H		2	2		2						**3**							H,M,B
Aedes (Fin.) koreicus	R	P					?									?				H,M
Exotic species, that could be introduced with probability of establishment under Belgian eco-climatic conditions																				
Aedes (Stegomyia) albopictus	[iii]	C		**4**	**4**		2		2	2		1	**3**	2	0	**4**				H,M,B,R
Aedes (Och.) atropalpus	-	N											**3**							H,M,B
Other exotic species, that could be introduced but have very low chance to establish under Belgian eco-climatic conditions																				
Aedes (Ste.) aegypti		C[iv]		**4**	**4**				2				**3**	**4**						H,M,R

Table 1b – Overview of the native mosquito species recently observed in Belgium that could pose a problem when they proliferate and when suitable conditions for pathogen transmission are present. Information is given on their biology and vectorial capacity. Selected pathogens have relevance to PH and AH, and are known to circulate in Europe, or to show intense activity in other parts of the world with evidence of introduction into Europe.

Mosquito species	Occurrence in Belgium	Current global distribution	Batai virus	Chikungunya virus	Dengue virus	Inkoo virus	Japanese encephalitis virus	Lednice virus	Rift Valley fever virus	Sindbis virus	Tahyna virus	Usutu virus	West Nile virus	Yellow Fever virus	*Plasmodium* sp. (H. malaria)	*Dirofilaria* sp.	*Setaria* sp.	*Francisella tularensis*	Myxomatosis pox virus	Host preferences
Native species																				
Aedes (Och.) cantans	C	P									1		1						1	H,M,B
Aedes (Aedes) cinereus/geminus	C[i]	H								**4**	1		1							H,M,B
Aedes (Och.) communis	C	P	1			1					2							1		H,M,B
Aedes (Finlaya) geniculatus	C	P											2	2				1		H,M,B
Aedes (Och.) punctor	C	H				1					2		2					1		H,M
Aedes (Rusticoides) rusticus	C	P																		H,M,B
Aedes (Aedimorphus) vexans	C	H							**4**		1		**3**			2	**4**	**3**		H,M,B
Anopheles (Anopheles) claviger	C	P	1								2				**4**	1	**4**	1	1	H,M
Anopheles (Ano.) plumbeus	C	P													2					H,M,B,R
Coquillettidia (Coq.) richiardii	C	P	1								1		1			2				H,M,B,R
Culiseta (Culicella) annulata	C	P									1	1								H,M,B
Culex (Culex) pipiens	C	C							**4**	**4**	2	1	**4**			**4**		1		H,M,B
Culex (Cux.) torrentium	C	P								**4**								1		B

Occurrence in Belgium: R = Rare; C = Common; A = Abundant. Distribution: C = Cosmopolite; P = Palearctic; N = Nearctic; H = Holarctic. Pathogens: Empty cell = Absence of information for the species; 1 = Species infected in nature only; 2 = Species competent in the laboratory only (at low, moderate or high level); **3** = Species infected in nature and competent; **4** = Species known as vector in regions and countries outside Central-Western Europe; **5** = Species known as vector in Central-Western Europe; (Numbers in bold indicate significant vector potential). Host preferences: H = human; M = Mammals; B = Birds; R = Reptiles; A = Amphibians.

Notes: [i] Adult females of these sibling species cannot be sorted; [ii] Reported for *An. maculipennis* sensu lato; [iii] Observed in Belgium at one occasion; [iv] Tropical and subtropical regions.

Table 1c – Overview of the native mosquito species recently observed in Belgium but that are usually not proliferating, with information on their biology and vectorial capacity. Selected pathogens have relevance to PH and AH, and are known to circulate in Europe, or to show intense activity in other parts of the world with evidence of introduction into Europe.

Mosquito species	Occurrence in Belgium	Current global distribution	Batai virus	Chikungunya virus	Dengue virus	Inkoo virus	Japanese encephalitis virus	Lednice virus	Rift Valley fever virus	Sindbis virus	Tahyna virus	Usutu virus	West Nile virus	Yellow Fever virus	*Plasmodium* sp. (H. malaria)	*Dirofilaria* sp.	*Setaria* sp.	*Francisella tularensis*	Myxomatosis pox virus	Host preferences
Native species																				
Aedes (Ochlerotatus) annulipes	R	P									1								1	H,M
Aedes (Och.) caspius	R	P							**4**		1		1			**4**	**4**		1	H,M,B
Aedes (Och.) detritus	R	P										1							1	H,M
Aedes (Och.) sticticus	R	H				1					1		1					1		H,M
Anopheles (Ano.) maculipennis s.s.	R	P	1							1[ii]	1[ii]	1[ii]	1[ii]		**4**	2	**4**		1[ii]	M
Anopheles (Ano.) messeae	R	P													**4**					M
Culiseta (Culiseta) fumipennis	R	P																		B,R
Culiseta (Cus.) morsitans	R	H								**4**			1							B
Culex (Cux.) territans	R	H																		A

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Fact sheet #2: Competent authorities in Belgium to support the entomological surveillance (and control)

Belgium is a federal State with a complex institutional structure. The competences for implementing the surveillance plan are divided among various authorities at federal, regional and community level depending on their competences in environment, public health or animal health. Two more additional organisational levels should also be identified: the provincial and local levels.

In Belgium, no single authority or institution can be held responsible for implementing all actions described in the surveillance plan. Fragmentation of competences obliges to build up efficient coordination among different authorities. This complex array of institutions should however not prevent achieving success through coordinated political and administrative actions as well as regular exchange of scientific knowledge.

The primary goal of this plan is for public health reasons. It aims at preventing the risk in Belgium of (re)emergence of vector-borne diseases (VBD) caused by exotic mosquitoes species (EMS). It also aims at reducing the risk of spread of infections in the case EMS and VBD are confirmed in Belgium. As human beings are part of the ecosystem and because VBD are linked to animal species, it is necessary to build up strong bridges with environmental and animal health competences.

Below-mentioned activities linked to entomological surveillance largely concern environmental competences as described in the law of 8/8/1980 on institutional reforms. Because the plan looks first at securing public health, the division of competences should be read bearing in mind this conceptual approach. Additionally it should be noted that some surveillance activities may --as such- also be also of direct interest for environmental authorities like the monitoring of invasive alien mosquitoes and the assessment of their impacts on the biodiversity.

Table 1 below describes authorities that could be involved in entomological surveillance and control activities as well as the legal driver that can be activated for that purpose.

Table 1 : Details of competent authorities for entomological surveillance and control activities

Strategic axis 1 : Wildlife survey **Surveillance of introduction and possible spread of exotic mosquitoes in the wild**		
4 Specific action	**5 Legal driver of action**	**6 Competent authority**
General active surveillance of exotic mosquitoes on the regional territory (wildlife survey)	General competences on nature conservation	Regional ministries of environment (LNE for Flanders, DGARNE for Walloon Region and IBGE/BIM for Brussels-Capital Region)
Local active surveillance on local areas where cases of presence of EM are reported at communal level	Municipal competences for all that is of “communal interest”	Municipalities
Local active surveillance on areas where cases of presence of EM are reported at provincial level	Provincial competences for all that is of “provincial interest”	Provinces

Strategic axis 2 : Wildlife survey **Surveillance of introduction and possible spread of exotic mosquitoes at PoE according the recommendations set out in the ECDC guidelines**		
Active surveillance at storage sites for imported used tyres	General regional competences on environment (permit license)	Regional ministries of environment
Active surveillance at shelters/greenhouses for imported plants like *Dracaena spp* (lucky bamboo)	General regional competences on environment (permit license) (tbc) Possibility to also activate this action through federal law(s) on products if importation and/or placing on the market is regulated (see strategic axis 3)	Regional ministries of environment (tbc) FPS Economy (tbc) AFSCA/FAVV (tbc)
Active surveillance at highways and road axes	General regional competences on environment (+ mobility tbc)	Regional ministries of environment (mobility tbc)
Active surveillance at ports	General regional competences on environment (+ mobility tbc)	Regional ministries of environment (mobility tbc)
Active surveillance at airports	General regional competences on environment (Brussels airport included given it concerns wildlife survey –tbc)	Regional ministries of environment
Strategic axis 3: Survey on products **Surveillance of introduction and possible spread of exotic mosquitoes through control of imported products**		
Importation of lucky bamboo	1994 Law on the safety of products[iii] Environmental competence (permit license) (tbc)	Customs FPS Economy FAVV/AFSCA Regional environmental authorities

[iii] It has to be noted that for the time being no prescriptive measures do apply for lucky bamboo with regards to the law on the safety of products.

Strategic axis 4 : Control measures		
Control of mosquitoes in the wild	General regional competences on environment (wild animals)	Regional ministries of environment
Control of mosquitoes at PoE	General regional competences on environment in the context of permit license At some PoE for animals (tbc) At some PoE for PH reason	Regional ministries of environment AFSCA/FAVV (tbc) Customs (tbc) SANIPORT(tbc)
Control of mosquitoes at local areas where cases of presence of EM are reported at communal level	Municipal competences for all that is of "communal interest"	Municipalities
Local active surveillance on areas where cases of presence of EM are reported at provincial level	Provincial competences for all that is of "provincial interest"	Provinces
Strategic axis 5 : Measures associated to control measures		
Obligation to use biocides on imported products (prior their placing on the Belgian market)	Norms of products (tbc)	FPS Health, Food Chain Safety and Environment (tbc) FPS Economy (tbc)
Authorization to use biocides at colonized area and imposition of use criteria thereof for public health reasons	Norms of products	FPS Health, Food Chain Safety and Environment, Biocides Department
Criteria being laid down for the use of biocides for environmental reasons	General environmental competence on environment	Regional ministries of Environment

Fact sheet #3: Personal protection measures[iv]

In case of nuisance problems or of mosquito-borne diseases (MBD) transmission, preventive personal protection actions may be promoted to reduce/avoid contact with mosquitoes. Whereas main vector control measures that aim at reducing the vector population are applied by specialists, personal protection can be applied by any citizen during the mosquito season, and strengthened in a context of severe nuisance or MBD transmission risk.

Personal protection measures include:

- Avoidance of mosquitoes, by minimising mosquito development around the citizen's home and limiting outdoor activities during the mosquito peaks of activity;
- Protection from mosquito bites, by wearing insect-proof clothing, using repellents, insecticide-treated nets or clothes, screens, bed nets, air conditioning, insecticide sprays or diffusers.

These measures might be implemented in particular (1) during MBD outbreak and at places where local or imported mosquito-borne disease cases are occurring (e.g. infected person's home, hospital), and (2) by field inspectors when surveying vector species. Repellents and insecticides have to be applied according to the manufacturer recommendations and taking into account age and physiological conditions of the user (pregnancy, underlying pathology).

7 Avoidance of mosquitoes

First of all, potential larval habitats of mosquitoes should be immediately eliminated from around houses, buildings and farms to minimise mosquito development. Several mosquito species, in particular the invasive aedine species, develop in temporal and permanent standing water containers. Such larval habitat sites around a housing range from buckets and other small waste containers able to collect rain water, over used tyres, drinking thoughts, bird baths, rain water barrels, unmaintained kid pools, clogged rain gutters, to ornamental artificial ponds and any recently created water bodies. All these sites should be eliminated (e.g. waste) and/or cleaned regularly or mosquito-proof covered (e.g. rain water containers) to avoid any mosquito proliferation.

In outdoor areas, a sensible precaution is to avoid areas that are known to have high biting insect activity such as wetlands. There, dense vegetation should be avoided during the day. The peaks of activity of pest species varies but *Aedes* mosquitoes do bite during the day in particular at dusk and dawn, while *Culex* and main *Anopheles* species will bite during the night and mainly indoor for the house mosquito *Culex pipiens*. To protect from invasive aedine mosquitoes, it is recommended to limit outdoor activities at dusk and down mainly in suburban areas and in forests.

8 Protection from mosquito bites

8.1 Insect-proof clothing

An easy way to prevent insect bites is wearing insect-proof clothing. This can consists in head net, gloves, boots as well as light-coloured long sleeves and trousers for those working outdoors. To a lesser extent, long and ample clothing helps to prevent mosquito bites. Dark clothing such as dark blue or black clothing is much more attractive to certain mosquitoes (e.g. *Aedes albopictus*, *Ae. aegypti*) than white clothing, an attribute that is also observed in other insect species (like certain fly families). For particular risk areas or occupations, protective clothing can also be impregnated with insecticides (such as pyrethroids). When applied to tissues (clothes, curtains, etc.) the insecticide is absorbed by the fibre and evaporates very slowly, augmenting the persistence of the applied product, and producing generally a double effect as repellent and insecticide. Body parts that are not covered by such clothes might be protected with repellents.

[iv] *Fact-sheet set up by AVIA-GIS (Francis Schaffner & Veerle Versteirt) on behalf of the Federal Public Service Public Health, Food Chain Safety and Environment (DG Environment).*

8.2 Repellents

Application of skin repellents has become a major method to prevent mosquito bites. However repellents might be used in combination with the above-mentioned measures and not as unique solution. They consist in an active substance that pushes off insects without killing them. They can be applied to all non-covered parts of the body, but care is needed when applying them near mucous membranes such as the eyes and lips and near skin lesions. The advised terms of use must be followed in all circumstances (see manufacturer's recommendations and Table 1).

It is strongly recommended to use only products of which the active substance has been submitted to an in-depth evaluation in the framework of the European biocide directive (98/9/EC) and thus have been approved by the European Union. Active substances that have been or are currently evaluated are:

- NN-diethyl-m-toluamide (DEET)
- IR3535, or EBAAP
- Picaridin, or icaridin, or KBR3023
- Cis- and trans-para-menthane 3,8-diol Rich Botanical Oil (PMDRBO)

Table 1 – Efficient concentrations of active substances of skin repellents according to user age and categories*.

Age and population category	Maximum number of applications per day	Active substance	Concentration
From 6 months to walking age	1	DEET	10-30%
	1	PMDRBO	20-30%
	1	IR3535	20%
From walking age to 24 months	2	DEET	10-30%
	2	PMDRBO	20-30%
	2	IR3535	20%
From 24 months to 12 years	2	DEET	20-30%
	2	Picaridin	20-30%
	2	PMDRBO	20-30%
	2	IR3535	20-35%
Over 12 years	3	DEET	20-50%
	3	Picaridin	20-30%
	3	PMDRBO	20-30%
	3	IR3535	20-35%
Pregnant woman	3	DEET	30%
	3	Picaridin	20%
	3	PMDRBO	20%
	3	IR3535	20%

* Based on "Recommandations de bonne pratique - Protection personnelle antivectorielle", edited by the French travel medicine society and the French society of parasitology, 2009.

