Written evidence submitted by Public Health England

Executive Summary

1. This evidence concerns the risks to public health posed by invasive arthropod disease vectors such as mosquitoes and ticks. Specific reference is made to the *Aedes albopictus* mosquito, a potential vector of dengue and chikungunya viruses and to *Culex modestus* mosquito, a potential vector of West Nile virus (WNV). This evidence also briefly looks at the various imported tick species that are known vectors of tick-borne arboviruses and bacterial pathogens.

2. There is a real threat of introduction and establishment of invasive mosquitoes which will increase the risk of exotic human infections occurring in the United Kingdom (UK) (Medlock *et al.*, 2017). This scenario will have significant implications for the resources required for control and other public health actions to mitigate this risk (Medlock *et al.*, 2018).

3. In addition, Local Authority Environmental Health teams are being encouraged to prioritise surveillance and control (both using larvicides and adulticides) to prevent invasive mosquito species from establishing in the UK. The cross-government national Vector-borne Disease contingency plan outlines actions that should be taken in the event of a non-native invasive mosquito species of public or animal health importance, or a human or animal non-travel associated case of an exotic viral illness being reported in England. It also includes a local plan for dealing with these events and will form the basis of local strategy planning. If these invasive mosquitoes do become established, updated mapping on infested areas and the impacts of control will be crucial in minimising the chances of local transmission of arboviruses.

4. Although previous surveillance for evidence of WNV in birds, mosquitoes and humans has not detected the virus (Phipps *et al.*, 2008; Vaux *et al.*, 2015), now that *C. modestus*, a competent vector, has been detected and expanded its range, enhanced surveillance for WNV exposure is a priority for PHE.

5. The threat from exotic tick-borne diseases (such as tick-borne encephalitis virus, Crimean Congo Haemorrhagic Fever virus) has increased following detections of potentially invasive species ticks. There are no current climate-based models that have addressed the survival of non-native ticks such as *R. sanguineus* and *H. marginatum / rufipes*. The lack of tick controls on travelling and imported pets has seen an increase in tick importations and house infestations (Hansford *et al.*, 2017).
1. Introduction

6. Factors such as globalisation, increasing volume of trade and travel, continuing urbanisation and environmental/climate change have contributed to the introduction and establishment of arthropod species in England which are vectors for human infections. In addition, relaxation of tick controls under the European Pet Travel scheme has led to an increased number of ticks identified on dogs returning to the UK, some of which have become established locally. Many of the ticks identified are recognised vectors of exotic animal and human infections or are species which are found in the UK and so could transmit infections to local tick populations.

2. Background on the main invasive species

7. The main invasive species posing the greatest threat to human health are mosquitoes (Diptera: Culicidae) and Ticks (Acari: Ixodidae).

2.1 Mosquitoes

8. The threats come from invasive and indigenous mosquitoes.

2. 1.1 Invasive mosquitoes (Ae. albopictus mosquitoes and risk from dengue, chikungunya viruses)

9. Invasive mosquito species are defined by their ability to colonise new territories. ‘Detected’ means presence of eggs and larvae in a location while ‘established’ means they appear in the same location the following year. This is in accordance with European Centre for Disease Prevention and Control (ECDC) definitions of invasive mosquito surveillance.

10. Over the last 30 years the Asian tiger mosquito, Aedes albopictus has established in large parts of southern Europe initially following importations by laying drought-resistant eggs on used tyres. Although typically a tropical mosquito, it has adapted
over time to a temperate environment and has now been detected in 28 European countries (Medlock et al., 2012; 2015). In more recent years it has spread along highway systems in vehicles and is now establishing in northern France. There is therefore potential for incursions into the UK through traffic movements (Medlock et al., 2017). It is a vector of dengue and chikungunya viruses and has been linked to local transmission of both viruses in Europe, following transmission from an infected traveller where this invasive mosquito has established (Schaffner et al., 2013; Medlock et al., 2015; Calba et al. 2017; Venturi et al., 2017).

11. *Ae. albopictus* eggs were detected in traps at a truck stop near Folkestone in 2016 (Medlock et al., 2017). Local control efforts coordinated by the local authority with support from Public Health England (PHE) were instigated and no further mosquitoes were found. A second incursion was detected at a truck stop near Ashford in 2017, and again at a separate truck stop near Folkestone in 2018, thus highlighting that these incursions will continue. As yet, establishment has not been detected.

