Management of invasive species of mosquitoes

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Chartered Institute of Environmental Health

UK Health Security Agency

Introduction

In the UK mosquitoes can create a distressing biting nuisance, which affects the well-being of local residents and can pose a major economic problem in areas where tourism is a main source of income to the local community.

Experts agree that climate change will make the UK more vulnerable to the problems caused by mosquitoes. There is already evidence of the resurgence of a number of serious mosquito-borne diseases in temperate regions of Europe and the USA. Mosquito control is quickly becoming an essential part of professional pest management.

Recent publications have emphasised the need for preparedness in the event of an outbreak of mosquito-borne disease including the recent publication of the National Contingency Plan for the detection of invasive mosquitoes.

The risks posed by mosquito-borne diseases have changed significantly in recent years, with continued outbreaks of West Nile Virus in Europe, the spread of invasive mosquitoes in Europe and the subsequent threat from dengue, chikungunya and Zika associated with imported human cases [local dengue, chikungunya outbreaks and Zika cases have occurred in Europe including France].

Enhanced mosquito surveillance is essential on both native and invasive mosquitoes to ensure early detection of invasive mosquitoes. Also vital is updated assessment of the risks posed by native mosquitoes, as well as an enhanced surveillance system to permit vector control ahead of an outbreak of mosquito-borne disease. Early detection and treatment of mosquitoes is essential.

Invasive mosquitoes of concern are *Aedes albopictus, Aedes japonicus, and Aedes aegypti*.

Aedes albopictus

Aedes albopictus
7- 8mm wingspan

Culiseta annulata
13 -15mm wingspan

Distinguishing feature of *Aedes albopictus:*
white central line on thorax

Aedes albopictus:

Aedes albopictus (or Asian tiger mosquito as it is commonly known) has undergone a dramatic global spread largely due to commercial activities, in particular the movement of used tyres and 'lucky bamboo' plants. It is now listed as one of the top 100 invasive species in the world and is considered to be the most invasive mosquito.

Aedes albopictus has the ability to breed in natural and artificial habitats, some of which include tyres, barrels, rainwater gulley catch basins and drinking troughs, flower vases found in cemeteries, and discarded drink cans. They are not known to breed in brackish or salt water and in general, have a marked preference for urban and suburban habitats.

Aedes albopictus feeds on a wide range of hosts. It is also known to be a significant human biting nuisance, with the potential to become a serious threat to public health as it is a known vector of chikungunya and dengue virus. *Ae. albopictus* eggs are frost tolerant and could therefore survive in northern Europe. In recent years the species has expanded its range throughout Europe, primarily via the movement of adults in vehicles along highway networks. It has been detected at vehicular transport hubs in most years since 2016 (Medlock *et al* 2017, Vaux *et al* 2020, Vaux *et al* 2021).

When identifying *Ae. albopictus* it is often confused with one of our native mosquitoes, *Culiseta annulata*. *Cs. annulata* whilst bearing similar black and white striped markings on the legs is considerably larger in size to *Ae. albopictus*. See illustration above for comparisons.

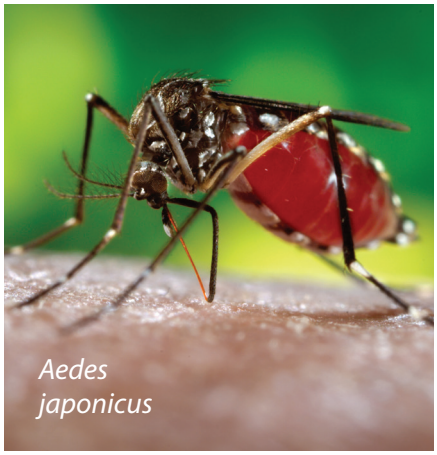
Aedes aegypti

Aedes aegypti:

Aedes aegypti is one of the most widespread mosquito species globally and is a known vector of several viruses including Zika, yellow fever, dengue and chikungunya.

Having adapted to more urban domestic habitats, they have exploited a wide range of artificial containers such as vases, water tanks and tyres often associated with human habitations. They have also been found utilising underground habitats such as septic tanks.

Unlike *Aedes albopictus*, the ability of *Ae. aegypti* to establish in more temperate regions such as the UK is currently restricted due to its intolerance to the prevailing winters. It is not thought likely therefore that this species will establish itself in the UK.