Repellents with the chemicals DEET or picaridin provide good levels of protection. Many plant-based products are reported to have some effect (such as Neem) but their use is not recommended because of their short efficiency and the risk of allergy and photoreaction.

Repellents can prevent bites from 4 to 8 hours, depending on the nature and concentration of the repellent, the conditions in which they are applied (temperature and humidity), the species of biting insect, the physical activity of the wearer (sweating can have an influence), or the application of sunscreen. The application has to be renewed after a bathing. The application of sunscreens diminishes the protective effect of the repellents and these should be applied onto the skin at least 30 minutes after the application of sunscreen.

Repellents must not be ingested and application over large areas of the body and extensive use for children is not recommended, particularly for those repellents with high concentrations. They are not recommended to be used on hands and face of children under 30 months. Precautions need to be taken when using these products for young children and pregnant women.

8.3 Mosquito screens and bed nets

The best method to avoid mosquito bites indoors is to check insect-proofness of windows and doors, and to install screens in front of windows that are often open. As biting insects often follow people into buildings (in particular *Ae. aegypti)*, screen doors can also aid in the avoidance of indoor mosquito problems. To work properly, screens should be of the correct mesh, fit tightly and be in good condition (without any hole). As for clothes, nets can be insecticide-treated (i.e. pyrethroids) to increase the protection rate and contribute to control mosquito population, as the mosquitoes that land on them will be killed.

Mosquito bed nets are additional effective measures to prevent mosquito biting during the night. They should be correctly applied (for example suspended over the bed and tucked under the mattress) and be in good condition (without any hole). Their usefulness increases when they are impregnated with pyrethroids (e.g. permethrin, deltamethrin). These products can be safely used and have a long-lasting efficiency with both repellent and insecticide effects, thus contributing to mosquito control. This method is particularly recommended for young children, for people that have to rest at bed or that show severe allergic reactions to mosquito bites, and for people returning from MBD-endemic regions.

8.4 Other methods and tools

There are some other methods and tools on the market that are less suitable but still can to a lesser extent protect from mosquito bites. These can be used as adjunctive measures and are thus only mentioned as such. Examples of these methods are: (i) air conditioning and fan-ventilation, (ii) knockdown insecticide sprays for indoor use (only ad hoc use), (iii) electric diffuser units that release insecticides (e.g. pyrethroids) from slow-releasing mats or liquids and (vi) mosquito coils containing insecticides (which might be used in sheltered outdoor areas and are not recommended for indoor use).

It is recommended not to use those products of which the effectiveness is not proven such as: ultrasonic sound devices, insect repellent bracelets, vitamin B1, homeopathic methods, and sticky tape. Insect light traps are not efficient to trap mosquitoes, as these are not attracted to the light at all, but to chemical components that warm-blooded animal bodies release (of which firstly carbon dioxide). There is no evidence that eating or drinking any particular food can increase or reduce the likelihood of being bitten. Furthermore there is no difference between clusters of people in susceptibility to mosquito bites. Some people do react more severely to insect bites and any activity or physical status (e.g. pregnancy) that increase body temperature and sweating will increase the attractance to mosquitoes. Except in case of MBD outbreak, mosquito coils might be avoided for children, old people, asthmatic and other people that show respiratory troubles.

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Fact sheet #4: Preventive actions targeting risks posed by trans-border movements of merchandises and private vehicles, to support entomological surveillance[v]

9 Introduction pathways

Due to increasing speed and their pervasiveness, modern transport networks, global trade, and tourism are becoming more and more pivotal in the international spread of vectors and the pathogens they can transmit.

9.1 International trade

The primary introduction pathway of exotic mosquitoes into Europe is the global transportation of used tyres. This trade has been largely responsible for the importation of *Aedes albopictus*, *Ae. aegypti*, *Ae. atropalpus*, and *Ae. japonicus* into Europe (transport of eggs deposited on the inner side of the tyres). Dispersal of infested tires from the site of importation throughout inland regions has further facilitated the rapid spread and establishment of *Ae. albopictus*. Used tyres involved in transcontinental trade, as for importation into Europe, are tyres for trucks and all kind of large machines (to be sold as second hand tyres), and of airplanes (to be recapped or recycled). Tyres involved in continental ground transportation include also tractor and car tyres. Used car tyres are also exported to Africa, raising the possibility to export exotic mosquito species (EMS) from the infested areas into new regions worldwide.

Several secondary introduction pathways have been identified for Europe. The Lucky bamboo trade was proven to generate importation of *Ae. albopictus* into the Netherlands (from 2005). These plant cuttings are imported from Asia and, when shipped in containers, transported with some water. Mosquito eggs deposited on the cuttings can thus be transported and larvae could develop in the water. Despite attempts to transport plants in gel as opposed to water, this mosquito continues to be reported at greenhouses in the Netherlands. However so far, these populations have not spread beyond greenhouses, suggesting that these populations are tropical strains (i.e. unable to overwinter under temperate climate). In addition, EMS populations of these greenhouses are controlled. Following acclimation and leaves growing, the Lucky bamboo cuttings are delivered to flower shops throughout Europe. This exportation is of low risk for EMS spread. Lucky bamboo trade in Belgium is of minor economic importance, as only few importers are trading and most of them import the plants through the Netherlands and not directly from Asia. However, other ornamental plants could play a role in the import and local spread of EMS species provided that certain conditions are met: plant cuttings on which the species can lay their eggs when stored in water, and/or that are transported with some water (e.g. aquarium plants).

Other trades/transports which could permit introduction of EMS are those involving goods or equipment that is stored outside for a time and can contain rain water: stone fountain, machines, repatriate military equipment. In Belgium, the presence of military domains nearby the place of establishment of *Ae. koreicus* raised the suggestion that repatriate military equipment could have plaid a role in its introduction. However it is challenging to get information on these trade and traffic. As a global approach, places of exchange of merchandise (where containers are opened and merchandise dispatched) could be surveyed.

[v] *Fact-sheet set up by AVIA-GIS (Francis Schaffner & Veerle Versteirt) on behalf of the Federal Public Service Public Health, Food Chain Safety and Environment (DG Environment).*

9.2 Tourism and transport

Public or private ground transport has been suggested as the main route of dispersal for *Ae. albopictus* along highway systems from Italy to neighbouring countries but also to more distant regions like southern Germany and north-eastern Spain, as well as to the Balkan countries and Malta via ferry traffic. This transport involves mainly mosquito females that enter the vehicles when seeking for a blood meal from humans. However this is only possible when the mosquito population is abundant and the females show an aggressive host seeking behaviour, which is typically the case for *Ae. albopictus*. Other EMS such as *Ae. japonicus*, *Ae. atropalpus*, and *Ae. koreicus* usually do not show such a behaviour. Hitherto, the risk of importation into Belgium of *Ae. albopictus* from southern Europe by this route is low, as widely established populations of *Ae. albopictus* remains quite distant from Belgian borders (540 km in Lyon, FR; 600 km in Ticino, CH) and drivers may have several stops on the way, during which mosquitoes could escape from the vehicles. However the risk could increase in a near future if *Ae. albopictus* proliferates in more close areas.

In addition, the potential exists for further spread of EMS through air and sea travel within Europe. This pathway could be at risk for the spread of *Ae. albopictus* within the Mediterranean area and for the importation of *Ae. aegypti* from Madeira into mainland Europe, or from other EU-overseas associated territories (because of intense traffic). They are very few cases of adult *Aedes* introduction via aircrafts but the numerous reports of so called airport malaria cases in Europe, including in Belgium, prove the introduction of infected adult female *Anopheles*. As for arboviruses, passenger travel is of key importance for their introduction into Europe.

10 Preventing introduction of mosquito vectors

10.1 International trade

Containers of used tyres are usually opened at the final destination, i.e. at the storage place of importing companies. Thus, it is not possible to control/spray these containers, and spraying will anyway not be efficient against mosquito eggs which are almost the only stage that could be imported with tyres (as water is taken out of the tyres before shipping). Prevention measures to apply here should be:

- To identify all companies importing commodity category 'Pneumatic tyres used' (#401220) via competent authorities (i.e. custom services), with data about the quantities and origin of imported merchandise. If not possible, these companies can be identified by requesting information from already known import companies or by contacting professional societies.
- To inform and alert companies importing tyres about the risk of introducing EMS. Employees may be aware of the possibility that opening an intermodal freight container could release mosquitoes; If so, they should immediately alert the team in charge of EMS surveillance and control.
- To request these companies to (1) immediately remove all damaged tyres; (2) store imported tyres properly out of water or if this is not possible, (3) identify tyres which pose the highest risk (imported from countries where EMS proliferate; see ECDC Guidelines, Annex 3) and store them in small and accessible piles for easy surveillance and larval control.

The Lucky bamboo trade seems not presenting a high risk in Belgium. However, a deep investigation might be performed to prevent risk or confirm the absence of risk. Prevention measures should include:

- To identify all companies importing Lucky bamboo whether from Netherlands or directly from Asia (China or Taiwan), based on data from competent authorities (i.e. custom services); Relevant information is more difficult to obtain, as Lucky bamboo are subsumed in a category called 'Cuttings and slips, not rooted' (#060210); However it is possible to identify importers though flower shops, garden centres, and Chinese stores, the best period to investigate being around Chinese new year (January/February).
- To inform main import companies about the risk to import EMS eggs and subsequently breading larvae in the water with the cuttings, and if so to suggest them to immediately alert the team in charge of EMS surveillance.
- To recommend mosquito control actions if larvae or adults are observed in their facilities, preventing them to escape.

Other import trades of goods or equipment that can retain rain water are at risk but cannot be identified except by investigating commerce activities in professional directories. Phone investigation should be performed to identify sites at risk and inform the managers about the risk of EMS introduction.

Also repatriate military equipment are at risk. The Ministry of Defence is already aware about the problem and is applying measures in this regards. However, updated information should be provided to defence services to raise awareness about the risk of importation of some particular species and/or from areas where dengue or chikungunya is endemic/epidemic.

Finally, information should be diffused at platforms of exchange of merchandise, to raise awareness about risk of carrying and releasing EMS during container opening and merchandise dispatching. Posters with a phone number to be called if any biting mosquito is observed would help surveillance.

10.2 Airports and ports

The International Health Regulations (IHR 2005), that came into force on 15 June 2007, aims at preventing the spread of diseases, minimising constraints to the international traffic, with commensurate PH measures and international coordination. It focused on reducing the risks of spread of vectors (1) in international means of transportation, and (2) at points of entry (PoE), in particular ports and airports.

According to the IHR, means of transportation must be kept free of vectors and thus disinsected (article 24 and annexe 5), and PoE must be kept free of vectors in a perimeter of minimum 400m around international transport facilities (annexe 5). However, this is limited to vectors that can carry pathogens of PH relevance, e.g. places where *Ae. albopictus* or *Ae. aegypti* occur and dengue is simultaneously endemic/epidemic.

Airplanes flying in from malaria endemic countries are routinely disinsected, but it is not clear that this is done for places with dengue or chikungunya outbreaks. Therefore, reinforcement of information and controls at a regular basis for the application of this prevention measure is suggested to prevent importation of infectious EMS at airports. Although suitable breeding places (e.g. catch basins) are available, survival of EMS at airports in Belgium is quite low due to lack of dense vegetation used as resting place during warm days. In case of emergency situations (e.g. large-scale outbreaks of vector-borne diseases, in particular in areas routinely not considered as risk areas, e.g. Madeira during the dengue outbreak, or observed increased vector presence on transport pathways), specific control activities should be implemented, especially during the period of May-October to prevent introduction of vector possibly carrying a pathogen.

Cargoes are not known to be routinely disinsected and here as well, reinforcement of information and control for the implementation of this preventive measure is needed. A survey on cargoes considering their provenance and travel duration will be relevant to assess the risk of introduction of an EMS. Passenger ships could represent a risk as well in particular if coming back from Madeira or the Caribbean. On ships sailing on international travel routes, hygiene inspection of the ships is carried out every six months, taken into account the vector risk (in relation to IHR 2005). But here as well, a survey for the risk of introduction of EMS will be relevant as for cargoes, before implementing systematic and specific prevention measure.

The regulation to keep PoE free of vector does not yet applies to Belgium, but it might be considered in the future if an EMS involved in a VBD outbreak of PH relevance proliferates at such a place.

Saniport is responsible for and carries out inspections on airplanes and on ships if needed, but is not in charge of surveillance activities in the airport nor in the ports.

10.3 Ground traffic

Preventive measures on other PoE that are connected to ground traffic might focus on informing road transport companies and drivers as well as tourists (in particular owners of caravans and camping cars) about the risk of carrying EMS (infected or not). Posters or leaflets disposed at platform of exchange of merchandise and main highway parking lots and fuel stations are good means to inform this audience.

10.4 Prioritisation of actions

Table 1 – Prioritisation of preventive actions according to sites at risk for the introduction of EMS.

Priority rank	Sites/trans-border movements	Representatives/audience	Actions
1	International tyre trade	Import company managers	Identify import companies inform and alert companies Recommend adapted site management actions
1	Repatriate military equipment	Defence service	Alert on risk of EMS introduction Identify sites and periods at risk, for surveillance
2	International Lucky bamboo trade	Import company managers	Identify import companies inform and alert companies Recommend mosquito control actions
2	Platform of exchange of merchandise	Road transport companies and driver	Inform about risk of carrying EMS (with or without pathogens)
3	Other trades at risk	Import company managers	Investigate risk on EMS introduction
3	Parking lots and fuel stations along highways	Private drivers, tourists (e.g. camping cars, caravans)	Inform about risk of carrying EMS (with or without pathogens)
3	Ports	Port authorities	Remind and control the application of cargo disinsection Survey cargo and cruise ships to assess the risk
3	Airports	Airport authorities	Remind and control the application of aircraft disinsection

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Fact sheet #5: Trans-boundary data exchange to support entomological surveillance[vi]

To be efficient, and thus to cover all exotic mosquito species (EMS) at risk for introduction and their known pathways of introduction, the surveillance programme need to be readjusted on a regular basis, according to up-to-date information. Crucial information can be extracted from scientific publications but active trans-boundary data exchange will allow to early get original and unpublished information.

