Government of **Western Australia**
Department of **Health**

Medical Entomology

2017/2018
Annual Report

Biological and Applied Environmental Health Hazards
Environmental Health Directorate
Public and Aboriginal Health Division
Department of Health, Western Australia
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Acknowledgements

The extensive and diverse work program undertaken by the Department of Health's Medical Entomology team outlined in this Surveillance Program Annual Report could not have been completed without significant assistance and collaboration from many partners and stakeholders.

In particular, the Medical Entomology team wishes to thank the Department of Health for its ongoing support in regards to this important public health program including:

- the Environmental Health Directorate;
- the Communicable Disease Control Directorate;
- the Public and Aboriginal Health Division
- Population Health Units/Area Health Services
- PathWest; and
- Communications Directorate.

PathWest's surveillance laboratory continued to have significant involvement in the program through provision of laboratory services for key components of the surveillance program for detection of arboviruses of public health significance to the State.

We also acknowledge and thank the Population Health Units and the Western Australian Country Health Service for their role in reporting and completion of follow-up questionnaires for human cases of disease, and especially the role of Local Governments in the management of mosquitoes and the diseases they transmit. These organisations play a key role in the provision of data, case follow up investigations, care and bleeding of chickens for the sentinel chicken program, trapping of mosquitoes, mosquito control treatments and advice to the Western Australian community about disease risk through their own communication plans.

In particular we thank Environmental Health Officers from the 139 Local Governments across WA, including those who are part of Contiguous Local Authority Groups (CLAGs), who respond to public complaints, undertake larval and adult mosquito surveys, and undertake mosquito control activities as part of their complex, integrated programs to manage the risks to public health and amenity within their regions.

The collaborative approach and effort by the teams and agencies listed above is a feature of this state-wide, integrated program, and is essential for its effective delivery across the largest jurisdiction in Australia.

Contents

Executive summary

This annual report summarises the surveillance components of the Medical Entomology program including human case notifications and mosquito and arbo-virus surveillance programs (Southwest mosquito and arbovirus surveillance; northern mosquito and arbovirus surveillance and the sentinel chicken program for flavivirus surveillance) for the period 1 July 2017 to 30 June 2018. It does not encompass the other achievements and extensive work undertaken in the Medical Entomology program during the 2017/18 financial year, much of which has been reported in the Environmental Health Directorate's Year Book (See: https://ww2.health.wa.gov.au/Reports-and-publications/Environmental-Health-Directorate-Yearbook) and in numerous Environmental Health Newsletters produced throughout the financial year.

Mosquito-borne disease case data:

Ross River virus (RRV): The total number of notified human cases of RRV infections for WA in 2017/18 was 606. The number of reported cases was lower than the monthly five year moving average for all months excluding August 2017, which was marginally above the average.

Barmah Forest virus (BFV): A total of 48 human cases of BFV were notified across WA for 2017/18. Generally, the number of human cases of BFV reported to the Department of Health in any one month was low and similar to previous years.

Murray Valley encephalitis (MVE) virus: There was one human case of MVE notified to the Department of Health during 2017/18.

West Nile virus Kunjin strain ($WNV_{(KUN)}$): There was one confirmed case of WNV_{KUN} disease notified to the Department of Health during 2017/18. This was associated with activity during the previous season in 2016/17.

Climatic conditions that influence mosquitoes and mosquito-borne pathogens:

Rainfall was below average for the majority of the state, particularly in all coastal areas south of the Pilbara/Kimberley border. In contrast, the west Kimberley coastline in the vicinity of Broome and Derby, received the highest rainfall on record. This was largely due to a succession of cyclones and low pressure systems between January and February and resulted in extensive flooding in Broome and surrounding areas.

All of Western Australia (WA) experienced above average maximum temperatures and much of the state also experienced above average minimum temperatures, with only parts of the Kimberley region experiencing below average minimum temperatures.

Mosquito-borne disease surveillance

Southwest RRV/BFV surveillance program:

A total of 89,912 mosquitoes were collected from 21 routine surveillance sites in high risk parts of the Southwest region of Western Australia. RRV was detected in 25 pools of mosquitoes from the Peel and Harvey Estuary only. A further 42 detections of BFV were made from mosquitoes collected in the Peel and Harvey Estuary, the Leschenault region and the Shire of Capel.

MVE virus and WNV_{KUN} surveillance

A total of 62 flavivirus detections were recorded from sentinel chicken flocks across northern WA during the 2017/18 financial year. This was approximately half that compared to the 2016/17 financial year when 128 flaviruses were detected. During 2017/18, seroconversions were detected in 62 of the 3930 samples tested (1.57%).

Northern mosquito surveillance:

In 2017/18 mosquito surveillance was undertaken in the Kimberley and Pilbara regions of Western Australia. A total of 191,483 mosquitoes were identified to species and sent to PathWest for detection of viruses. Results of testing will be published in the 2018/19 annual report.

Sentinel chicken program:

The level of flavivirus activity in sentinel chickens in northern WA in 2017/18 was lower than previous years. Seroconversions were detected in 62 of 3930 (1.6%) blood samples submitted for analysis. This is lower than the previous year where 140 of the 3807 samples tested (3.6%) with the Kimberley and Pilbara regions detected virus activity.

Introduction

There are 300 different species of mosquitoes in Australia, of which approximately 100 are known to occur in Western Australia (WA). Viruses have been isolated from over 30 species across Australia and many other species have not been tested to determine their ability to transmit these viruses. The main mosquito-borne viruses of concern to public health in WA are:

1) Ross River virus (RRV) – (all of WA);
2) Barmah Forest virus (BFV) – (all of WA);
3) Murray Valley encephalitis virus (MVEV) – (northern WA – Kimberley, Pilbara, Gascoyne, Midwest)*; and
4) West Nile virus Kunjin strain ($WNV_{(KUN)}$) – (northern WA – Kimberley, Pilbara, Gascoyne, Midwest)*.

*See Appendix 1 for a map of Western Australian regions.

Furthermore, the Medical Entomology (ME) program monitors the occurrence of infections with exotic mosquito-borne pathogens in visitors or returning residents from countries outside of Australia. These include:

1) chikungunya virus (CHIKV);
2) dengue virus (DENV);
3) Japanese encephalitis;
4) malaria; and
5) Zika virus (ZIKV).

The role of Medical Entomology

The ME program is responsible for:

- monitoring human cases of mosquito-borne diseases through the Western Australian Notifiable Infectious Disease Database (WANIDD) to determine patterns of disease occurrence and provide warnings to at risk communities;

- provision of expert advice to the Minister for Health, senior WA Department of Health (DoH) staff, other State Government agencies, Local Government Authorities (LGAs) and members of the public on matters concerning mosquitoes and the diseases they carry;

- provision of specialist advice for development projects through the identification of existing mosquito breeding sites and to minimise the potential for newly created mosquito breeding habitat that may impact the development sites;

- undertaking State-wide surveillance of mosquito-borne diseases in conjunction with PathWest, including surveillance of mosquitoes for RRV/BFV activity in the Southwest region and surveillance of MVEV and WNV_{KUN} through sentinel chicken flocks in the northern two-thirds of WA;

- issuing warnings and media statements when virus activity escalates, environmental conditions are suitable for vector breeding or surveillance activities identify particular risks;
- conducting field investigations and surveys of mosquito-borne disease outbreaks and mosquito-breeding habitat;
- conducting and assisting other agencies in research projects focusing on mosquito ecology, arboviruses, innovative mosquito management practices, mosquito management equipment trials and calibration and newly available chemicals and/or formulations for mosquito control;
- development of policies for best practice mosquito control and use of chemicals, mosquito management plans, minimising risks for residential developments and avoidance of man-made mosquito breeding;
- provision of training courses, seminars and lectures to personnel involved in mosquito management and to disseminate information to stakeholders and the public;
- coordination of the aerial larviciding program in the Southwest region of WA; and
- coordination of the Contiguous Local Authority Group (CLAG) Funding Scheme.