Aedes japonicus

Aedes japonicus:

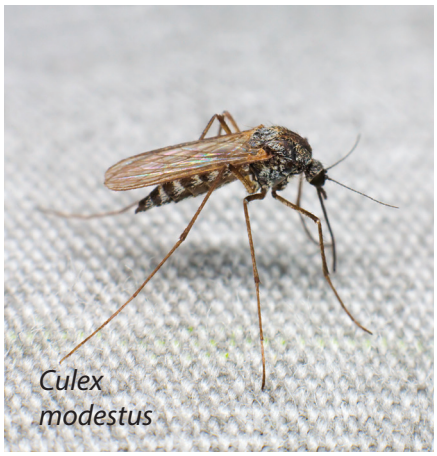
Aedes japonicus has become the third most invasive mosquito species to be reported in Europe. Its geographical spread has been due largely to commercial activities such as the international trade in used tyres. Its distribution in central Europe is expanding.

Native to Japan and Korea, there is now concern that this species may be involved in the transmission of arboviruses such as West Nile virus.

It will readily colonise urban environments where female mosquitoes are active during the day.

Aedes japonicus can produce freeze and desiccation-resistant eggs that can remain dormant over winter and hatch once environmental conditions become favourable in the spring. This therefore increases the risk of the species being transported in infested containers.

Recent sampling in Germany revealed the presence of larvae in a variety of containers including flower vases, flower-pot saucers, watering cans and paddling pools.



Culex modestus

Culex modestus :

Although not considered an invasive species, *Culex modestus* occurs in parts of England and is suspected of transmitting West Nile virus (WNV) to humans during sporadic epidemics in southern Europe. WNV has never been found in the UK so there is no known current risk to public health in the UK. The virus primarily infects birds, but when the pathogen is transmitted from birds to humans by the bite of the mosquito it can very occasionally cause severe disease, although it usually causes only mild infections.

Culex modestus requires specific habitat conditions to thrive and prefers shallow coastal ditches in wetlands which are found around the Thames estuary, and other sites.

Mosquito Life Cycle

Life cycle

All mosquitoes go through an egg – larva – pupa – adult cycle.

The female mosquito typically lays eggs either individually on the water surface, (*Anopheles*) individually on the margins of pools and dry hollows and containers (*Aedes*) or as rafts floating on the water-surface (most *Culex*). The number of eggs laid at one time will range from c. 30 - 300. Having laid one batch of eggs, the female will typically need to take subsequent blood meals in order to undergo further cycles of egg production and egg-laying.

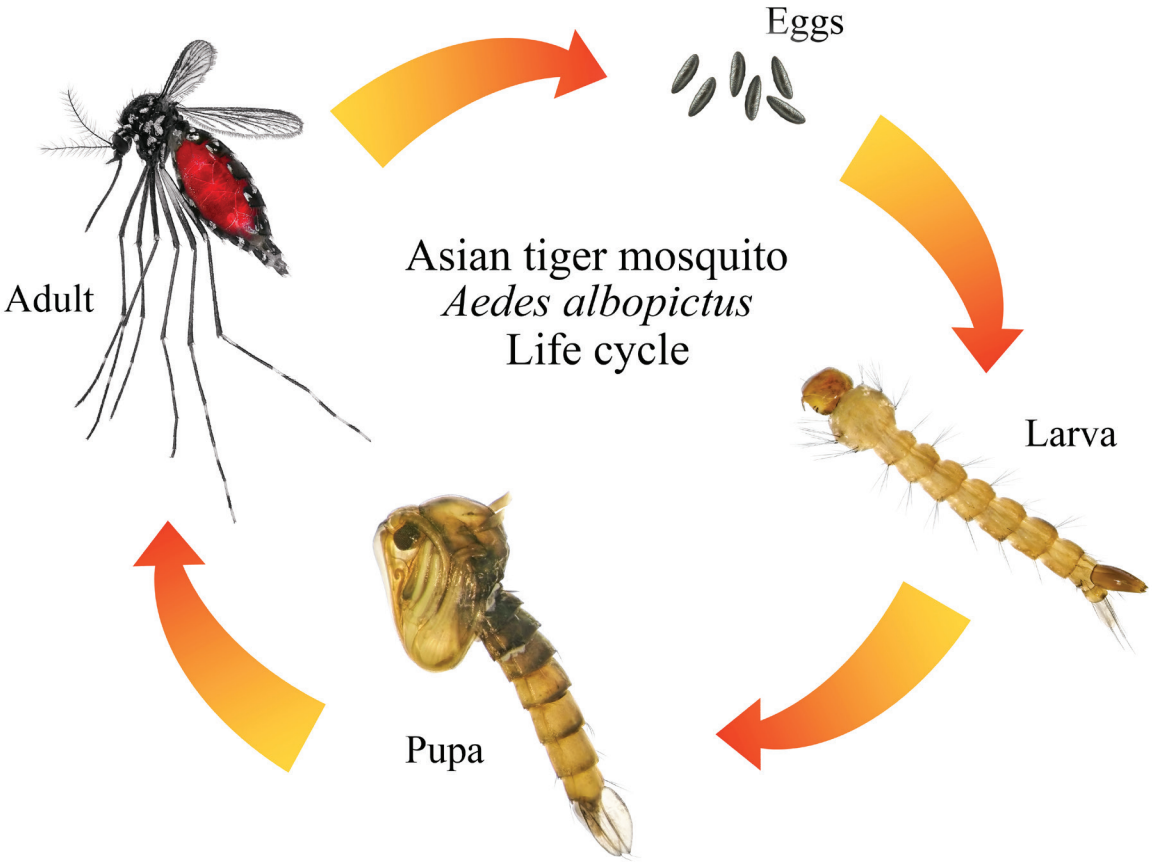
With some species the eggs will hatch very quickly. With others especially at the end of the summer, the eggs will not hatch until they are submerged by autumn / winter rains, or in some cases will not hatch until the following spring, even if they are submerged. With some species, the eggs can remain dormant during a dry winter, and will hatch the following winter, if they are then submerged.