11 Trans-boundary data exchange

Information that is relevant for readjusting a Belgian surveillance plan comprises:

- Implementation of surveillance programmes of EMS in neighbouring regions/countries and their results, in particular findings of introduced EMS and the identified introduction pathway, localisation and abundance of established EMS populations and the possible introduction pathways from these areas to Belgium, evidence of spreading of EMS, evidence of pathogen-infection of EMS, and data on the vectorial capacity of these populations;
- Implementation and results of mosquito-borne disease (MBD) surveillance, in particular dengue and chikungunya, as for locally-acquired cases and outbreaks.

Table 1 – Expected information to be shared according to agencies/institutions involved in EMS surveillance in neighbouring countries or at European level.

Country	Surveillance activity	Agency/Institution	Information
France	Surveillance of insect vectors, including EMS	Centre national d'expertise des vecteurs, Montpellier, http://www.cnev.fr/	EMS introduction, establishment, spread, vectorial capacity, control methods and results
Germany	Surveillance of mosquito vectors, including EMS	Bernhard-Nocht-Institut für Tropenmedizin, Hamburg, http://www.bni-hamburg.de/; Friedrich-Löffler-Institut, Insel Riems, http://www.fli.bund.de/	EMS introduction, establishment, spread, vectorial capacity, pathogen infection
Luxemburg	Survey of mosquitoes and pathogen infection	Centre de Recherche Public de la Santé, Luxemburg, http://www.crp-sante.lu/	Mosquito distribution, pathogen infection
The Netherlands	Surveillance of insect vectors, including EMS	National Institute for Public Health and the Environment, Bilthoven, http://www.rivm.nl/; Centre for Monitoring of Vectors, Wageningen	EMS introduction, control results
United Kingdom	Surveillance of insect vectors, including EMS	Public Health England, http://www.hpa.org.uk/	EMS surveillance
Europe	Gathering data on presence/absence of major vectors and their surveillance in Europe, including EMS	VBORNET (European Network of entomological and public health specialists), http://vbornet.eu/	EMS presence/absence, surveillance and control
Europe and larger	Promoting information exchange on surveillance activities,	European Mosquito Control Association and its *'Aedes albopictus* and	Any issue related to EMS

[vi] *Fact-sheet set up by AVIA-GIS (Francis Schaffner & Veerle Versteirt) on behalf of the Federal Public Service Public Health, Food Chain Safety and Environment (DG Environment).*

	including EMS	other invasive mosquitoes working group', http://emca-online.eu/	

Informing neighbouring regions and countries promptly will allow them to rapidly implement or adjust measures which will be beneficial for the whole region. If a new exotic species is found, it is also advisable to inform the scientific community through rapid publication and/or direct communication to identified correspondents in charge of surveillance and/or to the European Mosquito Control Association (EMCA), preferably through EMCA national directors, as scientists often perform mosquito monitoring even if there are no formally validated surveillance plans. Later on, crucial information might be published in scientific journals (e.g. Eurosurveillance, Journal of the EMCA, Parasites & Vectors) to make it available to the whole scientific community.

Identified partners in neighbouring regions (Northern France, Western Germany, Luxemburg, The Netherlands, UK) and expected information to be shared are suggested in Table 1. Details on neighbouring countries are given below.

12 Surveillance of EMS in neighbouring countries

In countries neighbouring Belgium awareness has arisen during the last years on the risk posed by exotic and indigenous vector species (not restricted to mosquitoes). In France, The Netherlands, and UK, a national coordinating agency was established, dealing with vectors and vector-related public health concerns, including surveillance of EMS. In Germany, two networks of institutes collect country-wide data on EMS, whereas in Luxemburg, only a short-term survey of pathogens in mosquitoes was recently performed.

12.1 France

In France, the state is in charge of public and animal health, including prevention and control. There are regional offices that are responsible for the daily organisation and coordination, although the local governments (départements) are in charge of mosquito control. In case of a MBD outbreak, the state funds vector surveillance and vector control however only around cases. Otherwise, the départements must implement vector control (and surveillance when the vector is widely established). This decision tree applies to the situation for mainland France, it differs in the overseas department and other associate territories. Local constraints have often led to adaptations in the authorities deemed to be in charge of vector control.

In mainland France, public mosquito control agencies (Ententes InterDépartementales pour la Démoustication, EID) have been created in several French regions (the first one in the 60s), and others more localised public institutions exist as well. Thus, mosquito surveillance and control is mostly performed by public agencies, which are also mandated by the French ministry in charge of health for surveying and controlling EMS. Declaration of dengue and chikungunya is mandatory and thus, cases (imported and autochthonous) are surveyed by regional health authorities, which transmit the information to EIDs for rapid implementation of vector surveillance and control around cases in areas where *Aedes albopictus* is established and active. These procedures are described in a 'plan anti-dissémination du chikungunya et de la dengue en métropole' (first edited in 2006) and its annual 'circulaire ministérielle'. Also a 'Guide de procédures de lutte contre la circulation du virus West Nile en France métropolitaine' is implemented since 2002. Both are country-wide integrated plans (surveying both vectors and diseases), with risk levels defined for local (department) situations.

Recently France has set up an expertise cluster devoted to the different aspects of vector surveillance and control, the Centre national d'expertise sur les vecteurs (CNEV). The CNEV has been established for an initial five-year period, under the authority of the Ministries of Health and of Agriculture, in liaison with the Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (Anses). It is a multidisciplinary structure, and with a perspective to support decision making, has in charge the tasks of rapidly and efficiently mobilizing the available French expertise and skills in terms of medical and veterinary entomology, vector control, and the human and social sciences applied to public health. The establishment of such an expertise cluster was one of the priorities set by a collegial audit of vector control in France, which published its conclusions in 2009. Data exchange can thus best be organised through this agency.

12.2 Germany

Little information is found on the decision making tree of Germany although the situation appears to be to a certain extent similar as in Belgium, as being a Federal State with scattered national/regional competences. Two major competent bodies are the ministry of health (BMG) and the ministry of food safety, agriculture and consumer safety (BMELV). The Bernhard-Nocht-Institut für Tropenmedizin is the reference Institute for all topics related to tropical diseases and is currently involved in one ample study network on mosquitoes in Germany, which associates also the KABS, a public mosquito-control agency from Baden-Württemberg. A second network of other institutes (Friedrich-Löffler-Institut, Leibnitz-Centre for Agricultural Landscape Research) aims at collecting data throughout the country and editing a mosquito atlas for Germany. Both networks survey EMS but there is no clear willpower for controlling EMS, except in areas already subject to mosquito (pest species) control programmes. Mosquitoes are occasionally screened for pathogens, but there is no integrated (vector and MBD) surveillance plan.

12.3 Luxemburg

Very little data on mosquitoes exists at all for Luxemburg. Only recently, a short-term survey (2010-2012) has been implemented for pathogen screening in mosquitoes, performed by the Centre de Recherche Public de la Santé, but data are not yet published and there is no information on plans or willingness for further surveillance.

12.4 United Kingdom

Animal health surveillance and control is managed by the Animal Health and Veterinary Laboratories Agency (AHVLA) which is an executive agency of the Department of Environmental, Food and Rural Affairs (DEFRA).

Human health surveillance and control is managed by Public Health England (formerly Health Protection Agency), Health Protection Scotland, Public Health Wales and Communicable Disease Surveillance Northern Ireland. All of these are 'executive agencies' of the Department of Health England, Welsh Assembly, Scottish Executive, Department of Health Northern Ireland, respectively.

The four countries collaborate through working groups. Emerging infectious diseases are tackled by an expert group, the Human Animal Infections Risk Surveillance (HAIRS) group, which is chaired by PHE and includes members from Department of Health England, DEFRA, Scottish Executive, AHVLA, Public Health Wales, Communicable Disease Surveillance Northern Ireland, and Food Standards Agency.

The HAIRS group reports to the National Expert Panel of New and Emerging Infections, which in turn reports to the Chief Medical Officer and Chief Veterinary Officer. They also report to the Secretary of State for Health (i.e. Minister of Health), and Secretary of State for the Environment, Food and Rural Affairs (i.e. Minister of Environment). The Chief Executive of PHE reports directly to the Secretary of State for Health (i.e. Minister of Health), via his Permanent Secretary. Exchange of data on mosquito surveillance might be best organised in cooperation with PHE.

12.5 The Netherlands

Surveillance of EMS is under the competence of the federal government who founded a special centre in 2009 (Centre for Monitoring of vectors, CMV) which is part of the Food and Drug Administration (NVWA), an agency of the Ministry of Economic Affairs, Agriculture and Innovation. The control of EMS is carried out using the Act of Public Health as underlying motivation. The responsibility for implementation of this law lies with the mayors of the communes involved (and not the entire town council). The mayor is also responsible to ensure that control is performed. However, the statutory duty to protect public health is under the responsibility of the communes (e.g. councils), which have transferred this responsibility to the health authorities and municipal health services. So, if dengue would emerge, the municipal health services would be in charge of the issue but would work in close collaboration with the National Institute for Public Health and the Environment (RIVM), an agency of the Ministry of Public Health. The RIVM directs by law the vector control, but the coordination is done by the CMV. So far there is not much expertise in controlling vectors and in practice only two private companies have acquired the necessary knowledge and are mandated to perform mosquito control.

There is currently no link with 'Koninklijk Instituut voor de Tropen', although there is a close collaboration with different other institutions in the Netherlands. Correspondent partners for Belgium might be the RIVM and the CMV.

13 International networks

In 2008 a consortium was set up to establish a European Network of entomological and public health specialists (VBORNET) in order to assist ECDC (European Centre for Disease prevention and Control) in its preparedness activities on vector-borne diseases. Though this network, data on major vector species, including EMS, are gathered. This allows producing updated distribution maps as well as a surveillance map for EMS, on a tree-month basis, and fact sheets and risk assessment documents. Through this system, up-to-date presence/absence data are available at territorial units for statistics NUTS3 level, for whole Geographical Europe. Sharing any new presence data for EMS and other vectors will contribute to support risk assessment over Europe.

The European Mosquito Control Association brings together most of the European vector entomologists. One of its core activity is the '*Aedes albopictus* and other invasive mosquitoes working group' that promotes and organises information exchange on any issue related to EMS. Another activity is the going-on production of 'Guidelines for the control of invasive mosquitoes and associated vector-borne diseases on the European continent', with support from WHO European Region. The EMCA has identified national directors in each European country, and information on important EMS issues might be communicated through these representatives.

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Fact sheet #6: Animal surveillance

1 Exotic and native mosquitoes of relevance for animal health

A recent country-wide inventory project (MODIRISK, 2007-2010) confirmed the presence of 25 mosquito species in Belgium, of which two are exotic (see Fact sheet #1/Table 1). In July 2013, *Aedes albopictus* was found for the second time at the same import site as in 2000. Historical records indicate the possible presence of at least 7 more indigenous species, being observed at some occasion, but because of their scarcity, they might not represent any risk to public health (PH) or animal health (AH) in Belgium. Besides Chikungunya and Dengue viruses, several mosquito-borne pathogens circulate in Europe, affecting only humans or animals, or both (zoonosis).

Two pathogens responsible of zoonosis are nowadays observed frequently in central-western Europe: Sindbis virus (genus *Alphavirus*) and Usutu virus (genus *Flavivirus*). Sindbis virus is well known to infect humans in Scandinavia, and the virus was recently reported from birds, which are the amplification hosts, in southern Germany. Usutu virus affects mainly birds, with some mortality observed in Germany and Switzerland, but two human infections were reported from Italy.

West Nile virus (WNV) is another zoonosis pathogen (genus *Flavivirus*) that circulates in Europe. Outbreaks are frequent in southern and eastern Europe since the late 1990's. The transmission cycle of WNV involves several mosquito species (Table 1), birds as reservoir and amplification hosts, and mammals as dead-end hosts. Among these, horses and humans are the most susceptible and present occasionally severe infections. Mosquitoes can act as reservoir (the virus overwinters in mosquito females or is maintained by vertical transmission), amplifier or enzootic vector (transmitting the virus from bird to bird), or bridge vector (transmitting the virus from bird to mammal).

Table 1: Mosquito species occurring in Belgium and their putative role in WNV transmission.

Species	Distribution in Belgium	Naturally infected	Laboratory vector	Field vector	Vector role
Aedes albopictus	-[i]	+	++++	?	Bridge vector
Ae. cantans	+++	+	?	?	Bridge vector
Ae. caspius	+	+	+	?	Bridge vector?
Ae. cinereus/geminus	+++	+	?	?	Enzootic vector
Ae. j. japonicus	+	+++	++++	?	Bridge vector
Ae. geniculatus	++	-	++	?	Bridge vector
Ae. punctor	++	-	++	?	Bridge vector
Ae. sticticus	+	+	?	?	Bridge vector
Ae. vexans	++	+++	++	?	Bridge vector
Anopheles maculipennis s.l.	+	+	?	?	Bridge vector?
Coquillettidia richiardii	++	++	?	?	Bridge vector
Culiseta morsitans	+	+	?	?	Enzootic vector
Culex pipiens	++++	++++	+++	+++	Amplifier, reservoir, bridge vector

[i] Observed at one occasion only.

Among the Belgian mosquito fauna, thirteen species have been identified in other countries as vector or putative vector of WNV (Table 1).

Although WNV has been identified in many field-caught mosquitoes, species do not share the same vectorial capacity. For many European species, information on vector competence (=laboratory vector) is still lacking. The ability to host a virus is genetically determined and variations exists between different populations of a species, and more importantly, between virus lineage and strain. Three species show significant vector potential as they have been found infected in nature, exhibit moderate or high level of vector competence, and currently occur in Belgium: *Cx. pipiens*, *Ae. vexans*, and *Ae. japonicus*.

Based on the present population densities, feeding preferences, vector competence, and role during previous West Nile outbreaks elsewhere, *Cx. pipiens* is the most likely potential vector in Belgium, followed by *Ae. vexans*. If the exotic species, *Ae. j. japonicus*, becomes widespread it could also play a role in spreading WNV, which again stresses the importance of surveillance and elimination. Furthermore, a re-introduction and widespread establishment of an acclimated strain of *Ae. albopictus* in Belgium would further increase transmission risks.