For further information on other activities, projects and research initiatives being completed by team members within Medical Entomology, please review the Directorate's Year book at the following link:

https://ww2.health.wa.gov.au/Reports-and-publications/Environmental-Health-Directorate-Yearbook

Endemic arboviruses

Ross River virus (RRV)

Ross River virus is the most common arbovirus known to cause human disease in WA. Patients with RRV infection experience a polyarthritic condition with or without other symptoms such as fever, sore muscles, rash, lethargy and headaches. These symptoms can last from weeks to months, and in very rare cases, years.

Overview

The total number of notified human cases of RRV across WA during 2017/18 was 606. The number of RRV cases was significantly less than the monthly five year moving average for all months except August and October 2017 which were statistically similar to the five year moving average (Figure 1).

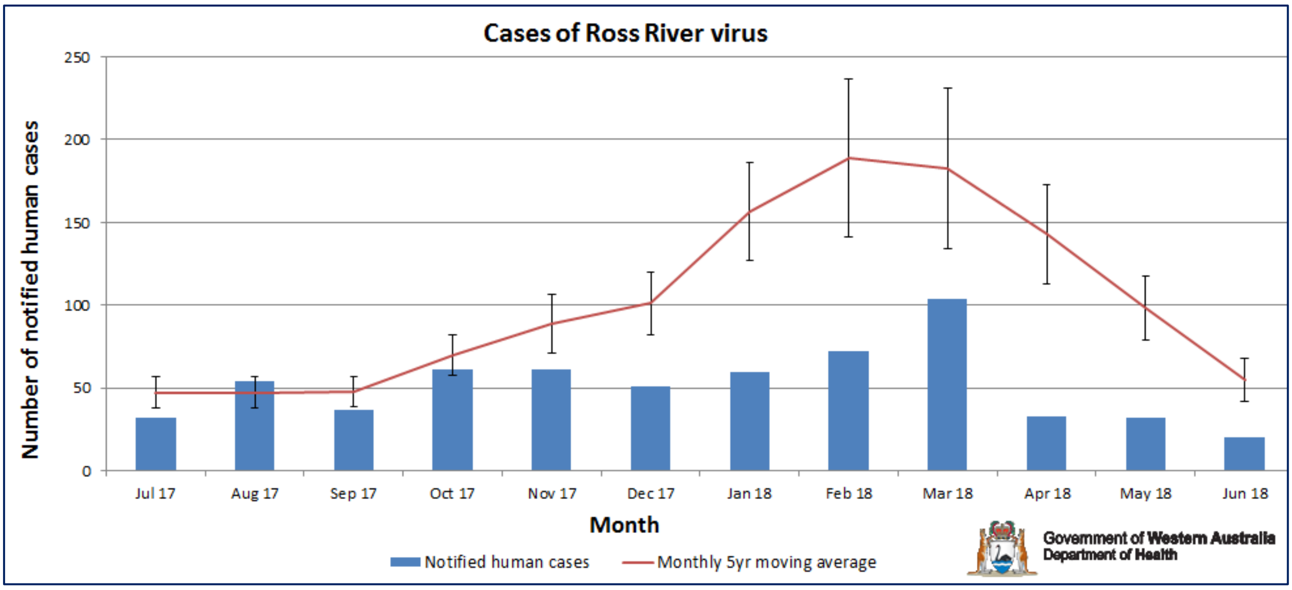


Figure 1: The total number of notified human cases of RRV per month across WA from July 2017 to June 2018*.

**Based on enhanced notified human cases from the West Australian Notifiable Infectious Disease Database (WANIDD) and includes enhanced surveillance data from follow-up questionnaires.*

Regional summaries

The majority of RRV cases were recorded in the Perth metropolitan and Southwest regions (Table 1). 300 human cases of RRV were recorded in the Perth metropolitan region. Although this region recorded the highest number of human cases, the large population in the Metro region meant the disease rate (incidence per 100,000 head of population) was actually the third lowest of all regions across the State (Table 1).

A total of 196 human cases of RRV were recorded from the Southwest region. The number of cases reported in all months was below the monthly long term average (Figure 2).

The crude rate (CR) represents the number of RRV notifications per 100,000 head of population in each region and the Age Standardised Rate (ASR) adjusts for differences in the age distribution between the regions to enable direct comparison of the rates across each of the regions. The highest CR of 79.7 and ASR of 79.8 were recorded from the Kimberley region in the north of WA for the 2017/18 financial year. This was followed by locations in the Southwest region including the Leschenault region (with a CR of 48.6 and an ASR of 50.0), the Peel region (CR = 48.6; ASR = 47.4), the Pilbara region (CR = 35.8; ASR = 39.3) and the Geographe region (CR = 39.9 and ASR = 38.8).

Table 1: Serologically confirmed, doctor-notified, and laboratory reported cases of Ross River virus disease per month for each WA region from July 2017 to June 2018. CR = Crude rate per 100,000. ASR= Age standardised rate (age standardised to 2001 Australian standard population)*.

REGION		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total	Crude	Age std
KIMBERLEY		0	1	0	1	1	0	0	10	10	2	2	2	29	79.7	79.8
PILBARA		1	2	2	2	5	0	1	0	2	3	3	1	22	35.8	39.3
GASCOYNE		0	0	0	0	0	0	0	1	0	0	0	0	1	10.2	6.6
MIDWEST		1	2	5	0	2	1	1	1	2	1	0	0	16	25.7	26.9
WHEATBELT		6	1	4	3	1	0	2	3	1	0	0	1	22	31.8	30.9
METRO		18	37	13	32	27	26	24	30	50	16	18	9	300	17.0	16.7
	PEEL	1	7	5	8	12	13	20	18	30	6	3	4	127	48.6	47.4
	LESCHENAULT	0	1	3	4	4	7	7	6	1	2	1	0	36	48.6	50.0
	GEOGRAPHE	2	1	1	5	2	4	2	3	0	0	1	1	22	39.9	38.8
	ELSEWHERE SW	1	0	1	2	2	0	1	0	3	0	1	0	11	23.6	22.4
SOUTHWEST		4	9	10	19	20	24	30	27	34	8	6	5	196	44.8	
GREAT SOUTHERN		1	1	1	1	3	0	2	0	0	0	1	0	10	16.6	15.6
GOLDFIELDS-ESPERANCE		1	1	1	3	0	0	0	0	2	1	1	0	10	17.7	18.9
WA UNDETERMINED		0	0	0	0	0	0	0	0	0	0	0	0	0		
INTERSTATE		0	0	1	0	2	0	0	0	3	2	1	2	11		
WA TOTAL (does not include interstate)		**32**	**54**	**36**	**61**	**59**	**51**	**60**	**72**	**101**	**31**	**31**	**18**	**606**		