The larvae live entirely in water. They feed on particles of organic material, algae, bacteria etc., which they either sweep into their mouth by creating a current using mouth brushes, or by browsing directly on the surface of submerged debris. The larvae breath air, which they will obtain using either a siphon at their rear end to penetrate the water surface, or by spiracles on the rear of the abdomen. When not feeding, larvae may be seen resting at the water surface. The larvae moult into the comma-shaped pupa, which may be seen floating or wriggling at the water surface.

The adult eventually emerges from the pupa, and spends a little time resting at the water margin while its wings dry and harden, before flying off.

Many UK species will spend the day resting in sheltered locations such as thick vegetation, hollow trees, drains, outbuildings etc., and will emerge at dusk in search of a blood meal. However the invasive *Aedes* species will bite during the day, with some species peaking at dawn and dusk.

The females may live from a few weeks, up to about 9 months with hibernating species. The males are often short-lived but may survive for a few months.



Public health risk posed by invasive mosquitoes

Chikungunya

The primary mosquito vectors for chikungunya are *Ae. aegypti* and *Ae. albopictus* – both have become established in Europe in recent decades following their importation through global commodities (e.g. used tyres). *Ae. albopictus* is expanding its distribution in Europe due to vehicle movements. In 2014 local transmission of chikungunya occurred in France. Locally established populations of *Ae. albopictus* acquired chikungunya from returning infected travellers. The virus was then subsequently transmitted to non-travellers. The first outbreak was reported in Europe (Italy) in 2007 with >300 cases and again in 2017 with 500 cases. Since then chikungunya has spread to the Caribbean, and since December 2013 there have been >1.4 million cases.

Dengue

Most years in Europe there are clusters of dengue. Dengue continues to cause a huge global burden of disease. As with chikungunya (see above) the main issues for Europe and the UK are the global spread of invasive mosquitoes, notably *Ae. aegypti* and *Ae. albopictus*. The former was responsible for transmission of >2000 locally acquired cases of dengue in Madeira in 2012. *Ae. albopictus* was not previously considered the primary vector of dengue however it can transmit dengue and has been responsible for local transmission of dengue in France in most years since 2010, following imported dengue cases. There has also been local dengue transmission in Croatia.

Zika

Zika virus is a newly emerging virus that has spread from Africa to Polynesia and now to south and central America and the Caribbean. Its primary vector is *Aedes aegypti*, but other vectors, including *Aedes albopictus* may become involved. Infection often occurs without symptoms but can also cause an illness similar to dengue.

Zika caused a global public health emergency in 2016 including large numbers of congenital Zika syndrome. Although there was no local transmission in Europe at that time, there has since been locally acquired cases in France.

West Nile Virus (WNV)

Most cases of WNV are not serious and many people have no symptoms or only mild flu-like symptoms, such as headaches, muscle aches and a high temperature (fever).

Serious problems occur in fewer than 1 in 100 symptomatic cases but can include infection of the brain (encephalitis), spinal cord, and tissues surrounding the brain and spinal cord (meningitis), which can be fatal.

WNV is spread through the bites of infected mosquitoes. Mosquitoes become infected when they feed on infected birds. They can then spread the virus to humans and other animals they bite. The virus cannot be spread from close person-to-person contact.

There have been no confirmed cases of WNV originating in the UK, and cases affecting travellers returning to the UK are very rare.

Surveillance and Management

Routine monitoring, recording and mapping of mosquito presence and activity is an essential component of a mosquito management programme. It enables the control programme to progress in a timely, efficient and targeted fashion.