The possible role of soft ticks in the transmission of West Nile virus has also been repeatedly reported. West Nile virus was isolated from soft ticks *Argas* species (Argasidae) and from hard ticks *Hyalomma* species (Ixodidae). Ticks may play a role in the geographical distribution and the maintenance of West Nile virus, but no tick species currently present in Belgium are known to be able to maintain or transmit the virus. A study testing *Ixodus ricinus*, the most common tick in Belgium, as a reservoir for West Nile virus showed that the ticks became infected after feeding upon viraemic hosts, but were unable to maintain the virus.

Besides West Nile fever, other mosquito-borne equine encephalitis including Japanese encephalitis (JE), Western equine encephalitis (WEE), Eastern equine encephalitis (EEE), and Venezuelan equine encephalitis (VEE) are considered for sanitary restriction measures (Arrêté royal du 1er février 2012 portant des mesures de police sanitaire relatives aux encéphalites virales des équidés). These diseases are listed as notifiable by the World Organisation for Animal health (OIE) as well as in Belgium. Viruses belong to *Flavivirus* genus (family Flaviviridae) for JE, and to *Alphavirus* genus (family Togaviridae) for EEE, VEE, and WEE. The epidemiological risk for Belgium is higher for WN than for the other encephalitis, EEE, VEE, and WEE, which are only present on the American continent and related to specific ecosystems (with in some cases rodents acting as amplifying hosts). JE has an intermediate position on term of epidemiological risk, as it could be introduced into Europe via birds (and pigs acting as amplifying host). Mosquito species having shown to be competent in the laboratory or naturally infected on the field are occurring in Belgium for JE virus (both invasive *Ae. japonicus* and *Ae. koreicus*), and for EEE virus (*Ae. cinereus*, *Ae. vexans*, *Cs. morsitans*, *Cx. pipiens*).

2 Surveillance of West Nile virus in Belgium

2.1 Basic surveillance

Without evidence of circulation of WNV, a number of basic measures are applied to evaluate the situation in Belgium.

Partners: The Veterinary and Agrochemical Research Centre (VAR), the Belgian Royal Institute of Natural Science (IRSNB), the Agentschap voor Natuur en Bos (ANB), the Direction générale de l'agriculture, des ressources naturelles et de l'environnement (DGARNE), the Leefmilieu Brussel/ Bruxelles-Environnement (BIM/IBGE) and the Federal Agency for the Safety of the Food Chain (FASFC).

Aim: Early detection of introduction/circulation of west Nile virus in birds.

Actions:

- Passive surveillance, by analysing carcasses of dead corvids collected by bird shelters for virus detection;
- Active surveillance, by (1) serological analyses of blood samples collected from captured corvids, (2) virus detection in oral swabs collected from migrating passerines captures during springtime, and (3)

serological screening of serum samples collected from goose and duck in the context of the avian influenza surveillance programme.
- Serological analysis of blood samples collected from cattle collected during the annual winter screening.

In addition, VAR and FASFC have agreed by convention to perform serologic screening of bird, equine and bovine samples, to improve diagnostic methods.

Competent authorities for surveillance, prevention and control of diseases in wildlife animals are the Regions, and thus in concrete terms placed under the competence of the following regional authorities: the Agentschap voor Natuur en Bos (ANB), the Direction générale de l'agriculture, des ressources Naturelles et de l'environnement (DGARNE), and the Leefmilieu Brussel/Bruxelles-Environnement (BIM/IBGE).

2.2 Surveillance in case of outbreak

In case of suspicion or evidence of WNV circulation in horses, alternative measures are applied.

Partners: FASFC, ANB, DGARNE, BIM/IBGE and VAR

Aim: To provide evidence on the source of the infection and assess the extent of the circulation, i.e. whether it consists of one isolated infection or a spread in the Belgian territory.

Actions:
- In case of a suspicion of WNV infection:
  - Clinical examination of the suspected case;
  - Analysis of serum and cerebrospinal fluid collected from clinical cases (also cerebrum from dead animals):
    - ELISA-test on serum for detection of WNV antibodies, followed by neutralisation test in case of a positive ELISA result,
    - Virus isolation or RT-PCR on cerebrospinal fluid or cerebrum for the detection of WNV;
  - Epidemiological investigations and contact tracing;
  - Enhancement of passive clinical surveillance in poultry, wild birds, horses, and humans.
- Additional measures in case of confirmation of WNV infection:
  - Definition of a surveillance zone (minimum 50km radius) ;
  - Serological screening of horses located in the vicinity of the confirmed case;
  - Vector surveillance for mosquito's in the vicinity of the confirmed case (including virus detection);
  - Additional active surveillance in horses, birds, sentinel animals, or insects in other regions.

2.3 Prevention

Prevention of WNV infection for animal health is organised in 3 different lines: vector control, horse vaccination, and mosquito bite avoidance.
- Horse vaccination: a vaccine is registered in EU and is considered efficient to control the disease.
- Vector control: aims at source reduction, i.e. reducing larval habitats and their immature mosquito populations (e.g. turning over wheelbarrows, pots, or cans that accumulate water or adding drain holes so they do not retain water; removing and replacing tyres on ensilage by sandbags; cleaning out livestock water troughs on a weekly basis…), and limiting the presence of adult mosquito resting sites such as large hedges and dense plant landscaping near areas where horses are housed.
- Mosquito bite avoidance: can involve three methods as (1) spatial, by keeping horses inside stables at night and utilizing screens on windows and doors to keep mosquitoes out; (2) temporal, by keeping horses inside during dawn and dusk which are the peak hours of mosquito feeding for most of bridge vectors; and (3) chemical, by use of chemical repellents specifically designed for use on horses.

These measures could be implemented in a region as soon as WNV circulation is reported. Thus, the early warning system based on wild bird surveillance (cf. section 2.1) is helpful to define the period to engage or

intensify the prevention measures. Bird watching societies could contribute to bird surveillance by collecting dead birds.

3 Other vectors of relevance for animal health

Information on the presence and distribution of *Culicoides* biting midges (Diptera: Ceratopogonidae) has been updated over the last years thanks to the implemented monitoring (under the responsibility of the FASFC) following the Bluetongue outbreak in 2006. Over a five-year period, several farms and sentinel herds were intensively monitored across Belgium: 44 sites were studied during 1-5 years, while sporadic sampling was performed at 73 additional sites. This resulted in a large amount of information, however focused on species that breed in agriculture areas. Only basic information exists on species breeding in other habitats. Overall, 49 *Culicoides* species were so far collected from Belgium, and vectors of Bluetongue and Schmallenberg viruses (that emerged in 2011) in Belgium belong to the *C. obsoletus* and *C. pulicaris* groups.

Research on ticks in Belgium was mainly focusing *Ixodes ricinus*, although valuable information is present at different institutes (such as the Royal Army) and universities. However no large-scale surveillance activities have been implemented in Belgium. Based on ancient and recent records, about 21 species are reported from Belgium. Tick-borne pathogens of animal health relevance are bacteria from genera *Anaplasma*, *Babesia*, and *Borrelia*, mainly transmitted by *Ixodes* species.

In 2013, a one-year surveillance study on mosquitoes, ticks and biting midges was launched at the Institute of Tropical Medicine and funded by FASFC.

This basic information, especially of tick distribution and information on the risks to animal health of both ticks and *Culicoides* should be kept updated. The need for ensuring a surveillance on those vectors and the frequency proposed (e.g. on the basis of a rotation with the surveillance on mosquitoes) should be carefully considered, as well as the pivotal necessity to maintain and enhance the existing expertise.

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Fact sheet #7: Competent authorities to perform wildlife and domestic animal surveillance

The Belgium mosquito fauna comprises both indigenous and exotic mosquito species (EMS) that are potential vectors of pathogens of animal health importance (see Fact sheet #6). To prevent mosquito-borne diseases (MBD), a key issue is to early detect pathogen circulation. This can be performed by surveying vectors or, often more efficiently, animal hosts.

1 Organisation of animal surveillance in Belgium

Animal health is organized at the federal level except for issues related to wildlife that are regions-dependent. In 2009 the notification of wildlife diseases was separated from the notification of domestic animal diseases. The competent authorities to perform animal surveillance are thus situated on both federal and regional levels. Domestic animal surveillance is the responsibility of the federal government and falls within the remit of the Federal Agency for the Safety of the Food Chain (FAVV/AFSCA), whereas wildlife surveillance is the competence of the regions. In 2011, a working group 'wildlife diseases' was created within the Directorate Animal Health and Safety of Animal Products of the FAVV/AFSCA. The objectives of this working group are (1) to facilitate the information exchange about wildlife diseases between the federal and regional levels, (2) agree about surveillance networks, and (3) streamline the reporting to the national and international authorities (especially to the World Animal Health Organisation, OIE).

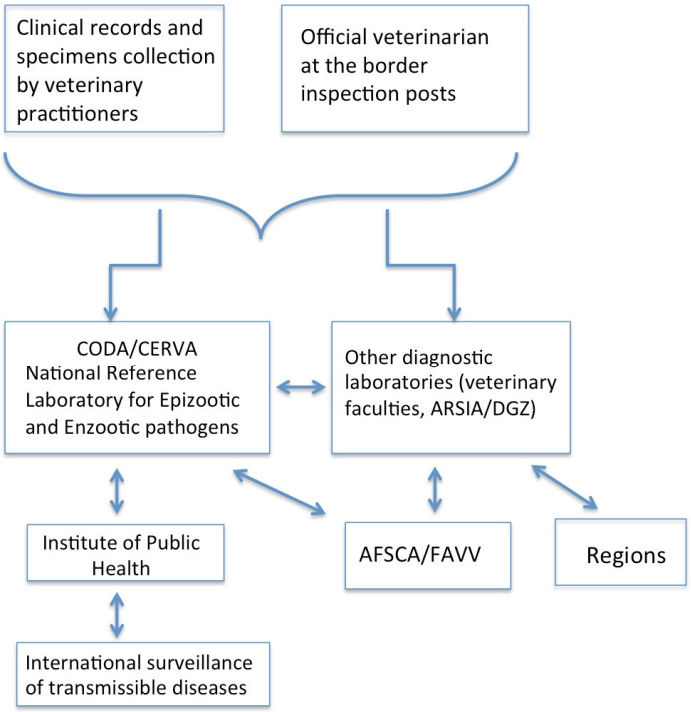

Figure 1: General flow chart of the surveillance system of live animals for animal and zoonotic viral diseases, adapted from VIRORISK (from Dal Pozzo *et al.* 2013)

The recently conducted VIRORISK project (Belspo, 2009-2011) generated a flow chart of the surveillance system for animal and zoonotic diseases and detailed the role of the agencies/institutions involved (Dal Pozzo *et al*. 2013).

First 'care and surveillance' level is often provided by the veterinary practitioners collecting information based on clinical surveillance in the field. At border control posts, veterinary checks on animals entering the country from third countries are being conducted based on procedures laid down by the European Union. These are in fact reinforced checks carried out by the competent federal authorities.

The link between the field and the administration is provided on one hand by the regional organisations ARSIA (Association Régionale de Santé et d'Identification Animales, for the Walloon region) and DGZ (Dierengezondheidszorg Vlaanderen, for Flanders) and other diagnostic laboratories at different universities such as the laboratories of Animal Virology of the University of Ghent and Liège.

2 Federal institutes responsible for animal surveillance

Two main federal institutes are responsible for the animal surveillance in Belgium, the Federal Agency for the Safety of the Food Chain (AFSCA/FAVV) and the Veterinary and Agrochemical Research Centre (CODA/CERVA).

AFSCA/FAVV (The Federal Agency for the Safety of the Food Chain) is an executive agency that has authority over the whole Belgian territory, and is in charge of the inspection and control within the agricultural and food sector. It lays down the operational standards applicable to businesses and integrates all official control and inspection services for the food chain (including the import/export of wildlife). Its task is to guarantee the safety of the food chain for public health, and to protect human, animal and plant health. It is responsible for risk evaluation, management and communication. This is done via controls, analyses and expertise of food, tracing primary compounds of foodstuffs, and communication.

The agency relies on the opinion of an advisory body (including representative of the AFSCA/FAVV, of public authorities, business associations, and animal protection associations) and a scientific committee (including members of universities and research centres). The scientific committee is in charge of risk assessment. To perform the controls, the organisation relies on different provincial control units (11 PCU).

AFSCA-FAVV funds research activities related to the safety of the food chain, including entomological and animal surveillance activities.

CODA/CERVA (Veterinary and Agrochemical Research Centre) is a scientific institute, administratively linked to the Federal Public Service Health, Food Chain Safety and Environment (SPF). It is under the supervision of the Minister of small and medium enterprises, traders, agriculture and scientific policy. The CODA-CERVA provides scientific and technical support, at both the national and international levels, concerning the control of communicable animal diseases, the protection of public health, and the guarantee of animal and plant food production quality from the standpoint of zoonosis, residues and contaminants.

The CODA/CERVA consists out of four Operational Directorates: 1) Interactions and Surveillance, 2) Viral Diseases, 3) Bacterial Diseases, and 4) Chemical Safety of the Food Chain.

The CODA/CERVA Operational Direction "Interactions and Surveillance" contributes to the missions of the Federal Agency for the Safety of the Food Chain (FASFC), of the Federal Agency for Medicines and Health Products (FAMHP) and of the FPS Health, Food Chain Safety and Environment. One of its operational units (Coordination of veterinary diagnosis - epidemiology and risk assessment) provides amongst others scientific opinion supporting internal and external (FASFC, FPS) health management, evaluates control programmes, monitors surveillance programmes of import risks, and develops control and surveillance instruments for the rapid identification of rare or (re)emerging diseases in livestock and wildlife.

3 Regulation system for animal health and zoonosis

Today, animal health is still a federal competence but will, according to the sixth state reform (2013), be regionalised. The legislation is thus organised at federal level whilst the cooperation is done at the whole

country (through AFSCA/FAVV) and with one central reference lab (CODA/CERVA). Although the competence of wildlife surveillance lies with the Regions, the welfare of wild animals remains a federal competence (cf. Chapter 1) and is described within the federal legislation.

The prevention of zoonosis is defined in the law of 24/03/1987; including a closed list of notifiable diseases. Preventive measures are organized by the FPS Health, Food Chain Safety and Environment. However there is little harmonisation between this list used in Belgium and two other lists that are currently used on European level (OIE: http://www.oie.int/fr/maladies/fr_classification2010.htm?e1d7 and EU: http://ec.europa.eu/food/animal/diseases/adns/index_en.htm). A scientific committee, assembled by AFSCA/FAVV, recently provided advice on the diseases per animal group that should be included in the Belgian list (Sci Com 2010/16, http://www.afsca.be/wetenschappelijkcomite/adviezen/2012.asp).