12. A number of models developed over the last 15 years suggest that the UK climate is warm enough for *Ae. albopictus* to survive and be active for several months (Medlock et al., 2006; ECDC, 2009; Caminade et al., 2012). In the UK, over the five-year period 2012-2016 there were a total of 2,127 imported dengue cases (range 347-549 cases/year) and 588 imported chikungunya cases (range 15-295 cases/year) reported. There is a risk of transmission of these viruses from travellers if *Ae. albopictus* becomes established in the UK.

13. The ability of *Ae. albopictus* to adapt to new environments and overwinter, its predicted spread and establishment in Europe, and its confirmed involvement in pathogen transmission cycles makes the early detection, surveillance and control of this species very important.

### 2.1.2 Invasive mosquitoes: UK actions

14. Surveillance for *Ae. albopictus* in the UK is coordinated by PHE in collaboration with Port Health and Local Authorities (Murphy et al., 2013; Vaux & Medlock, 2015). This started in 2010 and now there are more than 30 UK ports conducting surveillance for invasive mosquitoes in England, Wales, Scotland, and Northern Ireland. Following the dissemination of the mosquito through France in vehicles, this programme of surveillance was extended to the highway systems in 2014 (Vaux & Medlock, 2015).

15. Progress has been made with regards to preparing for future incursions. This includes:
   - Providing training in mosquito surveillance to local authorities
• Producing a cross-Government contingency plan for dealing with incursions and dealing with any possible establishment of the mosquito; as well as management around any local human cases of arboviral disease that may occur
• Local authorities are now actively involved in assisting PHE with surveillance, and the importance of these mosquitoes and the need for rapid action has become an elevated priority
• PHE has worked closely with the ECDC and other European academic colleagues to contribute expertise for developing the best strategies for surveillance and control of invasive mosquitoes and understanding the priorities for vector borne diseases
• PHE support health in UK Overseas Territories, and as part of this, PHE have provided training in surveillance and control of Ae. aegypti and associated viruses in Bermuda, British Virgin Islands, Montserrat, Anguilla, Turks & Caicos Islands, Gibraltar and Akrotiri. In addition, PHE has been supporting Anguilla explore options for release of Wolbachia-infected Ae. aegypti.

2.2 Indigenous mosquitoes: Culex modestus mosquitoes and risk from West Nile Virus

16. West Nile Virus (WNV) is a zoonotic arbovirus transmitted between birds and other animals, including humans, by mosquitoes. The birds are the natural host, and many species of birds have been shown to carry the virus. All WNV cases diagnosed in the UK have been in returning travellers. Surveillance activities to date in the UK have not isolated WNV from birds or mosquitoes, nor has it been associated with any clinical disease amongst birds.

17. In 2010, the mosquito Culex modestus was detected in the UK, for the first time since 1944, breeding in coastal marshes in North Kent (Golding et al., 2012; Medlock & Vaux, 2014; Vaux et al., 2015; Cull et al., 2016). It is assumed that this mosquito has colonised in the last 15 years and spread to new wetlands (where previously it has not been recorded) and therefore this species is now considered invasive. This mosquito species is the principle bridge vector (responsible for transmission between birds, horses and humans) for WNV in Southern Europe. This finding will increase the risk of WNV being transmitted in the UK.

18. Since detection, PHE has been tracking its distribution and it now occurs across North Kent and coastal parts of Essex.

2.2.1 Indigenous mosquitoes: UK Actions

• PHE conduct enhanced surveillance for C modestus and a map of its distribution is updated on the GOV.UK website
• Clinicians in the area where the mosquito has been found have been alerted to the prospect of WNV infection in patients presenting with viral encephalitis
PHE and the Animal and Plant Health Authority (APHA) are currently updating a contingency plan and will continue to work with local authorities in the infested area.

2.3 Ticks: Non-native tick incursions and associated pathogen risk

2.3.1 “Imported” ticks and threat to human health

19. Following the harmonisation of pet travel regulations in 2012, tick controls on pets travelling to or from Europe were no longer required. Since 2012, there has been a trend for an increasing number of imported and travelling dogs infested with the brown dog tick, *Rhipicephalus sanguineus* s.l. reported to PHE’s Tick Surveillance Scheme (PHE TSS) (Hansford *et al.*, 2015a; Hansford *et al.*, 2017). This scheme has reported and published numerous papers on imported ticks, sometimes with high numbers of both male and female *R. sanguineus* s.l. on the same dog. Importations of these non-native ticks have led to house infestations (Hansford *et al.*, 2015b). These Mediterranean ticks are not thought to survive outdoors in the UK, but they can complete their life cycle indoors, laying many thousands of eggs, with ticks being able to survive long periods without a blood meal, infesting furniture, and living behind skirting boards and wallpaper. This tick is a known vector of *Rickettsia conorii*, the causative agent of Mediterranean spotted fever. Climatic changes will likely enhance the chances for the survival of this tick outdoors.