Defining areas for survey

Local authorities should be familiar with those locations in their area of responsibility, in which mosquito breeding occurs. Priority areas for investigation will be where suitable mosquito breeding habitat adjoins human populated areas. 1: 25,000 O.S. maps will show many medium to large permanent water-bodies. Although 1:25000 O.S. maps will be convenient for initial exploration, they will omit most areas that are important from a mosquito breeding perspective. The maps must therefore be supplemented by appropriate field investigation.

Recording field survey data

Although O.S. maps may be convenient for initial surveying, they are not appropriate for recording data in a professional vector management programme. Geographic Information Systems (GIS) should be used wherever possible for recording and processing such data. Hand-held data capture devices supported by GPS, enable field data on breeding sites etc to be recorded precisely. This enables those sites to be relocated quickly by treatment teams.

Ovitraps

Special small containers of water (ovitraps) are used to monitor the density of container breeding mosquitoes. Traps are positioned in areas in which mosquitoes may be present. Eggs deposited in the traps are identified and indicate species and abundance in the area. These are particularly effective for *Ae. albopictus* and are widely used in Italy for example. If *Ae. albopictus* is found in the UK, then ovitraps should be used (together with other techniques), to map distribution and plan and monitor control activities.

(Details of ovitraps and where to obtain them, siting and frequency of inspection are given in Appendix 2)

Larval mosquito monitoring

Monitoring mosquito larvae, as opposed to adults, has the following advantages:

- It can be carried out during normal working hours
- It can be carried out early in the season, before adult mosquito numbers are high and disease transmission has become a possibility
- It enables timely targeted source reduction measures to be used, which will result in long-term suppression of mosquito numbers
- It enables guidance to residents on source reduction to be clear and focussed
- It enables localised larvicidal treatments to be applied to identified breeding sites, if necessary, before the adults emerge and disperse over large areas

Larval monitoring and sampling should normally be carried out using a mosquito dipper, typically comprising a pan with an extended handle. The pan is gently dipped into the water so the surface layer runs into the pan, and the water is then examined for mosquito larvae and pupae. Alternatively an aquatic sampling net may be used. Very small sites can often be sampled using a large pipette.

Areas sampled should include natural, semi-natural and artificial habitats. Approximate numbers and stages of larvae found should be recorded. Representative samples of larvae from each water body should be retained for subsequent identification. Findings at all sites, both positive and negative, must be recorded on the GIS database.

Adult mosquito monitoring

Adult mosquito monitoring techniques will enable:

- Mapping the distribution of human biting mosquito species
- Recording seasonal trends in mosquito abundance
- Investigating species and numbers present in areas where disease outbreaks have occurred
- Catching mosquitoes for research on feeding behaviour or infection levels etc.
- Monitoring the impact of mosquito control measures.

Adult monitoring methods:

Human landing rate

People stand in the selected area for a short period; say 15-30 minutes, typically in the evening although daytime catches can be carried out in sheltered areas such as woodlands. They catch the mosquitoes that land on them (before they are bitten), using an aspirator. The mosquitoes are counted, identified, and recorded. The technique is relatively labour intensive. Records should be entered on the database.

A Risk Assessment for human landing rate catches will need to be carried out in the event of active disease transmission in the area.

Light/carbon dioxide/odour traps

Trapping adult *Culex*

A number of different models are available commercially. Carbon dioxide baited CDC type miniature light-traps are widely used elsewhere in Europe and the USA. Light-traps consist of a light source (to attract mosquitoes) and an electric fan (to suck the mosquitoes into a collecting bag). In addition, a bag containing several kilograms of dry ice (solid carbon dioxide) is suspended close to the trap, to improve the attraction of the trap. Traps are normally powered with a rechargeable battery.

In addition to conventional light-traps, there are also larger traps that use bottled gas, and synthetic odours. These are very effective at catching mosquitoes, but are considerably more expensive and cumbersome than conventional carbon dioxide baited light traps.

Mosquito catches are often highest when the trap is in a humid, sheltered area with long vegetation. They are best positioned away from bright light sources such as street lights.

Traps can be set and run for consecutive days depending on power source. It is important to ensure that the traps are located in secure environments e.g. concealed from public view on a collaborator's land, or theft may be an issue.

The number of traps required and used will vary depending on the area and objectives. Routine use of a number of traps, located in groups at different locations on different nights, would soon give much useful information (See Appendix 2).

The mosquito catch should be identified, counted and recorded on a database. Specimens should be sent to Mosquito Recording Scheme or Public Health England for expert identification. Report Forms etc and address details can be obtained from **https://www.brc.ac.uk/scheme/mosquitoes-recording-scheme** and **https://www.gov.uk/guidance/mosquitoes-how-to-report**

Other mosquito records

Recent records of mosquito incidents (ideally over the last 10 years, where available) within the area, should be entered on the GIS database.