**Table may vary from previous or future version due to inclusion of additional enhanced surveillance data.*

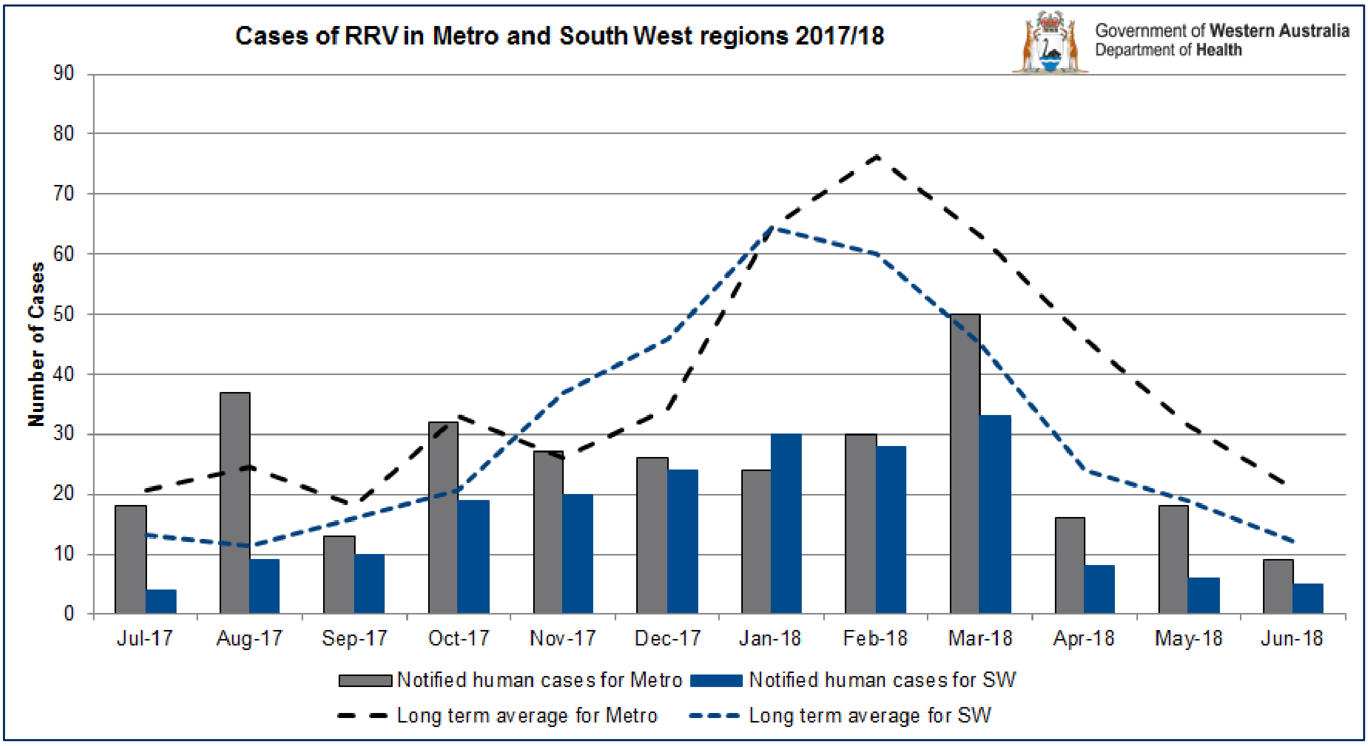


Figure 2: The total number of notified human cases of RRV per month across Metro (Grey) and Southwest (SW-Blue) regions from July 2017 to June 2018*.

**Based on notified human cases from the West Australian Notifiable Infectious Disease Database (WANIDD) and includes enhanced surveillance data from follow-up questionnaires.*

During 2017/18, most Local Governments (LGs) reported similar rates of RRV disease incidence compared to the state average (Figure 4). Only 10 of 139 LGs had significantly higher rates of RRV compared to the state average, including Broome, Derby/West Kimberley and Karratha in the north of WA and along the southwest coastal region including Mandurah, Rockingham, Murray, Waroona, Harvey, Capel and Dardanup (Figure 3 and Figure 4). The Shire of Ashburton was the only LG region to have a RRV rate significantly lower than the overall state average in any of the regional areas of WA.

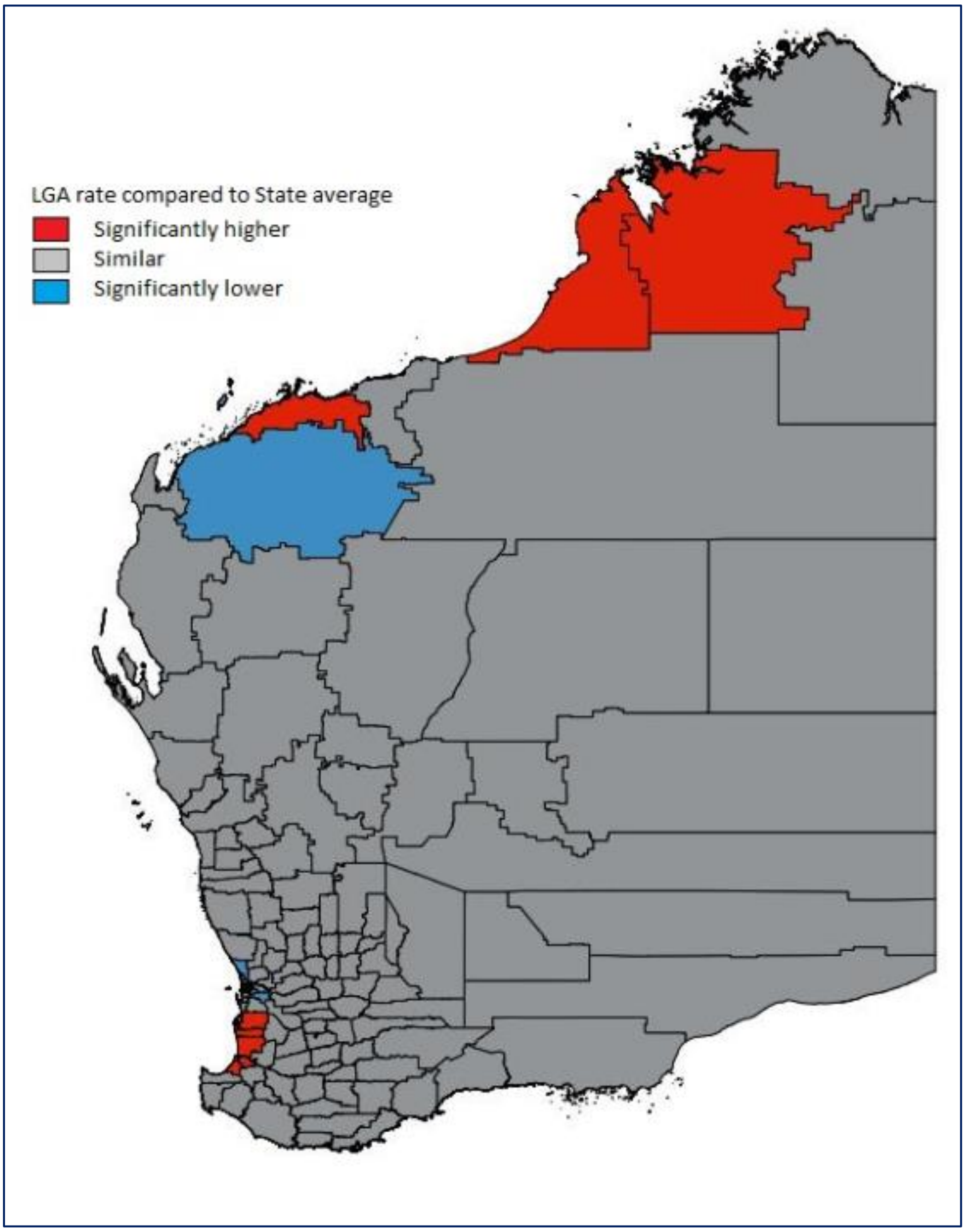


Figure 3: Map of Western Australian Local Government Areas with rates of human cases of RRV per 100,000 head of population in 2017/18 compared to the overall State average rate of RRV infection. Local Government areas shaded in blue indicate a RRV rate significantly less than the state average; grey indicates a rate similar to the State average and areas shaded in red indicate a significantly higher RRV rate compared to the overall state average.