Information on these diseases is centralized at CODA/CERVA and based on this information AFSCA/FAVV can organize and coordinate specific measurements throughout Belgium. In the law of 1987 a part on emergent diseases was included, that is the responsibility of the FPS Health, Food Chain Safety and Environment. To overcome the gap in emergent diseases, "MoSS" was created on behalf of Belgian health authorities via the web application *MoSS-emergences2*, a system for early detection and identification of emerging syndromes was created. This system relies on veterinarians and other observers to detect unusual clinical cases in domesticated and wild animals.

VIRORISK conducted a SWOT analysis on the current regulation system in Belgium (see Figure 2), revealing weaknesses especially on regional level.

Figure 2: SWOT analysis of the regulation system for animal health and zoonosis.

Internal approach	**Strengths** Federal competence With regional initiatives (limited) List of diseases that are notifiable Complex structures, with a networking on the whole territory including stakeholders (vets and farmers)	**Weaknesses** Regional initiatives are not coordinated Closed list of diseases, slow response new emergent diseases "One health"
External approach	**Opportunities** Harmonization EU List of diseases at EU and international levels should be used to harmonize list	**Threats** No measure to avoid entry on the territory (e.g. no quarantine) Global change

4 Agencies/institutes involved in the surveillance of West Nile virus

As arboviruses can rapidly spread over a country, early warning signs of an emerging disease can be crucial for implementing control measures in time. In the United States and Canada, bird mortality is one of the first indications that West Nile virus is circulating in a given area. However, as birds in Europe often do not display symptoms for West Nile when they are infected, the disease might go undetected until human or equine cases occur. However, with more virulent virus strains it could be possible that bird mortality is observed in Eurasia as well (e.g. Israel 1998, Hungary 2004-2005. An active surveillance of sentinel birds was set up in France between 2002 and 2007 to monitor West Nile activity, but it yielded limited results in relation to the financial resources invested in the system (ECDC 2009). Therefore, France has moved to surveillance of dead birds alone, which is less time consuming and costly. In Belgium, wild birds are being surveyed since 2009 in a joint research program of the Veterinary and Agrochemical Research Centre (CODA-CERVA) and the Royal Belgian Institute of Natural Sciences (RBINS) authorised by the Federal Agency for the Safety of the Food Chain, along two axes:

- A passive surveillance of dead corvids, collected by animal rescue centres and tested for the presence of viral pathogens;
- An active surveillance in which (i) blood samples from captive corvids are analysed by serology, (ii) oral swabs of migrant songbirds caught in the spring are analysed for virus detection, and (iii) sera of geese and ducks, collected in the context of the surveillance for avian influenza are screened.

Furthermore, the Federal Agency for the Safety of the Food Chain (AFSCA-FAVV) support the Veterinary and Agrochemical Research Centre (CODA-CERVA) in the serological screening of bird, horses and cattle samples to refine the current used diagnostic methods and to asses monitoring and surveillance activities (especially in case of persistent absence of West Nile virus on our territory). For public health, the national reference centre for West Nile is the Institute of Tropical Medicine (ITM).

When West Nile virus is detected in the samples by CODA-CERVA, the subsequent actions that need to be taken are under supervision of the AFSCA-FAVV. The latter institute has described the scenario with steps and decisions that need to be taken in case of a West Nile outbreak (http://www.favv-afsca.be/dierengezondheid/westnilekoorts/_documents/ScenarioWNVv1.0_nl_20091201.pdf) .

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Fact sheet #8: Risks levels and competent authorities

5 Risk levels, recommended action, and competent bodies

Combining entomological and epidemiological situation, six risk levels can be identified for exotic mosquito species (EMS) and mosquito-borne disease (MBD) in Belgium (see also Fact sheet #1, Table 2):

Level 0: EMS is absent.

Level 1: An EMS is reported in limited number and is active.

Level 2: An EMS is established and active.

Level 3: An EMS is abundant and active.

Level 4: An EMS has reached a critical density (average number of eggs per trap >200; residents complain).

Level 5: An EMS has reached a critical density and generates a MBD outbreak.

Recommended actions and competent authorities are summarised in Table 1. The risk levels are defined on an entomological basis, but from level 1, the risk analysis takes into account the potential presence of MBD cases (both imported and locally-transmitted). Risk level changes are decided by the EMS platform (Risk Assessment Group (RAG) extended to environment and animal health), based on updated field information, and notified to regional, provincial, and local authorities.

The EMS platform should be assisted by a pool of experts to be nominated to support decision making. Its mission would be to propose any change in the prevention plan and appropriate measures according to the risk levels, and to determine the outbreak areas. It would gather experts in entomology, epidemiology, clinic and virology, together with delegates from the concerned federal, regional and community level authorities. It could be permanently active or active only during a defined period linked to entomological and/or epidemiological events.

Table 1: Competent bodies and current and recommended actions according to the risk level.

	National	Federal	Regional/Communities	Provincial/ Local
Level 0: EMS is absent.	• Global coordination: **EMS platform (to be created)**	• Public health surveillance: **??** • Animal health surveillance: **AFSCA/FAVV** • Sanitary control of ships and planes (cf. IHR): **Saniport**	• Entomological surveillance (including at airports, cf. IHR): **Regions (Ministries of Environment)** • Sanitary control at ports and airports: Regions? or Communities? • Animal health surveillance (wildlife): **Regions (Ministries of Environment)** • Public health surveillance: **Communities** Preparedness for action plan in case of introduction and establishment of EMS: **Regions (Ministries of Environment)**	**Provinces, municipalities:** Possibilities to contribute to the entomologi-cal surveillance.

Table 1 (continued): Competent bodies and current and recommended actions according to the risk level.

	National	Federal	Regional/Communities	Provincial / Local
Level 1: An EMS is reported in limited number and is active. Absence of local transmission of MBD.	**EMS platform:** Alert competent authorities. Recommended to establish a risk assessment for EMS and MBD and to develop an integrated control plan: - analysis and identification of introduction pathways and sites; - listing and mapping of risk of PoE; - defining EMS at risk for introduction and establishment; - defining mosquito collection strategy and methods; - defining mosquito and pathogen identification capacities; - defining diagnostic and control capacities.		In addition: Application of IHR to make airports and ports free of vectors: **Regions** Development of regional plans for EMS and MBD surveillance: **Regions (environment competences) and Communities (public health competences)**: - survey and control at the colonized sites; - collect biological parameters; - identify origin and pathways of introduction; - identify possible spread and passive dispersal; - implement the EMS and MBD control measures to prevent establishment and spread; - identify critical issues and preventive measures to be discussed at national level; - report to EMS platform.	In addition: Possibilities to contribute to the entomological control: **Provinces, municipalities, Civil Protection Service** **(for each level)**
Level 2: An EMS is established and active. Absence of local transmis-sion of MBD, presence of imported MBD cases.	**EMS platform:** Recommended to: - Reinforce surveillance activities around the area where the EMS has established; - identify the optimal surveillance period; - define and support the local control activities; - establish a risk assessment on potential spread and areas at risk.	As in level 1.	In addition: • Entomological control: **Regions (Environment)** Intensification and extension of surveillance. Attempt to eliminate EMS, or at least block the spread. • Human health control: **Communities (Health)** Intensification and extension of surveillance of MBD. Attempt to eliminate MBD, or at least block the spread. • Animal health surveillance (wildlife): **Department of environment**	In addition: Cooperation in dissemination of information to residents, to obtain community participation and avoiding local conflicts: **Provinces, municipalities**
Level 3: An EMS is abundant and active. Absence of local transmis-sion of MBD, presence of imported MBD cases.	**EMS platform:** In addition: - optimise surveillance and control strategies; - conduct epidemiological survey to detect MBD cases; - inform the local public health authorities; - communicate to regional and local authorities to optimize surveillance and control.	As in level 1.	In addition: **Regions (Environment)** - implement optimised/ intensified surveillance and control strategies, to reduce the population density; - inform the public for community participation in source reduction.	As in level 2.

Table 1 (continued): Competent bodies and current and recommended actions according to the risk level.

	National	Federal	Regional/Communities	Provincial/ Local
Level 4: An EMS has reached a critical density (average number of eggs per trap >200; residents complain). Presence of cases of local transmission of MBD.	**EMS platform:** In addition, recommended to: - inform European, regional and local authorities; - communicate to reference labs, general practitioners, pharmacists - reduce mosquito population around cases (adulticiding, larviciding).	As in level 1.	In addition: **Regions (Environment)** - survey mosquito density, activity, and control measures efficiency.	As in level 2.
Level 5: An EMS has reached a critical density and generates a MBD outbreak. Presence of local outbreak(s) of MBD.	**EMS platform:** In addition, recommended to: - inform international health authorities (ECDC); - inform local authorities; - prevent the spread of the MBD by intensive control measures within given perimeters.	As in level 1.	As in level 4.	As in level 2.

6 Tasks according to the authority level and collaborative links

Table 2 gives an overview of key partners that could play a role in the development, implementation and coordination of risk assessments and surveillance and control plans in Belgium.

National level

Risk assessment and management plans for EMS and potential MBD are as a principle best developed at the national level, in collaboration with all competent authorities (federal, regional/community and provincial/local level). Thus, it is proposed at this stage to create an EMS platform (see Fact sheet #2), which will take over this coordination task.

Cooperation with the provincial/local competent bodies should be launched at the initial phase of drawing the surveillance program, to better exploit in-country competence and to design a program that can be implemented by the provincial/local authorities if necessary.

Federal level

At federal level, the veterinarian services may contribute to surveillance activities of zoonotic vector borne diseases. Saniport performs surveillance in airplanes and on ships and implements EMS surveillance through goods surveillance.

Regional level

On regional level, Flanders (Community and Region), the Walloon region, the Brussels-Capital region, the COCOF, the VGC, the COCOM-CCC/GGC and the German-speaking Community are the competent bodies for all surveillance, monitoring and control of activities related to invasive and native mosquitoes (departments of public health as environment), except those related to the federal competences (see above).

For risk level 1 and 2, surveillance and control strategies are to be developed and implemented at the regional/provincial level, taking into account the national guidelines. These plans could, in specific cases, be elaborated in cooperation with local authorities (local PH units, provinces, municipalities) and technical units (competent in field entomology). In all cases, it is recommended that this happen under the coordination of the national EMS platform.

Cooperation with the local authorities (local PH units, provinces, municipalities) should be established in the initial phases of the plan's organization, to better exploit local knowledge and capacities and better adapt the program to the specific local situation.

Local level

On a local scale, the province, the municipalities, and local PH units (especially in the provincial capitals) that have sites at risk for EMS and/or MBD introduction on their territory should be involved in the surveillance and control activities.

Entities have still to be identified for the management of surveillance and mosquito control applications. The Civil Protection Service could contribute to mosquito control application.

Table 2: Overview of the responsibilities of key players in the surveillance and control plans of EMS and MBD

Competent bodies	***Action list***
Federal Ministry in charge of Environment and Health : Federal Public Service Public Health, Food Chain Safety and Environment	For what concerns its competences in Public Health: - International negotiation on regulations to prevent/limit the worldwide spread of EMS and MBD (Saniport). - Responsible for the application of IHR (Saniport). For what concerns its competences in Environment: - Manage appropriate biocide registration and allow the placing on the market and the use thereof.
Regional Ministries in charge of Environment	- Contribution to the coordination of risk assessment and management plans for zoonotic MBD in wild animals. - Contribution to the coordination of risk assessment and management plans for biodiversity and to the assessment of side effects of mosquito control measures. - Promote environmental friendly mosquito control measures/use of biocides. - Management of surveillance and mosquito control applications.
Public health services: Direction Générale de la Santé, Fédération Wallonie-Bruxelles; Vlaams Agentschap zorg en gezondheid	Surveillance of MBD (i.e. mosquito pathogen screening, human cases) and to the assessment of health impact of control measures.
Federal veterinarian services: Agence Fédérale pour la Sécurité Alimentaire ; Centre d'Etude et de Recherche Vétérinaires et Agrochimiques	Surveillance of zoonotic MBD (i.e. animal cases livestock and pets, mosquito pathogen screening).
Municipalities	Participation in implementation of surveillance and mosquito control measures. Contribution to communication to the local residents to obtain community participation.
Research institutions, like : Institut de Médecine Tropicale, Université de Liège, Université Catholique de Louvain-la-Neuve, Royal Museum of Natural Sciences …	Scientific contribution to the surveillance of EMS. Support risk assessment/management activities, the efficacy/quality assessment of mosquito control applications and their side effects (impact on non-target fauna, impact on dispersal of mosquitoes, impact on human health), pesticide resistance management. Support the collection of data on bionomics of EMS in specific contexts, determining spread, nuisance and vector potential. Contribute to the training of field/lab workers.
Regional Ministries in charge of Environment	Management of surveillance and mosquito control applications.

Reference documents

ECDC. Guidelines for the surveillance of invasive mosquitoes in Europe. Stockholm: ECDC, Technical Report, 2012. Available from: http://ecdc.europa.eu/en/publications/Publications/TER-Mosquito-surveillance-guidelines.pdf

WHO. International Health Regulations (2005). Second Ed. Geneva: WHO, 2008. Available from: http://www.who.int/ihr/IHR_2005_en.pdf

Fact sheet #9: Human Surveillance

General context

The surveillance of communicable diseases is one of the responsibilities of the Federation Wallonia-Brussels, The Brussels-Capital Region and the Vlaamse Gemeenschap. The surveillance on is based on mandatory notification as well as on surveillance systems (sentinel systems, data monitoring,…).

All health professionals having some information regarding a patient with a disease listed on a predefined list of diseases with mandatory declaration must inform the competent authorities to support the implementation of information, prevention and prophylaxis measures relevant to the identification of a case.
The circumstances and gravity of the disease are therefore crucial and can trigger, if necessary of an alert if a puzzling case demands a swift reaction and the implementation of prophylactic measures to prevent an outbreak.

If needed, a field epidemiology investigation followed by control measures are implemented (investigations to identify the source of contamination and organization of the requested prevention around the cases).

Communicable diseases identified in a school or a shelter center must be notified as well to the person in charge. The services PSE and ONE (in Federation Wallonia-Brussels) and the CLB and Kind en Gezin (Flemish Community) must implement the relevant prophylactic measures in the community.