Any new complaints of biting insects should be thoroughly investigated. Where these are believed to be caused by flying insects, then specimens should be collected and identified. Mosquito records arising from such investigation should be recorded on the database.

Treatment Strategies

It is important that as soon as significant species have been identified as being present at a site then treatment measures are put in place.

Mosquito control programmes should use larvicides in the first instance, and adulticides only where larvicides are not considered appropriate. An appropriate risk assessment under the COSHH regulations and to comply with the product label must be carried out before any treatment is undertaken.

Larvicide Application

Mosquito larvicides are applied directly to the water surface of aquatic habitats in which mosquito larvae are present usually via a conventional knapsack pneumatic sprayer. Larvicide treatment is attractive in that mosquito populations can be controlled while they are still relatively localised, before the mosquitoes are able to disperse.

In the UK the only currently approved mosquito larvicide is a sprayable formulation of *Bacillus thuringiensis* var *israelensis*, usually known as 'Bti'. Bti is most active in cleaner water and against the early stage mosquito larvae. Bti is a very selective product, being active only against mosquito larvae, and some other very closely related insects. The duration of activity in treated water is a few days, however treatment may need to be reapplied at regular intervals, as indicated by monitoring information.

For small water bodies where access is good, then a conventional hand-held pressure sprayer, with a nozzle providing a coarse droplet size, is suitable. Where large shallow water-bodies occur, or where access to the margin is difficult, then a sprayer with an extended lance or "boom" may be required. A knapsack mist blower fitted with a rotary atomiser set to give coarse droplets, may be suitable. Treatments should be carried out when there is little or no wind. Where access is essential but difficult, then amphibious vehicles may be required to carry the sprayer out to target areas. If treatments of flowing water e.g. storm drains, or marshes that are part of or near to Sites of Special Scientific Interest (SSSIs), are considered necessary, then the Environment Agency and SNCO will need to be involved in the planning.

Liquid mosquito films based on PDMS Silicone can be used to control mosquito larvae and pupae by pouring onto standing and fresh water. Areas of use include lakes, reservoirs, drains, channels, manholes, gullies, water tanks, plantpot saucers, buckets, septic tanks, tyres, guttering, and other artificial containers in urban habitats. Apply 1 mL undiluted product per m^2 of water surface.

Ultra Low Volume (ULV) treatment

ULV adulticides are active against the adult mosquitoes. They are typically only used when the risk of severe biting or disease transmission is believed to be high and a rapid reduction in adult mosquitoes is considered necessary.

ULV treatments are effective against exposed adult mosquitoes, for a period of perhaps 30 minutes after application. Mosquitoes that emerge from pupae later that night, or which are concealed within dense vegetation or other refuges at the time of treatment, are likely to survive.

Some species, such as *Cx. pipens* biotype *molestus*, have behaviour that tends to make them inaccessible to area-wide ULV treatments. In a given area, a succession of treatments, e.g. applied at 3 day intervals, may be used to intercept newly emerging mosquitoes, or to mop up mosquitoes that have fed on infected birds etc. Adult mosquitoes tend to be dispersed across large areas, so ULV insecticides for adult mosquito control are typically applied across areas ranging from one to many hectares. The exact area to be treated will be defined operationally, and will depend on a range of factors, related to the landscape, the flight range of the particular mosquito, the distribution of disease cases and of the human population, together with environmental sensitivity.

Typically treatments are applied as area wide drift treatments. The ULV sprayer (hand-held or vehicle-mounted) is carried in long passes at right angles to the wind, with each consecutive pass upwind of the last. The breeze will drift the spray plume across the target area, contacting exposed mosquitoes as it does so. The speed of movement of the sprayer, the output of the sprayer, and the distance between consecutive passes, must be adjusted to ensure that the label dose of insecticide is applied. A range of ULV application equipment is available.