20. Imported ticks on both animals and humans remain a potential risk to the UK. Various examples of ticks imported into the UK, which are associated with potential public and veterinary health risks include: imported Crimean Congo Haemorrhagic Fever virus vectors *Hyalomma* spp. ticks on animals (Jameson & Medlock, 2009, Hansford *et al.*, 2016), imported non-native *Dermacentor* ticks of rickettsiosis in luggage (Pietzsch *et al.*, 2015), and tick species from Australia (Pietzsch *et al.*, 2014) known to cause tick-borne paralysis.

2.3.2 “Imported” infections in ticks and threat to human health

21. *Ixodes ricinus* and *Dermacentor reticulatus*, which are native to the UK (Medlock *et al.*, 2017), are also regularly imported on travelling dogs from Europe, providing a potential route of entry for pathogens such as tick-borne encephalitis virus and Babesia *canis* which are endemic in several European countries and transmitted by these species respectively. A recent outbreak of canine babesiosis caused by *Babesia canis* in Essex (Phipps *et al.*, 2016; de Marco *et al.*, 2017) is likely linked to
animal travel or a tick importation. A published summary of the ticks imported into the UK on animals highlights the increasing incidence (greater than 65 non-native imported tick reports 2005-2016) and potential risk associated with the various tick species (Hansford et al., 2018).

22. During the summer of 2018, a tick was submitted to PHE Tick Surveillance Scheme from an untraveled horse from Dorset. It was identified as the African tick *Hyalomma rufipes* (Hansford et al. 2019). It is likely that this tick entered the UK on a migratory bird as an engorged nymph. Normally the UK climate is too cold for these exotic ticks from Africa to complete their moult to the adult stage, the hot summer of 2018 facilitated completion of the moult. These ticks are known vectors of Crimean-Congo haemorrhagic fever virus, and whilst the tick was tested negative, and the incursion is a first, this suggests that with climate change, hot UK summers could support local survival of these exotic tick vectors.

2.3.3 Actions for ticks

- Following publication of PHE tick surveillance data in 2017 (Cull et al., 2018), PHE has been working towards raising awareness of ticks and Lyme disease risk through local authority engagement, raising awareness of travel-associated risks, and getting a better understanding of human bite risk. This can be viewed at: https://www.sciencedirect.com/science/article/pii/S1877959X17305137
- PHE and APHA have produced leaflets highlighting the risk of invasive ticks and the importance of tick treatments in travelling pets
- PHE has coordinated European wide surveillance and mapping of tick vectors to aid risk assessment and monitor change.

3. Specific responses to key questions in the enquiry

**How well is the UK and its overseas territories managing the impact of invasive species and controlling the risks of further invasion?**

23. Regarding invasive species of public health concern, this response deals solely with those invasive arthropod species that may play a role in disease transmission, specifically mosquitoes and ticks.

24. PHE assesses the risk from invasive disease vectors through results from vector surveillance outputs and by the cross-government, multidisciplinary Human Infections and Risk Surveillance group. This informs government risk assessment and the cross-government expert group on emerging infectious threats and guides further PHE enhanced surveillance with local partners in local authorities and port health.
25. The main concerns for invasive species of public health concern are invasive *Aedes* mosquitoes and imported tick species. The former is known to be imported into new territories through movement of goods such as used tyres, and in vehicles along highway systems. Preventing their movement globally has proven extremely difficult, hence why these *Aedes* mosquitoes have been able to successfully move between continents and establish locally.

26. PHE with port health and local authorities is working on enhanced surveillance to monitor incursions of these mosquitoes and control these species where they are found. Further details on these incursions and control efforts are reported in section 2.1 and 2.2 under invasive mosquito species.

27. Ticks are potentially imported into the UK through a number of different pathways: on travelling pets, migratory birds and on human travellers. PHE, along with colleagues at Animal and Plant Health Agency, has worked on a number of initiatives for enhanced tick surveillance to assess routes of importation and manage any incursions. Since the relaxation of tick controls on pets, non-native ticks are reported each year, and PHE has been advocating for a re-introduction of tick controls on travelling pets. This work is coordinated by PHE’s Tick Surveillance Scheme and further details of this work, and records of imported ticks on human travellers are detailed in Section 2.3.