The competent authorities also have access to the data of the surveillance systems which main objective is to monitor the trends to describe the epidemiologic progression including the incidence. These systems allow the definition of thresholds.

The microbiologic surveillance through national reference centers (NRC) completes the epidemiologic surveillance.

The surveillance concerns around forty communicable diseases identified as having a potential impact on public health. All the data are used at the regional, national, European and international level.

1. Legal frame

Regional : Vector Borne diseases are in these lists (one list per entity).
23 AVRIL 2009. — Arrêté du Collège réuni de la Commission communautaire commune relatif à la prophylaxie des maladies transmissibles.
19 JUNI 2009. — Ministerieel besluit tot bepaling van de lijst van infecties die gemeld moeten worden en tot delegatie van de bevoegdheid om ambtenaren-artsen en ambtenaren aan te wijzen.

National :
Royal Decree of 1 March 1971 « relatif à la prophylaxie des maladies transmissibles ».

European :
Decision 1082/2013/UE, Cross border Health Threat.

International : International Health Regulation: some diseases are so severe that they request exceptional measures on an international scale and they must be notified to the World Health Organization (WHO). Yellow Fever is one of them.

2° Mandatory notification

0. Diseases to be declared

Most of the diseases included in the list of communicable disease with mandatory notification must be notified within 24h of the first suspicion.

Vector Borne Diseases are in that list: Dengue fever , Chikungunya, West Nile Virus, Yellow Fever. Malaria is added also (paludism). All emerging disease or all disease with a potential impact on public health must be notified.

These diseases must be notified, on all Belgian territory, as soon as the diagnosis is confirmed.

This confirmation is based on the case definitions of the ECDC : : 2008/426/EC: Commission Decision of 28 April 2008 amending Decision 2002/253/EC laying down case definitions for reporting communicable diseases to the Community network under Decision No 2119/98/EC of the European Parliament and of the Council

	Mandatory notification			Surveillance	NRC	
	Brussels	Wallonia	Flanders			Vector
Chikungunya	x	x	x	X	RL	mosquito
Dengue	x	autochthonous	x	X	RL	mosquito
West Nile Virus (WNV)	x	autochthonous	x	X	X	mosquito
Malaria	x	autochthonous	autochthonous	X	RL	mosquito
Yellow fever		autochthonous	x	X	RL	mosquito
Rickettsiosis	x	x	x	X	X	ticks/louse
Anaplasma				X	X	ticks
Tickborne encephalitis (Tbe)				X	X	ticks
Borrelia				x	X	ticks

RL: reference laboratory = the diagnostic capacity exists in Belgium as some laboratories developed a reference activity but they are not part of the NRC financed via the Royal Decree of 9 February 2011: Arrêté royal fixant les conditions de financement des centres de reference en microbiologie humaine.

1. Epidemiologic surveillance

It is mainly based on a network of clinical microbiology laboratories, transmitting on a weekly basis, the number of diagnosed cases for the following pathogens : Borrelia, Plasmodium. The pathogens included in this list can be reviewed every year. When the diagnosis is partly based on clinical signs, like for Lyme disease, complementary research can be done through the network of sentinel patricians.

The reference centers in human microbiology communicate the clinical, epidemiological and microbiological data on a regular basis. The reference laboratories communicate the surveillance programme data once a year.

3. Diagnostic capacity in Belgium

Since 2010, Belgium has a network of national reference centers (NRC) , financed by INAMI (National Institute of Medical Insurance) having as objective to support the laboratories for the specific diagnosis of a patient and to contribute to the microbiologic surveillance and provide a support to the health authorities in case of risk for the public health.

The national reference centers cover the following pathogens: Borrelia, Rickettsia, Anasplasma, TBe, WNV. The list of these centers is available on the following link: https://nrchm.wiv-isp.be/fr/centres_ref_labo/default.aspx

NB: the microbiological expertise exists for other pathogens, without specific financing : chikungunya, yellow fever, plasmodium, dengue.

***CHIKUNGUNYA, DENGUE, WEST NILE VIRUS, YELLOW FEVER**
Responsable :
Name : Dr. VAN ESBROECK M.
Hospital / Laboratory : I.T.G. - Klinische Biologie
Address : Kronenburgstraat 43/3 - 2000 Antwerpen
Tel. : 03/247.64.07 (08) **Fax** : 03/247.64.40 **E-mail** : mvesbroeck@itg.be

****PLASMODIUM***
Responsable :
Name : Dr JACOBS J.
Hospital / Laboratory : I.T.G. - Klinische Biologie
Address : Nationalestraat, 155 - 2000 Antwerpen
Tel. : 03/247.64.45 **Fax** : 03/247.64.40 **E-mail** : jjacobs@itg.be

4° How and who to declare ?

Federation Wallonia-Brussels

Notification of communicable diseases to the Health Inspection Department of the Directorate of Health Surveillance of the Federation Wallonia-Brussels (cellule d'inspection d'hygiène de la Direction de la surveillance de la santé de la Fedération Wallonie-Bruxelles (previoulsy called French Community)can be done in many ways:

- With of paper form describing the disease, the identity, profession, age and sex as well as contact details of the patient. This form must be sent within 24h to the Directorate of Health Surveillance of the Federation Wallonia-Brussels.
- Immediately by phone (02/6000490) :
- By e-mail: surveillance.sante@cfwb.be
- By a secured web application: https:// www.wiv-isp.be/matra/cf/connexion.aspx

Region Brussels-Capital

Dr Bots, Dr Waegenaere and M. Trémerie

- By a secured web applicationl: Enregistrement des Maladies Transmissibles (Matra-Bru).
- **In case of emergency :** as soon as possible by GSM (0478/77 77 08) or phone (02/ 552.01.67)

Flanders

All notifiables infectious in the list should be communicated to the doctor in infectious disease control within 24 hours from the first suspicion of disease.

Each suspicion of a major infectious disease not being listed but that – according to the estimation of the potential reporter – has a risk to become epidemic or became epidemic according to the medical knowledge should also be notified.

The notification must be made in an electronically secure manner, by telephone or orally, or possibly in writing to the infectious disease control doctor of the infectious disease control team of your Province.

For any urgent notification of infectious disease out-of-hours, contact may be taken at 02 512 93 89 with one of the infectious disease control doctors.

Coördinatie Dr. Ruud Mak Koning Albert II-laan 35, bus 33 1030 BRUSSEL tel.: 02 553 35 86 fax: 02 553 36 16 e-mail: ruud.mak@wvg.vlaanderen.be	**Oost-Vlaanderen** Dr. Wim Flipse Elf Julistraat 45 9000 GENT tel.: 09 244 83 60 fax: 09 244 83 70 e-mail: willem.flipse@wvg.vlaanderen.be
Antwerpen Dr. Koen De Schrijver Lange Kievitstraat 111-113, bus 31 2018 ANTWERPEN tel.: 03 224 62 04 fax: 03 224 62 01 e-mail: koen.deschrijver@wvg.vlaanderen.be	**Vlaams-Brabant** Dr. Pia Cox Diestse poort 6, bus 52 3000 LEUVEN tel.: 016 66 63 50 fax: 016 66 63 55 e-mail: pia.cox@wvg.vlaanderen.be
Limburg Dr. Annemie Forier Koningin Astridlaan 50, bus 7 3500 HASSELT tel.: 011 74 22 40 fax: 011 4 22 59 e-mail: anmarie.forier@wvg.vlaanderen.be	**West-Vlaanderen** Dr. Valeska Laisnez Koning Albert I-laan 1-2, bus 53 8200 BRUGGE tel.: 050 24 79 00 fax: 050 24 79 05 e-mail: valeska.laisnez@wvg.vlaanderen.be

4° Information flow

A doctor inspector is monitoring the mandatory notification sheet and the appropriate measures will be taken to avoid any further spread of the disease.
The Public Health Institute (PHI) monitors and analysis the data coming from the networks of surveillance laboratories (sentinel-laboratories), of the NRCs and of the sentinel-practitioners, understand the global evolution of germs and diseases and evaluate their impact.
If and when a public health threat is identified, the doctor inspector will contact the PHI in order to assess the event and start implementing the appropriate measures to manage the incident.
Assessment:

- Describe the case and start a descriptive investigation regarding the exposition and risk factors;
- Compare these elements with the data from animal and entomologic surveillance ;

Evaluation of the impact at a national, European and international level :

- Decision to gather the RAG
- Make a risk assessment (RA)
- Transmission of the alert

Event

1. identification of an autochthonous case of a communicable disease newly imported on our territory
2. identification of a cluster or outbreak of a vector borne disease

The PHI will, on his side, immediately inform the competent authorities of all unusual or unexpected change of a vector borne disease, based on these surveillance systems, but also but also based on the RA provided by the ECDC (allowing a scope in all EU Members) and on the WHO recommendations.

The International Health Regulation (IHR) published by WHO was revised in 2005, and it aims at preventing, assessing and reacting in a coordinated manner to the international spread of diseases and events which could have an strong impact on public health.
The Belgian legislative frame adopted the 'Focal Point 'structure of the IHR(2005) in the Agreement Protocol between the Federal Government and the Authorities mentioned in the articles 128,130 et 135 of the Constitution concerning : Focal Point for the International Health Regulation (11 December 2006).

The National Focal Point (NFP)

It is the Sanitary Risks contact point at the FSP Public Health for international, federal, communities and regions authorities for the IHR(2005) and for the European alert system 'Early Warning and Response System' (EWRS) which managed by the l'ECDC for the European Commission.

The RAG

Based on the IHR, a « risk assessment group » (RAG, consisting of scientific experts and members of the relevant administrations) was put in place at the national level. It is a group under the leadership of the Public Health Institute (PHI). It acts as central point for collecting the national data of the health inspection services and other services competent for health risks.

The RAG is also the contact point for the risks within a Community/Region which could represent a threat for another Community/Region or for the national level.

The RAG must do a risk analysis for events with a potential strong impact on public health and make recommendations to the risk management group (RMG, consisting of representatives of the relevant ministerial teams). The NFP is part of the RAG.

The RMG

It is part of the Focal Point system and is consisting of representatives from the Communities/Regions, from the Federal authorities and the PHI.

The decisions of the group are adopted by consensus, following the IHR(2005) and the provisions between the Communities/Regions relating to level of the crisis.

The mission of the « risk management group » is to take the final decision concerning the measures to implement (and their funding) at a national level in order to react to the threat, including if the risk management is coordinated at an international level.

5° International notification

The RMG also takes the decision to notify, or not, to WHO any event which took place on our territory, and which could represent a public health emergency of international concern as assessed by the RAG.
The international notification is made through the NFP via a specific alert website linked to the IHR.

The surveillance of communicable diseases and the alert in case of outbreak is done at a European level and at an international level.

Decision 1082/2013/UE, Cross border Health Threat established a network at the European Community level to promote cooperation and coordination between member States to improve the prevention and control of communicable diseases.
This network allows the epidemiological surveillance of these diseases and is an early warning and respond system for health threats. Each member State is part of the network.

The European Centre of Disease Prevention and Control (ECDC) is mandated to implement and improve the health surveillance and early warning systems in Europe. L'ECDC centralizes the surveillance data in order to monitor them and provide evidence-based recommendations on risks posed by new and emerging diseases. The harmonization of disease notification has been achieved following agreement on case definitions accepted by all member States.

The severity of some diseases (like plague, cholera, yellow fever) asks for the implementation of exceptional measures at an international level . These diseases must be notified to WHO.

Fact sheet #10: Communication plan according to risk levels

7 Communication strategy

The communication strategy has to be adapted according to the risk level that is faced (risk levels are depicted in Fact sheets #1 and #8). Table 1 summarizes the dissemination methods, main audiences and messages, according to the risk level. It must be performed in co-ordination with all actors (federal, regional/provincial, local) in order to have a harmonized and coherent communication.

Table 1: Communication strategy according to the risk level, with dissemination methods, main audiences and messages.

Risk level	Dissemination methods	Audiences and messages
Level 0: Exotic mosquito species (EMS) is absent.	Webpage on surveillance/control strategies as part of the general website of a national platform that could be set up and/or regional websites (department of environment) ; message to travellers on website of the Federal Ministry for Foreign Affairs; link to ECDC/VBORNET website.	General public: EMS and other mosquitoes, nuisance risk. Travellers: import risk for EMS and diseases; personal protection when travelling. Local authorities: EMS, sanitary risks, disease and vector control principles.
Level 1: An EMS is reported in limited number and is active. Absence of local transmission of mosquito-borne disease (MBD9.	In addition: adapted/updated website, media, call centre for interaction with general public.	In addition: General public (local): participation to EMS control, transmission risk. Travellers: personal protection when returning with clinical signs. Local authorities: results of EMS surveillance and control actions, further plans.
Level 2: An EMS is established and active. Absence of local transmission of MBD, presence of imported MBD cases.	In addition: leaflet, public (local) meetings, specific correspondence	In addition: General public (at local level): stress importance of community participation; use of personal protection measures. Local authorities: results of disease surveillance, further actions.
Level 3: An EMS is abundant and active. Absence of local transmission of MBD, presence of imported MBD cases.	As in level 2.	As in level 2, reinforced.
Level 4: An EMS has reached a critical density (average number of eggs per trap >200; residents complain). Presence of cases of local transmission of MBD.	In addition: posters, educational packages for schools; accentuate with updated information through media.	In addition: General public (at regional level): accentuate needs of community participation and use of personal protection measures. Travellers: prevent disease spread to other areas.
Level 5: An EMS has reached a critical density and generates a MBD outbreak. Presence of local outbreak(s) of MBD.	In addition: accentuate with updated information through media.	In addition: General public (national): accentuate needs of community participation and personal protection measures.

8 Competent authorities for communicating

Competent bodies and partners might belong to the regional level for Risk level 0 if no national platform is being set up, to a national platform and/or regional, community and local levels for Risk levels 1-2, and to national platform and/or and regional and community levels for Risk levels 3-5.

From Level 1, it is important to coordinate communication actions on local level (concerned by the presence of EMS) with regional and community levels and federal level, where appropriate. The best way to ensure such coordination is to set up a national and multidisciplinary platform where different public authorities could join and act in a coherent way (see Fact sheet #2). All actors must inform each other to guarantee a coherent communication. Social mobilisation, in particular through bodies such as community councils, school, and associations, is essential.