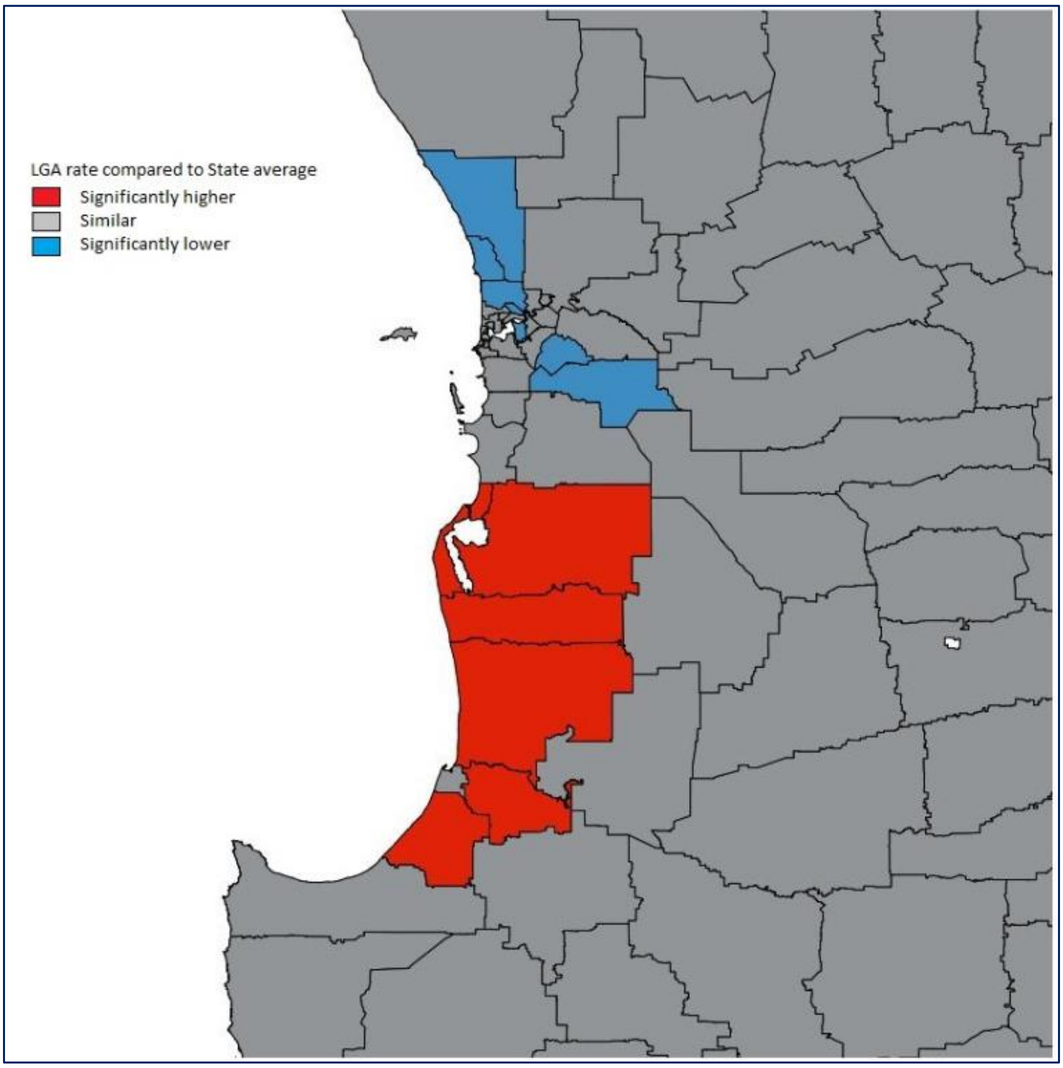


Figure 4: Map of the Perth Metropolitan Area showing Local Government borders shaded to indicate the rate of human cases of RRV per 100,000 head of population in 2017/18 compared to the state average rate. Areas shaded in blue indicate a RRV rate significantly less than the state average; grey indicates a rate similar to the state average and areas shaded in red indicate a significantly higher RRV rate compared to the overall state average.

Barmah Forest virus (BFV)

Barmah Forest virus is the second most common arbovirus causing human disease in WA. The virus is closely related to RRV and the symptoms of infection are similar. However, BFV is generally regarded as the milder of the two and is less common than RRV human cases.

Overview

A total of 48 human cases of BFV were notified across WA in 2017/18. The number of human cases was similar to, or below the long-term average for most months, excluding March 2018 (Figure 5).

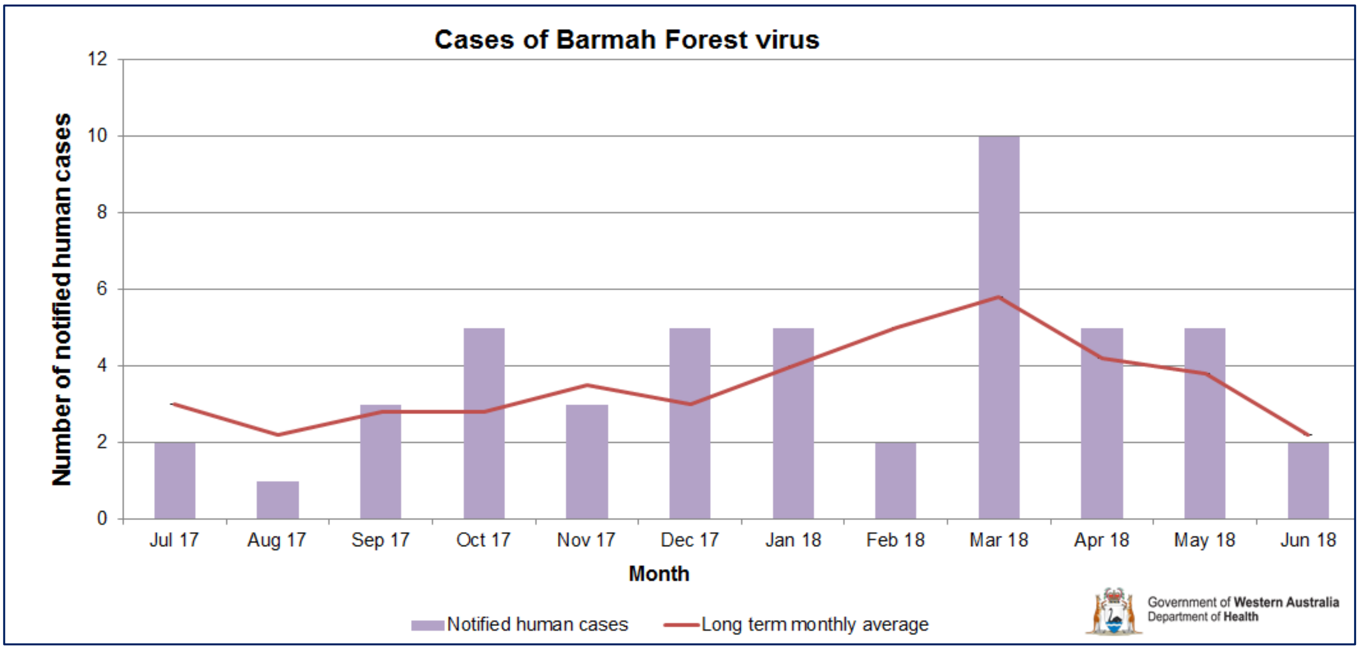


Figure 5: The total number of monthly notified human cases of BFV across WA from July 2017 to June 2018*^.
**Based on notified human cases from the West Australian Notifiable Infectious Disease Database (WANIDD) and includes enhanced surveillance data from follow-up questionnaires.*
^monthly averages are based on data collected from January 2014 onward due to false positive results reported from some laboratory testing methods prior to this date.