28. The importation of ticks on migratory birds are harder to control, and current PHE research under the National Institute for Health Research (NIHR) Health Protection Research Unit is assessing which tick species are imported on birds, and whether there is any risk from imported pathogens within these ticks, and whether non-native tick species could establish locally.

Of those that are already in the UK, which invasive species are posing the greatest harm to human health;

29. With regard specifically to invasive arthropod vectors, there is no current evidence that any invasive vector species is causing human disease. However, if *Aedes albopictus* mosquitoes were to establish in the UK [currently they have not established], there is the potential for local transmission of both dengue and chikungunya viruses (see 2.1). Other mosquito species such as *Culex modestus* that appears to have established in south-east England in the last decade, is a nuisance species. As detailed in 2.2 this species is a potential vector of West Nile virus in the rest of Europe, and therefore has the potential to act as a disease vector in the future.

30. Native ticks are already vectors of pathogens of public health concern, primarily Lyme borreliosis. Imported ticks on pets and migratory birds have the potential to act as vectors of new pathogens (either imported by the tick or by infected travelling animal), or to act as new vectors of existing pathogens.

What are the risks of invasive non-native species migrating to the UK from future climate change?
31. Neither invasive mosquito species, nor invasive tick species, will migrate alone. The movement of invasive mosquitoes is occurring through human movement of goods or vehicles, and upon their arrival these mosquitoes will be able to establish in a more climatically suitable environment. Ticks may be moved on migratory animals, and again, their ability to survive will be enhanced by a more suitable local climate.

What actions should the UK take to mitigate the risk, or adapt to, climate migrations of invasive species?

32. For invasive mosquitoes, enhanced surveillance efforts are now required to sustain and expand the current system of invasive mosquito surveillance to include all UK ports, a wider network of traps across the highway systems, greater involvement of local authorities and the uptake and implementation of national contingency plans for dealing with incursions of invasive mosquitoes.

33. For invasive ticks, the current PHE tick surveillance scheme is successfully detecting non-native tick species.

Where should the four nations prioritise resources to tackle invasive species?

34. Invasive mosquito surveillance, although coordinated by PHE, does take place at ports in all four nations, although most effort occurs in England. Only England is involved in surveillance for invasive mosquitoes along the highways, and the limited resources are focused on south-east England. With further resources, work in England could be expanded to Eastern parts of the country. So far there is no specific highway surveillance in the other three nations. Due to these mosquitoes being climatically limited, it is advisable to conduct surveillance at least in South Wales.

35. Tick surveillance is coordinated for England by PHE. Although this scheme acquires submissions from the other three nations, there is no specific tick surveillance scheme that PHE is aware of for Wales, Scotland or Northern Ireland. We believe discussions are being held in Scotland to advance this.

How can the risk of trade and future trading relationships bringing non-native invasive species to the UK be mitigated?

36. Re-introduction of tick controls on travelling pets is required to ensure mitigation strategies for preventing imported tick are robust.

37. Minimising the movement of invasive mosquitoes by trade and travel has proven problematic across the world. The trade in used tyres has been one of the primary routes of importation into the rest of Europe, however now that these mosquitoes are established in Europe, their movement is primarily through vehicular traffic. Ensuring that surveillance along these highways systems is well resourced must now be a priority.
How effective have the European Union’s Invasive Alien Species Regulations been at addressing and tackling invasive species?

38. PHE can only comment on invasive mosquitoes. PHE is involved in the EU Cost Action on *Aedes* invasive mosquitoes’ surveillance and control and this will be crucial in dealing with the risks associated with these mosquitoes.

How should the UK work with the European Commission and others internationally to reduce the risk of invasive species?

39. UK should continue to work with European networks for developing best practice on surveillance and control of these species, as well as supporting research on novel interventions. Applying control strategies for movement of vectors by animals or people is crucial.

4. Conclusion

40. Ensuring that sufficient resource is made available for robust surveillance systems for invasive disease vectors is paramount to effective detection and control of these species. Robust surveillance systems spanning the entire country could potentially avoid the establishment of invasive mosquito vectors of disease, with the potential for local arbovirus transmission, as well as the repeated introduction of non-native ticks with the potential to introduce, spread and vector a range of native and non-native pathogens of public health concern.

*May 2019*
5. References