Thermal fogging is not considered appropriate for outdoor mosquito control under UK conditions.
The approximate work rate of the various basic ULV application systems is as follows:

Vehicle = c. 50 ha/hr

Hand = c. 3 ha/hr

The efficacy and safety of ULV application equipment is very dependant on maintaining a mean droplet diameter (VMD) in the 15 – 30 microns range. This requires regular calibration of the spray equipment. For maximum efficacy, ULV treatments should be applied at the time of day when:

- The insect vectors are active and therefore likely to acquire insecticide droplets
- Meteorological conditions are suitable for dispersion of the droplet cloud through the mosquito habitat Ideal conditions for terrestrial application of ULV adulticides are warm evenings (>15°C) with a gentle (1 – 3 m/s) breeze. Avoid cool weather, daytime treatments, rainfall, and winds in excess of 5 m/s. ULV adulticides are non-selective and may have an impact on a wide range of non-target organisms

In particular:

- Honeybees are susceptible to ULV insecticides. In the event that application of ULV insecticide is required, then beekeepers close to the treated area will need to be informed, with at least 48h notice, of the time and place of treatments. They can then seal or move their hives to avoid mortality. A buffer zone of 200-300m around beehives should be established. County beekeeping associations will be able to supply lists of members
- Wetland and coastal areas may be of importance for mosquito production, but may also be protected areas. There is a requirement for 200-300m buffer zones around sensitive water bodies with respect to ULV treatment. Again, appropriate agencies will be involved through the ICT, and appropriate risk-based decisions made
- Unprotected people and animals should be excluded from areas to be treated with ULV insecticides

Insecticides

A selection of professional use adulticide and larvicide products, with specific label guidance on mosquito control.

Type of application	Product name	Active ingredient(s)	Area of use
Larvicides			
	Vectobac 12AS	*Bacillus thuringiensis* var *israelensis*	For the control of mosquito and blackfly larvae in water where mosquito and blackfly breeding occurs
	SilMax liquid mosquito film	Polydimethylsiloxane (PDMS silicone)	Standing and fresh water
Space spray treatments (e.g. ULV) for adult control			
	ULV 1500	Tetramethrin & 1R-trans-phenothrin	Emergency treatment programme: for use outdoors against mosquitoes in areas where there is evidence that transmission of West Nile Virus is occurring or there are cases of West Nile Fever
	Vazor ULV 500	Tetramethrin & 1R-trans-phenothrin	For indoor use only
	Aquapy Micro (ULV)	*Chrysanthemum cinerariaefolium* extract	Indoors & outdoors
	Aquapy	*Chrysanthemum cinerariaefolium* extract	Indoors & outdoors
	Deadline Pyrethrum Fog	*Chrysanthemum cinerariaefolium* extract	For indoor use only
Aerosols			
	Envu Flying Insect Killer	d-tetramethrin & 1R-trans-phenothrin	For indoor use only
Residual surface sprays for adult control			
	Vazor Phepra CS	1R-trans-phenothrin & prallethrin	For indoor use only
	Vazor Cypermax Plus	Cypermethrin & Tetramethrin	In and around properties
	Cimetrol Super EW	Cypermethrin, tetramethrin, pyriproxyfen	For indoor use only
	Cytrol Forte WP	Cypermethrin	In and around buildings
Physical immobilisation spray			
	Vazor Provecta	Polyalkyleneoxide modified heptamethyltrisiloxane	Indoors and outdoors

Note: a number of other insecticides are available for mosquito control – this list is not exhaustive. Authorised biocides are listed here https://www.hse.gov.uk/biocides/uk-authorised-biocidal-products.htm

Use biocides safely. Always read the label and product information before use.

Invasive Mosquitoes : Species Habitat

Brief overview of ways invasive species can enter UK

Mosquitoes may enter the UK in a number of ways. They can be inadvertently imported in larva and egg form in plants such as "lucky bamboo" imported from the far East, as eggs possibly in diapause imported in used tyres from mainland Europe, or as adults from lorries with container cargo returning from Europe or via aircraft cabin and cargo holds which have not been disinsected. Given the expansion of *Aedes albopictus* in Europe, the primary route of importation for this species will be via vehicular traffic.

Measures to remove mosquito breeding sites

Source reduction is potentially a very effective mosquito control measure. The type of breeding sites to be eliminated will be very dependent on the species of mosquito responsible, or likely to be responsible, for disease transmission.

However source reduction raises issues of:

- Impact of proposed measures on water conservation measures
- Landowner cooperation

A number of Statutory Powers are available.

Rural / natural breeding sites

In practice, elimination of breeding sites in natural and semi-natural habitats raises a number of issues. Apart from the technical difficulties in draining or filling areas of waterlogged and marshy land, such sites are often privately owned, and may also be protected because of their conservation value. Alterations to water tables may adversely effect the conservation value or the drainage patterns of the area. Any source reduction work proposed in such areas will require the detailed involvement draining and re-wetting areas can also lead to increase in mosquito numbers of the landowner, the Environment Agency, and the SNCO, through the ICT. Agencies may need to use powers of entry in some cases.

Urban / suburban mosquito breeding sites

Elimination of largely artificial breeding sites in urban or sub-urban areas poses different challenges. Sites are often very numerous and most are in private ownership.