Regional summaries

Half of the notified human cases of BFV occurred in the Southwest region (24) (Table 2). The Kimberley region had the second highest number of human cases of BFV recorded across the state, however, due to the small human population in this region, they had the highest crude and highest age standardised rates (24.7 and 23.9 respectively) per 100,000 head of population (Table 2). Most other regions had very low crude or age standardised rates, reflecting the low number of notified human cases of BFV.

Table 2: Serologically confirmed, doctor-notified, and laboratory reported cases of Barmah Forest virus disease per month for each WA region from July 2017 to June 2018. Crude = Crude rate per 100,000 population. Age std= Age standardised rate (standardised to 2001 Australian standard population)*. Blank cells = '0'.

REGION		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total	Crude	Age std
KIMBERLEY		1	1	1	0	1	0	0	0	2	1	2	0	9	24.7	23.9
PILBARA		0	0	0	0	1	0	0	0	1	1	0	0	3	4.9	7.2
GASCOYNE		0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
MIDWEST		0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
WHEATBELT		0	0	0	0	0	0	0	0	0	0	1	0	1	1.4	0.8
METRO		0	0	1	1	0	0	1	1	0	1	1	0	6	0.3	0.4
	PEEL	0	0	0	1	0	1	1	0	2	1	0	1	7	2.7	2.5
	LESCHENAULT	0	0	1	1	0	3	1	0	1	0	0	0	7	9.4	9.8
	GEOGRAPHE	0	0	0	1	1	1	1	1	0	0	0	1	6	10.9	9.5
	ELSEWHERE SW	0	0	0	0	0	0	1	0	2	1	0	0	4	8.6	7.5
SOUTHWEST		0	0	1	3	1	5	4	1	5	2	0	2	24	5.5	
GREAT SOUTHERN		0	0	0	0	0	0	0	0	1	0	1	0	2	3.3	3.8
GOLDFIELDS-ESPERANCE		1	0	0	1	0	0	0	0	1	0	0	0	3	5.3	4.5
WA UNDETERMINED		0	0	0	0	0	0	0	0	0	0	0	0	0		
INTERSTATE		0	0	0	0	0	0	0	0	0	0	0	0	0		
WA TOTAL (does not include interstate)		**2**	**1**	**3**	**5**	**3**	**5**	**5**	**2**	**10**	**5**	**5**	**2**	**48**		

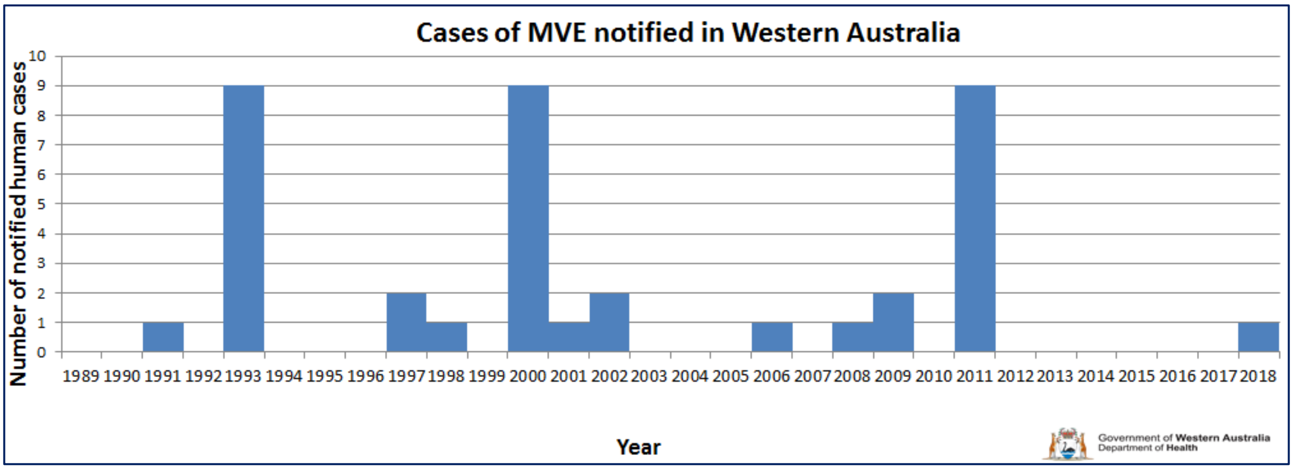
**Table may vary from previous or future version due to inclusion of additional surveillance data.*

Murray Valley encephalitis (MVE)

The rare but potentially fatal Murray Valley encephalitis (MVE) virus is endemic in the Kimberley region and epidemics can, at times, extend further into the Pilbara region. It is occasionally active in other regions, such as the Gascoyne, Goldfields and Midwest.

Approximately one in one thousand people will develop disease symptoms if they become infected from the bite of a MVEV-carrying mosquito. Symptoms of MVE in young children can include fever, floppiness, irritability, excessive sleepiness and fits. In older children and adults, symptoms can include fever, drowsiness, confusion, headache, stiff neck, nausea, vomiting, dizziness and muscle tremors. Patients with severe MVE infections become ill very quickly with confusion, worsening headaches, increasing drowsiness and possible seizures. Patients can slip into a coma, suffer permanent brain damage or die.

There was one confirmed case of MVE notified to the DoH during 2017/18 (Figure 6). The patient had travelled extensively throughout the Kimberley including the Bungle Bungles and parts of the Pilbara region between 9th May and 15th June 2018, just prior to onset of symptoms (including high fever, headache, myalgia and memory loss) on the 22nd June 2018. Therefore, it was not possible to confidently identify a likely place of exposure for this patient. Prior to this case, the last confirmed case of MVE occurred in 2011 when 9 cases of MVE were reported in WA.



West Nile virus Kunjin strain ($WNV_{(KUN)}$)

West Nile virus Kunjin strain ($WNV_{(KUN)}$) is closely related to MVE virus. Kunjin disease symptoms are similar to, but generally less severe compared to MVE although it is often associated with joint pain.

There was one confirmed case of Kunjin disease notified to the WA DoH on 18 August 2017, with date of onset of disease originally estimated to be 1 July 2017. After follow up, onset of disease was revised to mid-June 2017, most likely acquired in the Northern Territory or Kimberley region. There were also three other cases of Kunjin disease (two probable) notified in July 2017, but these have all been placed on hold in the Western Australian Notifiable Infectious Disease Database (WANIDD). In addition this one case notified in 2017/18, there were four confirmed human cases of Kunjin disease notified to the DoH in 2016/17, all originating from the Kimberley region (Broome), giving a total of 5 confirmed cases during 2017 (Figure 7).