Communication to health professionals must be performed as well (but is described elsewhere), i.e. the general practitioners, hospitals, and pharmacists in affected cities and regions should be rapidly informed about EMS and MBD risk (and MBD diagnostics), in particular when there are changes in the EMS and MBD situation (evidence of circulation of pathogens, adult mosquito activity period, etc.). They should also guide citizens on the best practices for using insecticides in a way that is not detrimental for their health (see Fact sheet #3).

New findings should also be reported to neighbouring countries, to the European competent bodies (ECDC), and to the scientific community (see Fact sheet #5).

9 Communication methods

The ECDC guidelines for the surveillance of invasive mosquitoes in Europe provides suggestions for dissemination methods, listed according to (i) the communicating body, (ii) the data, (iii) the targeted audience (broad public, end-users and stakeholders) and the (iv) the desired social, political or scientific impact and/or feedback. It describes also strengths and weaknesses of the dissemination methods. When selecting a communication tool, the timing and distribution costs should be taken into account; for example, during a mosquito-borne disease outbreak, the fastest and broadest method should be considered.

Depending on the affected area, the local situation, risk levels and scenarios, the communication approaches can differ significantly. It is crucial to avoid misinterpretations and precautions need to be taken when communicating about introductions, establishment and spread of EMS, and assessments of transmission risk.

A key point is that once an (introduction of) EMS is observed, this should be reported as soon as possible to competent national authorities, to allow rapid implementation of extended surveillance and tailored control strategies, according to the risk level. The EMS platform (see Fact sheet #8) should be activated when an EMS is observed and it could decide which communication method might be implemented.

An example of dissemination to the general public concerning the presence and surveillance/control strategies of an EMS (*Aedes japonicus*) can be found on the Walloon website: http://biodiversite.wallonie.be/fr/le-moustique-japonais.html?IDC=5667.

Reference documents

Anonymous. Guide relatif aux modalités de mise en œuvre du plan anti-dissémination du chikungunya et de la dengue en métropole. Ministère du travail, de l'emploi et de la santé, Mise à jour 2012. Available from: http://www.sante.gouv.fr/IMG/pdf/guide_modalite_mise_en_oeuvre_plan_anti_dissemination_chikingunya_et_dengue.pdf

ECDC. Guidelines for the surveillance of invasive mosquitoes in Europe. Stockholm: ECDC, Technical Report, 2012. Available from: http://ecdc.europa.eu/en/publications/Publications/TER-Mosquito-surveillance-guidelines.pdf

Fact sheet #11: Elimination and control of exotic mosquitoes

10 Basics on vector control

Mosquito vector control (MVC) consists in applying control measures on mosquito species that may transmit pathogens. These measures, preventive or curative, must be defined in proportion of the sanitary risk and according to the biology of the targeted species.

MVC might be designed answering clear objectives that are defined by the concerned competent authorities together with experts (i.e. entomologists), and considering, for the optimal use of resources for vector control:

- Integration of several key elements in a mid- and long-term management programme (IVM: see Box 1);
- Sustainability of measures to be implemented in mid- or long-term perspective;
- Promotion of environment-friendly methods preserving the health of people and the environment;
- Cost-efficiency of measures to get adhesion of funding authorities and support sustainability.

Box 1: Key elements of Integrated Vector Management (WHO/CDS/CPE/PVC/2004.10)

- Advocacy, social mobilization, and legislation: promotion and embedding of IVM principles in development of policies of all relevant agencies, organizations and society, the creation or strengthening of regulatory and legislative controls for public health; self-realization of the communities.
- Collaboration with the health sector and other sectors: consideration of all possibilities within and between public and private sectors, applying the principles of subsidiarity for the planning and decision making, strengthening channels of communication between policy makers, (vector-borne) infectious disease control managers and other IVM partners.
- Integrated approach: ensure rational use of available resources through the application of a multi-disease approach, integration of non-chemical and chemical control methods and integration with other disease control measures.
- Evidence-based decision making: Adaptation of strategies and interventions to local vector ecology, epidemiology and resources, guided by operational research and subject to routine monitoring and evaluation.
- Capacity-building: Development of essential material infrastructure, and financial resources and adequate human resources at national and local level for the IVM program, based on a situation analysis.

11 Control of EMS

11.1 Goals of mosquito vector control

The overall goals of MVC applied to EMS fall into three major categories:

A. The interruption of pathogen transmission in an incident or outbreak of mosquito-borne disease (MBD) infection;
B. The elimination of exotic/invasive species at early stage;
C. The control or population management of widely established EMS to prevent nuisance or MBD transmission.

11.2 Methods and tools for mosquito vector control

MVC for EMS is based on:

- Preventive measures, i.e. source reduction by suppressing (active and potential) larval habitats and larviciding, performed by individuals within a community participation programme as well as by competent public bodies and mosquito abatement agencies (public or private; in particular for larviciding);
- Curative measures, i.e. larval habitats suppression, larviciding, adulticiding, performed by competent mosquito abatement agencies (public or private).

Preventive measures necessitate the implementation of a large community participation programme, possibly involving schools. Larviciding might be restricted to larval habitats that cannot be suppressed. Curative measures are mainly applied around cases or during an outbreak. Thus, they may consist in adulticiding completed by larviciding. Adulticiding aims at killing the infected mosquitoes, but has only a temporary and limited effect, and thus must be completed by larviciding which will delay the re-colonisation of the environment by adult mosquitoes. Adulticiding might be restricted to (1) cases of virus circulation, (2) elimination of an EMS when/where freshly established and still possible to eliminate, (3) highly abundant vector populations.

Box 2: General categories of mosquito habitats and their main vector/pest species in Belgium

- Urbanized and rural environment (private, commercial, or public)

  - Tyres, man-made containers: *Aedes albopictus, Ae. japonicus, Ae. koreicus, Anopheles plumbeus*
  - Tree holes, old manure pits: *Ae. japonicus, An. plumbeus*
  - Sewer and underground drainage: *Cx. pipiens* form *molestus* (human-biting), *Culiseta annulata*

- Water and wetland

  - Flooding areas: *Ae. vexans, Ae. sticticus*
  - Marshy woods: *Ae. cantans, Ae. rusticus*
  - Salt marshes: *Ae. caspius, Ae. detritus*
  - Lake borders and ponds: *An. maculipennis s.l., Coquillettidia richiardii*

EMS develop almost exclusively in containers, in opposition to other indigenous vector/pest species that also develop in nature environment, in a large panel of standing water bodies (Box 2). Thus, control sites will differ according to the species, and control methods will also differ according to the environment. Indeed, mosquitoes are almost the only insects developing in tyres or underground drainage, whereas a large spectrum on invertebrates and vertebrates colonize natural wetlands, which must be taken into account when selecting a control tool and in particular an insecticide (Table 1).

In addition, insecticides (active substances) must be listed on the biocide list agreed for the EU (Directive 98/8/CE), and must be registered (commercial formulation) on the Belgian market. The list of products that can be used at EU level is restricted and resistance of mosquitoes to these insecticides is increasing, often due to non-opportune use of these products. Currently in Belgium, no insecticide is registered for mosquito control. In 2012 and 2013, a specific agreement was delivered by the SFP Public Health, Food Chain Security and Environment, DG Environment, for the importation and use of Aqua K-othrine (in 2012 only), VectoBac WG and VectoMax WSP, for the control of *Aedes japonicus* in the Waloon region. However these agreements are exceptional and temporary and thus cannot be renewed. It is crucial to get some specific insecticides registered in Belgium (i.e. the 3 products cited above), in order to be able to provide an appropriate response to control EMS and MBDs.

As a rule, efficiency of control measures must be assessed in order to readjust measures if necessary. Also resistance to insecticides must be checked on established populations, for chemical insecticides that could be used.

Table 1: Insecticides (active substances) recommended to be applied according to the control aim/situation and mosquito habitats.

Mosquito control aim/situation	Type of measure	Larval habitats and environments

Eliminating a freshly introduced or a locally-established EMS.	Source reduction: storing out of rain water, eliminating waste containers, cleaning and covering,… Larval control with bioinsecticides: VectoBac (ground liquid pulverisation) or VectoMax (ground granule application). Optional: adult control with a pyrethroid (e.g. Aqua K-othrine; spatial fogging) in case of presence of adults.	Tyres and other containers, rain water barrels, drinking thought, unused pools, garden pools without fishes, tree holes… Peri-focal, urban environment only (not in nature, not on natural water bodies nor fish pools).
Controlling a widely-established EMS.	Source reduction: as above (community participation requested). Larval control: as above. No adult control.	As above. -
Controlling an EMS around MBD cases or during a MDB outbreak.	Source reduction: as above. Larval control: as above. Adult control: with a pyrethroid (e.g. Aqua K-othrine) around MBD cases or if high abundance of adults. Individual and household protection[1].	As above. Garden and bushes around MBD cases' homes, within a distance[2] of 300 m.
Controlling nuisance due to mosquitoes.	Source reduction: as above for container-inhabiting species. Larval control: as above for container-inhabiting species; VectoMax in manure pit, sewer and underground drainage; in wetlands for other species, with VectoBac (aerial application, e.g. helicopter). No adult control. Individual and household protection[1].	Container-inhabiting species: as above, also old manure pits, sewer and underground drainage. Natural water bodies-inhabiting species[3]: ponds and wetlands, flooding areas, marshy woods, coastal salt marshes, lake borders. -

[1] See Fact sheet #3; [2] This is an indicative distance; the intervention perimeter should be defined considering the local context; [3] At some extend, natural water bodies can be managed in order to reduce mosquito development, i.e. avoiding drying up/flooding by stabilising the water level.

11.3 Recommended insecticides

It has to be noted that the above-mentioned recommended insecticides are currently not authorized for the placing on the Belgian market. For any further information on the state of play of those insecticides in Belgium, please contact :

Federal Public Service (FPS) Health, Food Chain Safety and Environment
Eurostation II
Place Victor Horta, 40 box 10
1060 Brussels
Belgium

Contact Center: +32 (0)2 524.97.97

http://www.health.belgium.be/eportal/Environment/Chemicalsubstances/Biocids/Biocidesunderclosesurveillance/index.htm?fodnlang=en

Larvicides

- *Bacillus thuringiensis* serotype H14 (=var. *israelensis*) (Bti), e.g. commercial product VectoBac™ WG

  This bacterium occurs naturally in soils and aquatic environments and produces a delta-endotoxin crystalline toxin which is ingested by mosquito larvae when spread on the water surface. Only when activated by the larval specific gut PH and enzymes, the crystals become toxic, causing damage to the mosquitoes' gut. Thus, the toxin in damaging for a limited number of insects only, i.e. Culicids (Mosquitoes), Simuliides (Blackflies that live in running water only), and at a lesser extend to Chironomids. However for the latter, no long-term effect has been observed on populations at normal (i.e. for mosquito control) dosage. Thus this microbial insecticide can be used in a wide range of artificial and natural larval habitats. It can be dispersed from ground as manual or mechanical liquid pulverisation or disseminated as granule formulation, or by aerial means as liquid or granule formulations. However, only ground applications are adapted to control EMS-inhabited containers, as they are often hardly accessible. In water VectoBac has a half-life lower than 7 days, and is naturally degraded by aquatic micro-organisms and sunlight; residual activity begins to decline 24h after treatment. In over twenty years of field use, no resistance was observed against Bti.

- *Bacillus thuringiensis* serotype H14 (=var. *israelensis*) (Bti) + *Bacillus sphaericus* (Bsph) (=*Lysinibacillus sphaericus*), e.g. commercial product VectoMax™ WSP

  Bsph is another microbial agent which produces an endotoxin that ix toxic to mosquito larvae, but multiplies and produces this toxin in the local environment for a few days/weeks. It is better adapted to environments that are rich in organic matter (e.g. sewage system), however it is degraded by sunlight. Like Bti, the substance has no adverse effect on non-target organisms. Combination of Bti and Bsph allows to have a residual effect of at least 4 weeks in containers protected from direct sunshine. VectoMax is often used as granular formulation, with corncob particles as carrier for the active ingredient. It can easily be spread by ground manual or mechanical application.

- Other larvicides such as Spinosad, S-methoprene or Pyriproxyfen have a proven effect in reducing mosquito populations. Spinozad is a microbial insecticide derived from an Actinomycetes bacteria; Methopren and Pyriproxyfen are juvenile-hormone analogs (insect growth regulators) preventing larvae from developing into adulthood and thus rendering them unable to reproduce. These insecticides have a broad spectrum of activity against insects and negatively affect non-targeted arthropods. Seen their less favourable ecotoxicological profile, these larvicides are not suitable to be used in natural environments. However, in urbanised areas and in particular in man-made containers, without risks of dispersion into the natural environment, they could be used and provide a valuable tool in controlling EMS or pest mosquitoes, given that they are applied by skilled personal.

Adulticides

- Deltamethrin, e.g. Aqua K-Othrine™

  Deltamethrin and other pyrethroids are the only adulticides currently available and registered at EU level. Their main handicap is the non-selectivity, as they are toxic to all arthropods as well as to poikilothermic vertebrates. Thus the environmental impact of such insecticides must be considered. In particular, spatial spaying might be avoided nearby running water are more generally in wetlands in absence of immediate MBD risk. Another handicap is the selection of insects by repeatedly use of these products, generating the apparition of resistance in targeted mosquito populations and reducing the efficacy of the treatments. However, Deltamethrin, or Permethrin as an alternative, can be applied in specific conditions (cf. Table 1), given that they are applied by skilled personal. To limit apparition of resistance, it is essential to perform the applications at the right dosages ant to regularly assess the sensitivity of the targeted mosquito populations.

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Fact sheet #12: Multidisciplinary approach

Preventive and Curative actions (human health)

It is recommended to set up a collaborative multi-disciplinary approach for exotic mosquitoes with the following mission :

- Initiate preventive and curative actions allowing to manage the potential public health threat posed by exotic mosquitoes. For this purpose, routine actions has to be developed and potentially be upgraded to a crisis management level .
- Follow-up of the implemented actions and supervise the information sharing at the Belgian and European level.
- Put in place a multidisciplinary structure and mechanisms allowing to be enlarged to other vector borne diseases (ticks, *culicoides, phlebotomes*) impacting human and animal health.

1° Long term surveillance (routine)

The long term surveillance is monitored with all partners involved in the exotic mosquitoes issue included.