Specific mosquito breeding sites

There are a very wide range of potential breeding sites, depending on the mosquito species in question. In addition to the classic rural habitats such as salt-marshes, fens, woodland pools etc, listed below are a range of other less obvious breeding sites that may be important, depending on the mosquito species involved.

Private gardens - Mosquito breeding may occur in containers for plants, water-butts, disused paddling pools, garden pools, water features, rain-filled wheel-

barrows, bird-baths, blocked gutters etc.

However, fish ponds are unlikely to support mosquito breeding, as the fish will prey on any mosquito larvae.

Drink Cans - Discarded soft drink and beer cans provide ideal habitats for mosquitoes. Collection and disposal of such containers is an essential element in any control strategy.

Garden centres / plant nurseries /botanical gardens –

Stand-pipes and leaking irrigation equipment may create waterlogged ground and pooling of water. Water features may also support breeding.

Allotments - The numerous water-butts, watering cans etc on allotments will support mosquito breeding.

Cemeteries - Some mosquitoes will breed in vases and other receptacles for flowers.

Construction sites - Neglected buckets, drums, wheelbarrows, dumper trucks, and other partially water-filled containers will sometimes support mosquito breeding.

Sewage treatment works – Mosquitoes may breed in the main waste water processing plant, and also in pools or puddles associated with waterlogged ground, overflows or leaks.

Marinas, sailing clubs, water-sports centres and boatyards - Mosquitoes may breed in rainwater in the bottom of boats, or in the covers of boats.

Tyres - Garages, used tyre storage processing plants, vehicle race-tracks, farm silage clamps and others may all have tyres stored in the open air, and at risk of containing rainwater. Fly-tipped tyres also create significant mosquito breeding opportunities.

Stables / smallholdings etc – Drinking troughs may support mosquito breeding, as may effluent from stables and manure heaps.

Roadside gullies and run-off catchment basins - Some species may breed in standing water in such sites. Liaison with the Highways Agency will help locate these areas.

Underground water bodies – Flooded cellars, lift shaft sumps, underground rail systems, boiler rooms etc may support breeding of specific species.

Local authorities have the following powers with respect to dealing with mosquito problems:

- The general provisions of the Environmental Protection Act 1990 provide a power of entry where a statutory nuisance (i.e. likely to be prejudicial to health, or a nuisance) exists. The local authority can, by issuing an abatement notice, require work necessary to abate the nuisance, such as remove mosquito breeding sites
- In addition, the Clean Neighbourhoods and Environment Act 2005, adds to the nuisances listed in the Environmental Protection Act, one of 'any insects emanating from relevant industrial, trade or business premises and being prejudicial to health or a nuisance'

Local Authority Advice to Residents

Clothing

Human / vector contact can be reduced to some extent by wearing long trousers and long-sleeved shirts when mosquitoes are active.

Personal behaviour

Staying indoors in the evening will reduce vector contact. When going out, avoiding areas such as wetlands or forested areas in the evening will reduce man-vector contact. Specific groups that may be outdoors (and are therefore potentially at higher risk) can be targeted directly, including:

- Anglers (contact fisheries managers)
- Campers (contact campsite managers)
- Those visiting wildlife centres
- Outdoor events such as concerts (contact event organisers)

Residents can minimise potential mosquito breeding sites at their properties and gardens by implementing the measures suggested in the diagram within Appendix 3.

Repellents

Use of insect repellents will reduce man/vector contact. Repellents are regulated by HSE, and some products are not approved for use on certain people, e.g. young children. Label guidance must always be followed. The Department of Health recommends the use of approved products containing 30% DEET.

(Further information is available from the Public Health England website www.gov.uk entering Mosquito Repellents in search criteria)

Training & Qualifications

Many local authorities are aware of the potential risk to public health posed by the introduction of invasive mosquitoes into the UK, however there are few who have the knowledge and skills to implement effective mosquito management strategies.

Recent events have emphasised the need for preparedness in the event of an outbreak of mosquito-borne disease. In response, pest management experts, have developed a comprehensive training course which covers the essential elements of an effective and safe mosquito control programme.