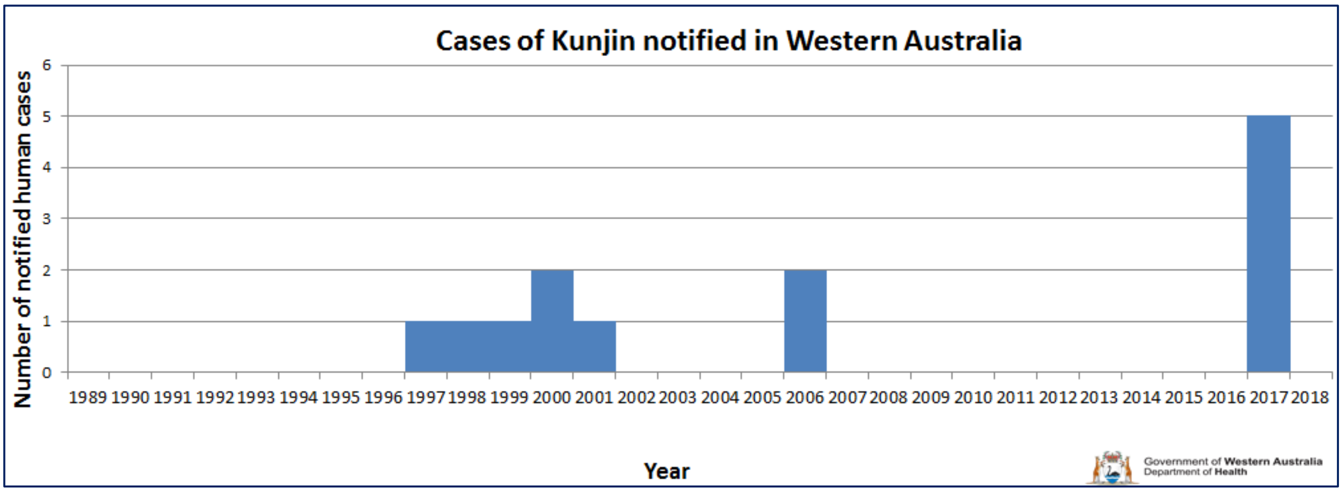


Figure 7: The number of notified (confirmed) human cases of Kunjin disease in WA since 1989.

Exotic mosquito-borne diseases

A number of mosquito-borne diseases are diagnosed in people returning home after international travel or in international visitors to WA. Due to legislative requirements to notify infectious diseases to the WA DoH, these cases are also entered into the WANIDD, but are considered ‘exotic’ as they are not acquired in WA.

The most common exotic mosquito-borne diseases diagnosed in WA are due to infections with dengue and chikungunya viruses and malaria (caused by infection with one of five different species of protozoan parasites). All notified cases of exotic diseases are followed up with an enhanced questionnaire to ensure the patients acquired the disease overseas.

Chikungunya virus

The risk of infection with chikungunya virus has traditionally been highest in Africa and Asia. More recently, the disease has emerged in countries in the Pacific and Indian Ocean regions as well as south-east Asia and the Caribbean. It is not endemic to Australia and the known vectors of this disease are not present in WA, although it is suspected that some native WA mosquito species such as *Aedes vigilax, Ae. notoscriptus* and *Coquillettidia* species near *linealis* may be capable of transmitting chikungunya virus if it were to become established here.

Symptoms of chikungunya include fever, chills, muscle aches, sudden headache, fatigue, nausea, vomiting and a flat rash on the limbs and torso. Many patients experience joint pain in peripheral joints such as the hands or feet. This joint inflammation can last for several weeks or months.

A total of five cases of chikungunya were notified to the DoH during 2017/18 (Figure 8). Enhanced surveillance questionnaires completed by patients found four to have acquired chikungunya in India and one case from travel in Somalia. This represents a decrease in cases entering WA from overseas travellers compared to the previous year.

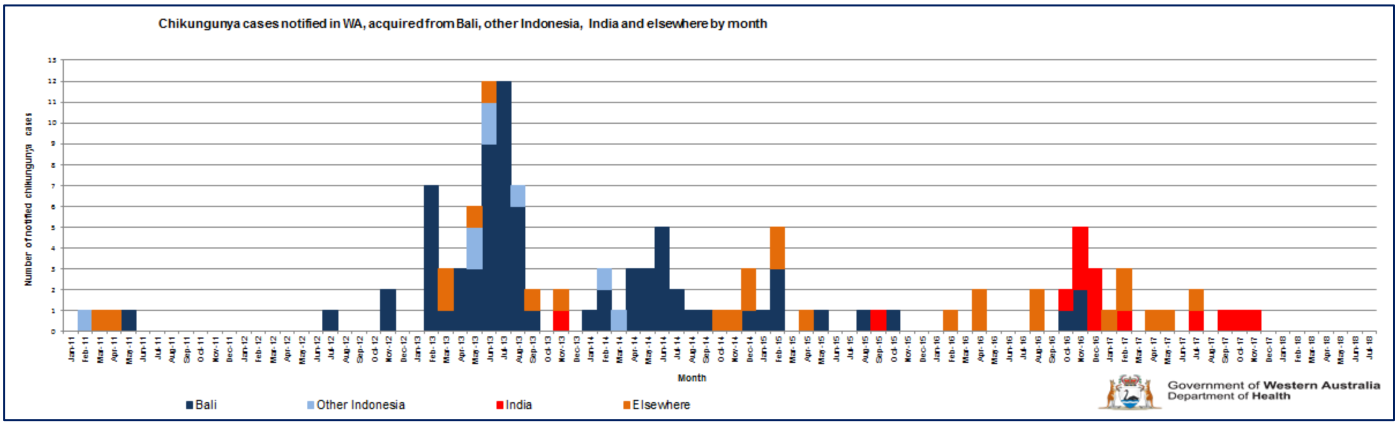


Figure 8: Monthly total number of human notifications of chikungunya reported from WA residents but acquired from overseas locations, since 2010.

Dengue viruses

Four dengue virus serotypes are currently recognised. An initial infection with the virus will result in dengue fever, characterised by fever, headache, muscle and joint pain and skin rashes. A subsequent infection with a different strain can lead to a severe form of the illness known as severe dengue. Severe dengue can include dengue haemorrhagic fever and dengue shock syndrome which can result in bleeding from body orifices, blood spots on the skin, a weak pulse and may be fatal. There is currently no commercially available vaccine. Dengue is spread by the bite of infected *Aedes aegypti* or *Ae. albopictus* mosquitoes, neither of which are currently present in WA.

The total number of dengue cases notified in WA during 2017/18 was 129. All cases reported during 2017/18 were acquired overseas.

The number of human cases of dengue acquired from overseas travel has declined over the last year, particularly those travellers who acquired dengue associated with travel to Bali, Indonesia (Figure 9).

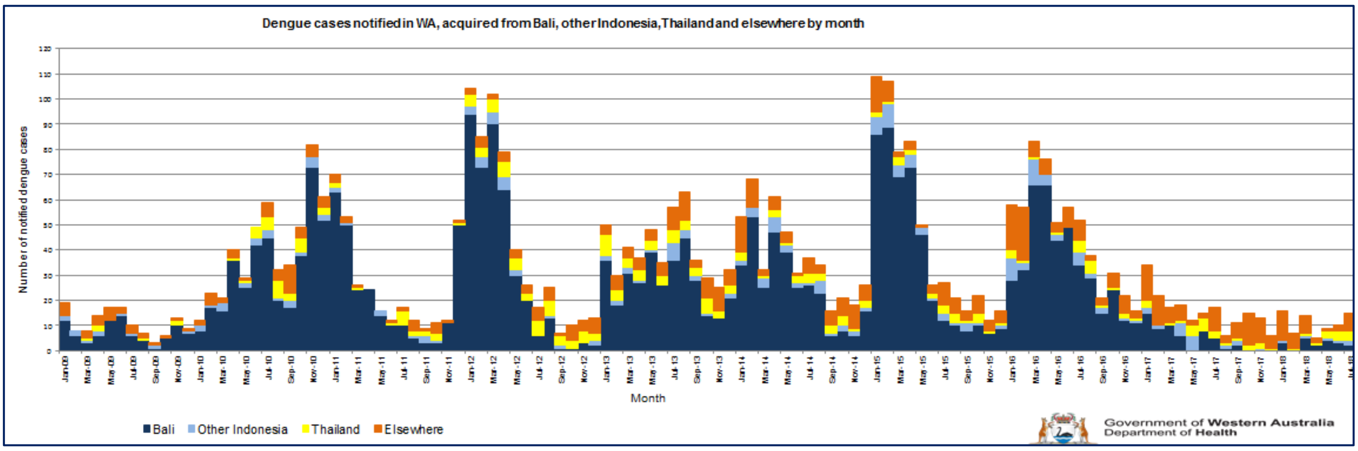


Figure 9: Monthly total number of notified cases of dengue reported in WA but acquired from overseas travel since 2009.