Three groups of members can be identified:
- A core group being permanent members of the public administrations (federal, Regions/Communities levels) of Public Health, Environment, Animal Health : FPS Public Health DG GS, International Relations, , DG4, DG5, Federal Medications Agency, Federal Food Safety Agency (FSCA), Veterinary and Agrochemical Research Centre (VARC), Scientific Institute of Public Health (PHI), Cocof, Cocon and Cocom, SPW (Service Public Service of de Wallonia) DGO3 (environment), DGO5 (health).

- A group of experts (not permanent members), dedicated to the problematic faced (Tropical Medical Institute, Universities, Animal Health). The enlargement to other vectors of pathogens (like *culicoides* and ticks) could be considered in a second phase.
- A group ad hoc, gathering field operators, for the implementation of measures: Civil Protection, Foreign Affairs (information to tourists), local/provincial administrations.

The following activities to be embraced by the multidisciplinary approach may cover :

- A long term surveillance of the populations of exotic mosquitoes (including the vector of West Nile Virus, pathogen with a strong impact on human health).
- A surveillance of vector borne diseases (human and animal health)
- A national coordination of these surveillance programs and a single and common communication program of the results.
- International networking (OIE, WHO, ECDC, trans-boundary data exchange- see fact sheet #5)).

The following business rules may be considered in the context of a multidisciplinary approach :

- A coordinator is appointed.
- The decisions are adopted by consensus and follow a multidisciplinary approach.
- The meeting schedule is of at least 3 times a year , for the administrations and the experts.

- Each meeting is reported to the appropriate ministerial decision-making level.
- Edit every year a report on the status of exotic mosquitoes colonies in Belgium, including a review of preventive and curative actions implemented by the relevant authorities.

An efficient communication tool could be developed :

- Between the different group members
- To provide to the public and to the media a common, clear, evidence-based information.

2° Crisis management

The implementation of the mentioned structure should be done after the modification of the Risk Assessment Group (RAG) and of the Risk Management Group (RMG) as defined in the belgian law frame (*Protocole d'accord entre le Gouvernement fédéral et les autorités visées aux articles 128,130 et 135 de la Constitution concernant : Focal Point pour le Règlement Sanitaire International (11 décembre 2006*).

The RMG should be extended to include the Environment and the Animal Health.

A three step algorithm defines crisis management:

a) Meeting of the RAG following a vector borne disease (VBD) threat

- This group includes the "core" members and the experts relevant to the assessment of the ongoing threat
- The RAG is triggered at the request of of an authority or of a professional organization, and with the agreement of the coordinator.
- The following alarm signals/data are being assessed : findings of introduced (exotic mosquito species) EMS, evidence of human mosquito-borne disease (MBD), increase of the numbered of cases of VBD, evidence of animal mosquito-borne disease, action of the media.
- A risk assessment report is written with recommendations and sent to the Risk Management Group.

b) Mobilisation of the RMG

- This group involves the decision-makers at the political level, following the recommendations of the RAG.
- It includes decision-makers from the Public Health, the Environment and the Animal Health, based on the allocation of competences to authorities as legally framed in Belgium.
- It could take decisions about measures to be implemented and about the budgets to be allocated.

c) Implementation of the measures to control the threat

- These measures will depend on many factors:
  i) the presence or not of EMS on our territory;
  ii) the presence or not of notified human cases or animal cases of mosquitoes-born disease (MBD);
  iii) the number and size – local or extended- of those human and animal clusters.

- A certain number of measures will be implemented in different sectors, according to the risk assessment (see fact sheet #8):

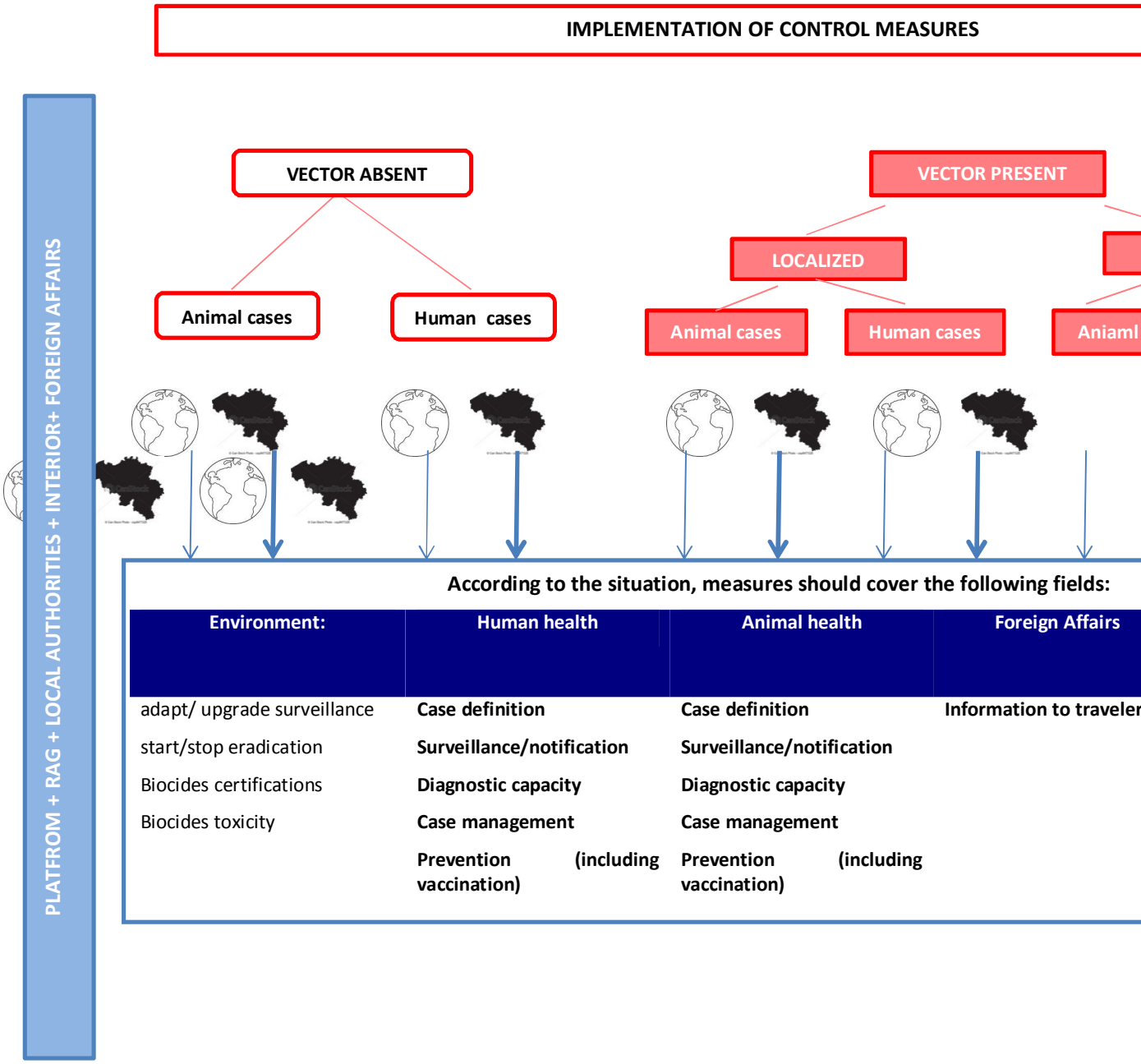
  i) environment (fact sheet #1, 11): upgrade the level of surveillance, eradication, certification of biocides, evaluation/surveillance of the toxicity of the biocides

  ii) human health (fact sheets 3 and #15): case definitions, surveillance/notification, laboratory capacity, case management, prevention (including vaccination), organs and blood products, toxicity of the biocides.

  iii) animal health (fact sheets #6 and 7): case definitions, surveillance/notification, laboratory capacity, case management, prevention (including vaccination), organs and blood products, toxicity of the biocides.

  iv) foreign affairs : information to the travelers

  v) communication (fact sheets # 5 and 10): for the public, the media, the health care workers and the international , with a multidisciplinary approach (human, animal, environment)


IMPLEMENTATION OF CONTROL MEASURES
PLATFROM + RAG + LOCAL AUTHORITIES + INTERIOR+ FOREIGN AFFAIRS
VECTOR ABSENT
VECTOR PRESENT
LOCALIZED
Animal cases
Human cases
Animal cases
Human cases
Aniaml
According to the situation, measures should cover the following fields:
Environment:
Human health
Animal health
Foreign Affairs
adapt/ upgrade surveillance
start/stop eradication
Biocides certifications
Biocides toxicity
Case definition
Surveillance/notification
Diagnostic capacity
Case management
Prevention (including vaccination)
Case definition
Surveillance/notification
Diagnostic capacity
Case management
Prevention (including vaccination)
Information to traveler

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Glossary[viii]

Adulticiding: The application of an adulticide – an insecticide that is targeting the adult life stage of an insect – on the field.

Amplifier or enzootic vector: A vector transmitting the virus within animal host population (e.g. from bird to bird), permitting the amplification of the transmission (more and more host and vectors becoming infected).

Amplifying vector: A species of arthropod that contributes to the buildup and transmission of a disease-causing agent by transmitting the agent among vertebrate hosts.

Arbovirus: Contraction of arthropod-borne virus; A virus transmitted by arthropods, such as mosquitoes and ticks, that include the causative agents of several encephalitis, yellow fever, and dengue.

Biological transmission: A vectors acts as active transmitter of an infectious agent, and as intermediate host, permitting an essential stage of development of the pathogen; Transmission occurs most often during a blood meal.

Bridge vector: A vector transmitting an infectious agent from its main hosts population (e.g. birds) to another animal host population (e.g. horses) or to human.

Community participation: The involvement of people in a community in projects to solve the problems with which this community is faced.

Dead-end host: A vertebrate animal that is infected by an infectious agent, but is not a source of infection of another host or of a vector for further transmission.

Diapause: The physiological state of an organism when it reduces the intensity of metabolic activities, genetically-driven (e.g. diapausing mosquito eggs).

Emerging disease: A disease that appears in a host population for the first time, or that may have existed previously (re-emerging), and is rapidly increasing in incidence or geographic range.

Epidemic/outbreak: The occurrence of cases of a disease, in higher number than expected in a given area or among a specific group of people/animals and over a particular period of time.

Establishment: The perpetuation, for the foreseeable future, of an exotic species within an area, following its introduction.

Exotic plant or animal species (synonyms: alien, foreign, non-indigenous, non-native): A species that is not native to an ecosystem and, if present, has been introduced.

Extrinsic cycle: The part of the transmission cycle within the vector, from the acquisition of the infectious agent by the vector to the vector's ability to transmit the agent to other susceptible vertebrate hosts.

Host: A human or an animal that can be infected by an infectious agent under natural conditions.

Infectious agent or pathogen: A microorganism such as a bacterium, a helminth, a protozoon, or a virus, that can produce disease in its host.

Integrated Vector Management (IVM): A rational decision-making process for the optimal use of resources for vector control.

Interception: The detection and elimination of an exotic species during inspection of an imported consignment, preventing establishment of the species.

[viii] *Glossary set up by AVIA-GIS (Francis Schaffner & Veerle Versteirt) on behalf of the Federal Public Service Public Health, Food Chain Safety and Environment (DG Environment) and for all fact-sheets except #9 and #12.*

Introduction: The process of bringing a species from its endemic range into a biogeographic area to which it is completely foreign.

Insecticide: A pesticide (chemical or biological) used to suppress insects.

Invasive species: An exotic species that establishes and proliferates within an ecosystem, and whose introduction causes or is likely to cause economic or environmental impact or harm to human/animal health.

Larviciding: The application of a larvicide – an insecticide that is targeting the larval life stage of an insect – on the field.

Lucky bamboo: Cuttings of *Dracaena* species, particularly appreciated for Chinese New Year festivities.

Mechanical transmission: A vectors acts as passive carrier of an infectious agent, and transmits via contaminated proboscis or feet.

Native or indigenous species: A species that occurs within its natural geographical range (past or present) and dispersal potential (i.e. within the range it occupies naturally or could occupy without direct or indirect introduction or other human intervention).

NUTS level: Nomenclature of Territorial Units for Statistics is a geocode standard for referencing the subdivision of countries for statistical purposes. NUTS0 is the country level; the other levels (1-5) refer to different administrative levels which differ in each country.

Monitoring: Procedures implemented for temporary or continuous observation (e.g. species dynamics) and is not followed by any additional activities.

Mosquito-borne disease: Infectious diseases transmitted by mosquitoes.

Parasitic disease: An infectious disease caused or transmitted by a parasite (typically protozoa and helmiths).

Pathogen: See Infectious agent.

Point of entry (PoE): A site where an exotic/non-native species can enter a new area.

Population: The total number of people/animals of a given area or country; In sampling, the population may refer to the units from which the sample is drawn, not necessarily the total population.

Reservoir: The 'location' in which an infectious agent normally lives, grows and multiplies; Reservoirs can be human, animal hosts, the environment, or vectors (e.g. a virus in overwintering mosquito females or maintained through vertical transmission).

Source reduction or environmental control: An important approach to the control of mosquitoes that involves the elimination of aquatic habitats in which mosquito larvae develop, or at least their modification in the way to reduce larval development.

Surveillance: Procedures implemented in response to a risk and carried out to support subsequent actions (e.g. vector control or disease control).

Susceptible: The status of being at risk of infection by and pathogen, i.e. being exposed to infection or lacking immunity or resistance to a pathogen.

Transmission cycle: The biological cycle in which an arthropod-transmitted pathogen is maintained; It comprises the pathogen, the vector, and the hosts that are susceptible to infection.

Transmission of an infectious agent: Any mode or mechanism by which an infectious agent is spread through a, animal or human host.

Vertical or transovarian transmission: The transmission of an infectious agent by a vector to its offspring.

Vector: An animal that transmits an infectious agent from one vertebrate host to another.

Vector-borne disease: A disease due to an infectious agent transmitted by a vector.

Vector competence: Refers to the ability to acquire, maintain and transmit microbial agents within the vector; Vector competence for biological transmission is genetically-driven.

Vectorial capacity: The measurement of the efficiency of vector-borne disease transmission; It considers external factors (such as biting rate, vector longevity, abundance, and host feeding preferences) that determine the efficiency of the disease transmission under specific environmental conditions.

Viraemia: Presence of a virus in the hosts' blood.

Viraemic host: A host in which the pathogen particles are present in the bloodstream.

Zoonosis or zoonotic disease: An infectious disease of which infectious agent may be transmitted from vertebrate animals to humans.