The course is aimed at those currently or potentially, involved in the control of mosquitoes in the UK. It provides in-depth knowledge and practical skills to enable delegates to:

- Identify key mosquitoes
- Survey areas for mosquito activity
- Carry out a range of targeted measures to reduce mosquito problems

(See Appendix 1)

References

Public Health England,

For further information on invasive mosquitoes, disease transmission and mosquito repellents go to Public Health England website at www.gov.uk entering "mosquitoes" in the search criteria - European Centre for Disease Prevention and Control. 2012

National Contingency Plan for invasive mosquitoes

https://www.gov.uk/government/publications/national-contingency-plan-for-invasive-mosquitoes

European Centre for Disease Prevention and Control

Guidelines for the Surveillance of Invasive Mosquitoes in Europe, Technical Report 2012

Public Health Issues posed by Mosquitoes
CIEH NPAP Library (downloadable from www.urbanpestsbook.com)

Appendix 1

Killgerm Mosquito Training Course

Syllabus

Course description

This course is designed to provide a greater understanding of mosquitoes and their control for established pest control technicians. It is intended principally for individuals already within the industry who wish to develop specialist expertise in order to be able to respond to the emerging threat posed by mosquitoes.

The syllabus covers the biology and identification of mosquitoes, site surveys, chemical and non-chemical control methods and health and safety requirements.

Attainment of the Learning Outcomes will be assessed by an examination and a practical assessment.

Appendix 2

Placement of Ovitraps & Frequency of Inspection

Ovitraps are a simple and effective method of monitoring for container-breeding *Aedes* species. They are small black cups, with an overflow hole drilled approximately 4 cms from the top, filled with water, and containing an oviposition support (eg: filter paper, wooden stick, or block of polystyrene).

Ovitraps can be used to detect presence of an invasive mosquito, or to assess the density, although the number of eggs at a trap can be influenced by the number of other oviposition habitats in the surrounding area. Traps should be placed in a range of micro-climate conditions, and be clearly labelled (eg: scientific study, please do not remove). A tent peg may be used to fix the trap in position, to ensure the trap isn't blown over or accidentally knocked.

When conducting surveillance to assess presence of an invasive mosquito, traps should be checked every two weeks. In high-risk areas where presence has been confirmed or very likely, traps should be checked, if warm/hot then check weekly. Insecticide should be added to the water if trapping is likely to be more infrequent.

Aedes eggs are laid on the substrate above the water line. For this reason, polystyrene blocks are recommended to ensure the eggs are never immersed in the water. In the UK, *Aedes geniculatus*, a native treehole species, may also lay eggs in ovitraps. Likely eggs should be examined under the microscope to confirm as mosquito eggs, and the immersed in water to rear larvae and adults for identification. Molecular methods are also available to identify eggs to species.

The number of traps used can vary depending on the aims of the surveillance and the staff resources available. For targeting particular locations, eg service stations, 10-20 ovitraps may be used, whilst 1 trap per 2500m^2 should be used to target broader areas across an urban landscape. Numbers of traps should be increased at sites where the quality and efficacy of control measures are to be assessed (20 / site).

BG Sentinel

A professional mosquito trap for use against *Aedes albopictus* without CO_2 and all mosquitoes with CO_2.

BG GAT

A professional mosquito trap, for use against ground *Aedes*. Used as a passive trap, for surveillance programs and mass trapping.

Appendix 3

Potential mosquito breeding sites produced by CIEH/PHE

Public Health England

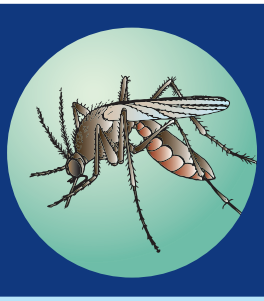
Protecting and improving the nation's health

Controlling mosquitoes in your garden

Chartered Institute of Environmental Health

There are more than 30 species of mosquito native to the British Isles. Some of these only bite birds and many species are confined to specific habitat types such as salt-marsh, reedbed, or wet woodland. However a number of species may breed in a range of aquatic habitats in gardens, and some of these bite people and may cause a nuisance.

Removing any standing water in your garden can reduce the number of mosquitoes in your garden and can help avoid nuisance biting by mosquitoes.



Blocked gutters and drains can provide habitats for mosquitoes, so keep them clear to allow the water to freely drain.

Rain water can collect in litter, tarpaulins, buckets, open bins, wheelbarrows, and tyres, so arrange these so that the water can drain away.

Mosquitoes often breed in water butts. A well fitted lid will help to stop mosquitoes breeding in these containers.

Permanent, healthy ponds will provide habitat for a range of predators that will reduce mosquitoes in these habitats.

Water in paddling pools and bird baths should be drained and refilled every few days, so that mosquito larvae do not develop.

Public Health England welcomes records and mosquito samples for identification from entomologists, environmental health officers, and people who are affected by mosquito nuisance biting. If you would like to send mosquitoes for identification please download the form from our website or contact us at **mosquito@phe.gov.uk**

Mosquito Watch: **www.cieh.org/policy/npap_mosquito_watch.html**

PHE information: **www.gov.uk/government/publications/mosquito-surveillance**

PHE publications gateway number: 2016195

Notes

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