Japanese encephalitis

Annually there is an estimated 68,000 cases of Japanese encephalitis (JE) world-wide, with up to 30% being fatal. Symptoms range from a mild febrile illness to encephalitis. It is not endemic to WA although the vector *Culex annulirostris* is present over much of the state.

There was one (fatal) case of JE notified in WA in 2017/18. The infection was acquired in April during travel to Thailand. There have only been three other cases of JE notified in WA in 1998, 1999 and 2013 acquired in Vietnam, Bali and Indonesia respectively.

Malaria

Malaria is caused by infection with one of five species of the *Plasmodium* parasite. *Plasmodium falciparum*, *P. vivax*, *P. ovale*, *P. malariae* and *P. knowlesi* are passed on by the bite from an infected *Anopheles* mosquito. Travellers to tropical regions of Asia, Africa and Central or South America are most at risk of infection. Malaria caused by *P. falciparum* and *P. knowlesi* can be fatal.

Malaria is characterised by fever, shivering, chills, headache and sweats but can also present as respiratory or gastrointestinal illness. Effective treatment relies on early diagnosis and specific anti-malarial medications.

Anti-malarial medication must be taken prior to and during travel to prevent infection. The most effective anti-malarial treatment will depend on the region of travel and the length of time away.

The total number of malaria cases notified in WA during 2017/18 was 44 (~50% were infected with *P. falciparum, ~45% infected with Plasmodium species)*. About 75% of these cases were notified in travellers and refugees from Africa. The monthly number of notified cases of malaria was lower between 2010 and present, compared to earlier years, 2006-2009 (Figure 10).

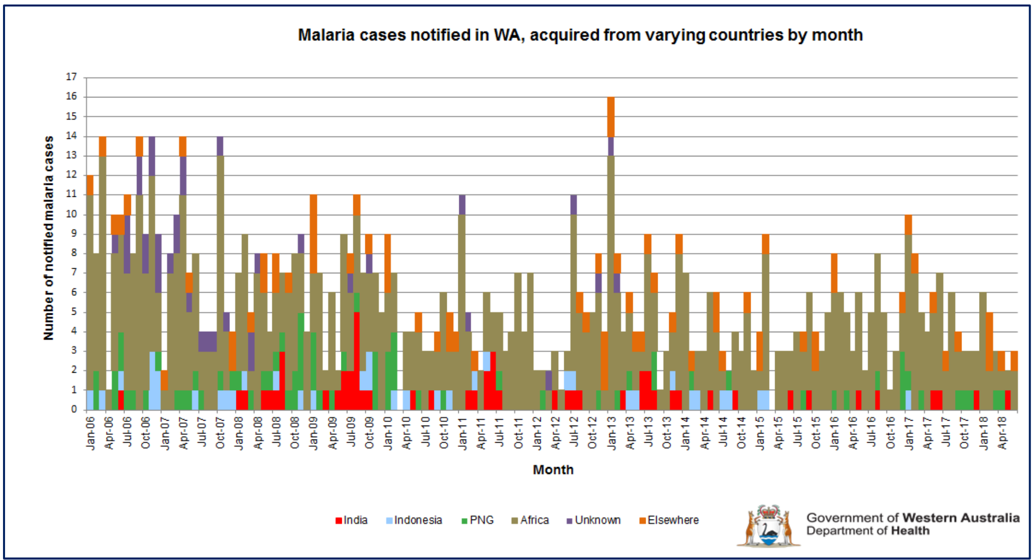


Figure 10: Monthly total number of notifications of malaria reported in WA but acquired from overseas locations, since 2006.

Zika

Zika virus causes an illness known as Zika virus disease which includes symptoms such as a mild fever, rash, conjunctivitis and muscle or joint pain. Research suggests that Zika virus infection in women during the first trimester of pregnancy may also be linked to abnormal foetal brain development, leading to a reduction in the size of the baby's head, known as microcephaly, which can result in permanent brain damage.

Since 1947, Zika virus activity was limited to parts of Africa, with occasional small outbreaks in Asia. However, it has recently spread to the Pacific Ocean, Central America, the Caribbean and South America. Since this recent spread, Zika virus cases have been diagnosed in returning overseas travellers who reside in WA (Figure 11). No cases of Zika virus infection were notified from returning overseas travellers from West Australians during 2017/18.

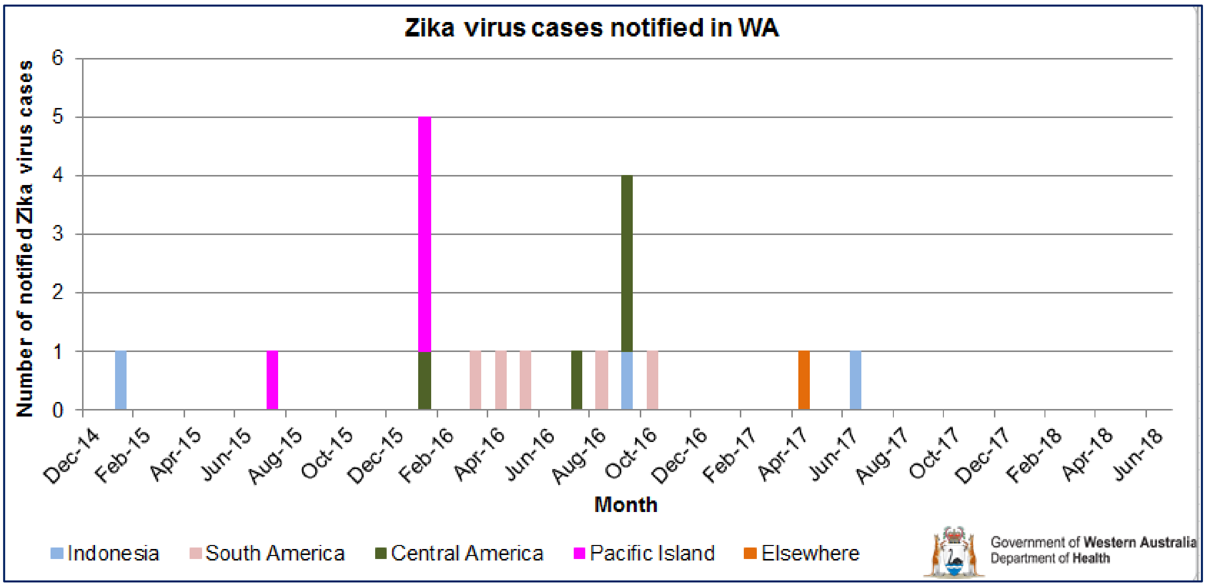


Figure 11: Monthly total number of human notifications of Zika virus disease reported in WA acquired from overseas travel, since 2014.

Climatic conditions 2017/18

El Niño, La Niña and Southern Oscillation (ENSO)

El Niño refers to extensive warming of the central and eastern tropical Pacific Ocean that leads to a major shift in weather patterns across the Pacific. La Niña refers to extensive cooling of the central and eastern tropical Pacific Ocean. It is sometimes considered the 'opposite of El Niño'. La Niña events are associated with increased probability of wetter conditions over much of Australia, and has been correlated with higher numbers of tropical cyclones during cyclone season. Importantly for WA, La Niña conditions translate to increased occurrence and magnitude of high tides (including an increased frequency of 'king' tides). This is particularly important in the Southwest region of WA, where the majority of mosquito egg-hatching is tidally driven.

During the 2017/18 financial year the Southern Oscillation Index (SOI) was largely neutral for many months of the year although weak La Niña (above +7) was observed in late July 2017; October and November 2017 as well as for January and March 2018 (See: Southern Oscillation Index values 2017/18 graph). However, these episodes were not sustained and the SOI remained predominantly neutral with little impact on mosquito production.

Rainfall

Rainfall deciles for the past twelve months were below to very much below average along coastal areas of central and southern WA (See: Rainfall deciles). In contrast, a pocket along the west Kimberley coastline, in the vicinity of Broome and Derby, received the highest rainfall on record (for example Broome Airport station recorded 1703.2mm of rainfall between December 2017 and February 2018, Bureau of Meteorology 2018).

July to September showed significantly drier rainfall patterns throughout the northern third of WA and across the southern coast. However the southwest coast had above average rainfall. October to December showed above average rainfall for the northwest coast and interior of WA, with this pattern increasing in influence showing above average rainfall for much of the northern coast and interior. However, this pattern was reversed in April through June 2018 showing significantly drier conditions for most of the state, particularly along the southern coast of WA.

Temperature

Maximum temperature

Maximum temperature deciles for the past 12 months indicated that the entire state experienced above average, very much above average, or highest on record maximum temperatures. July to September 2017 was particularly warmer in the central and north two-thirds of WA. This trend continued from October to December 2017 for much of the state but to a lesser degree, being above average for this period. Temperatures were average for much of the state from January to March 2018, excluding the central areas that showed below average maximum temperatures. However, the entire state showed average, above average or very much above average maximum temperatures for the last quarter.

Minimum temperature

Minimum temperature deciles during 2017/18 were above average or very much above average for most of WA, with only parts of the Kimberley experiencing below average to very much below average minimum temperatures . This pattern was observed in three of the four quarterly periods including July to September 2017, January to March 2018 and April through June 2018. Only October to December 2017 showed average to above average minimum temperatures across most of Western Australia, including the northwest coast.

The increased minimum and maximum temperatures were likely to have contributed to increased water temperatures, which in turn promotes a more rapid development of mosquito larvae. Warmer temperatures also enable arboviruses to replicate at a higher rate in the vector mosquitoes.

2017/18 Australian tropical cyclone season summary

The 2017/18 cyclone season in WA was average for tropical cyclone formation. The season was however unusual in that the steering winds, which direct the path of a cyclone, came from the east or north easterly direction and subsequently pushed all the systems over the north and west Kimberley coast. Subsequently the majority of the tracks affected the Kimberley, in particular the western Kimberley.

There were four major tropical cyclones that impacted WA including:

- TC Hilda (26-28 December 2017);
- TC Joyce (7-16 January 2018);
- TC Kelvin (11-19 February 2018); and
- TC Marcus (16-24 March 2018).

Mosquito-borne disease surveillance programs

Southwest arbovirus surveillance program

Outbreaks of RRV and BFV occur in the Southwest region every three to four years. The DoH undertakes regular arbovirus surveillance in the region to monitor disease activity and provide an early warning of increased disease risk. Monitoring of mosquitoes and mosquito-borne virus activity in the Southwest region commenced in 1987.
For this season, a total of 89,912 mosquitoes were collected from fortnightly trapping at 21 sites across the Southwest of WA (Table 3-8). There were 476 traps set over 24 trap nights in the Southwest, of which 445 traps were successful (93%).

There were a total of 25 detections of RRV during the 2017/18 across the 21 routine surveillance sites in the Southwest of WA. However, all the detections for RRV were from traps located within the Peel Region (Including the Peel Inlet (Table 3) and Harvey Estuary (Table 4). RRV was not detected in the Leschenault or Geographe, including Capel and Busselton wetlands, regions of WA.

BFV detections were higher this season compared to previous years with a total of 42 detections across the Peel (14 detections (Table 1)); Harvey Estuary (16 detections (Table 4)); Leschenault (19 detections (Table 5)) and Capel (9 detections (Table 6)) regions of southwest WA. Barmah Forest Virus was not detected in the Busselton region of Western Australia during the 2017/18 season (Table 7).

Table 3: Mosquitoes collected and processed for virus isolation from Peel Inlet trap sites, Southwest WA: 1st July 2017 to 30th June 2018.

Species	Total	%	Processed	Pool Count	Virus	MIR
Female	**24752**	**99.6**	**20369**	**1501**		
Ae. (Finlaya) alboannulatus	604	2.4	514	89	1RRV	2.0
Ae. (Finlaya) notoscriptus	1572	6.3	1263	134	1BFV	0.8
					6RRV	4.8
Ae. (Ochlerotatus) camptorhynchus	17177	69.1	13404	730	13BFV	0.1
Ae. (Ochlerotatus) clelandi	19	0.1	17	6		
Ae. (Ochlerotatus) hesperonotius	4	<0.1	4	1		
Ae. (Ochlerotatus) nigrithorax	2	<0.1	1	1		
Ae. (Ochlerotatus) vigilax	3589	14.4	3512	223	1RRV	0.3
An. (Cellia) annulipes s.l.	68	0.3	66	23		
Cq. (Coquillettidia) species near *linealis*	1	<0.1	1	1		
Cs. (Culicella) atra	19	0.1	16	10		
Cx. (Culex) annulirostris	93	0.4	92	32		
Cx. (Culex) australicus	445	1.8	378	70		
Cx. (Culex) globocoxitus	815	3.3	802	91		
Cx. (Culex) quinquefasciatus	217	0.9	206	55	1RRV	4.9
Tripteroides (Polylepidomyia) atripes	5	<0.1	5	5		
Unidentifiable *Aedes* sp. (too damaged/features missing)	86	0.3	54	11		
Unidentifiable *Culex* sp. (too damaged/features missing)	36	0.1	34	19		
Male	**69**	**0.3**	**68**	**36**		
Ae. (Ochlerotatus) camptorhynchus	4	<0.1	3	3		
Ae. (Ochlerotatus) vigilax	1	<0.1	1	1		
Ae. species (unidentified) - new or difficult to ID species	7	<0.1	7	6		
An. (Cellia) annulipes s.l.	1	<0.1	1	1		
Cx. species (unidentified) - new or difficult to ID species	56	0.2	56	25		
Bloodfed	**32**	**0.1**	**0**	**0**		
Ae. (Finlaya) notoscriptus	1	<0.1	0	0		
Ae. (Ochlerotatus) camptorhynchus	24	0.1	0	0		
Ae. (Ochlerotatus) vigilax	6	<0.1	0	0		
Cx. (Culex) quinquefasciatus	1	<0.1	0	0		
Grand Total	**24853**	**100**	**20437**	**1537**	**9RRV**	**0.4**
					14BFV	**0.7**

Table 4: Mosquitoes collected and processed for virus isolation from Harvey Estuary trap sites, Southwest WA, 1st July 2017 to 30th June 2018.

Species	Total	%	Processed	Pool Count	Virus	MIR
Female	**9308**	**98.6**	**6952**	**464**		
Ae. (Finlaya) alboannulatus	291	3.1	211	27		
Ae. (Finlaya) notoscriptus	103	1.1	68	25		
Ae. (Ochlerotatus) camptorhynchus	6977	73.9	4913	260	4RRV	0.8
Ae. (Ochlerotatus) clelandi	24	0.3	13	4		
Ae. (Ochlerotatus) hesperonotius	1	<0.1	1	1		
Ae. (Ochlerotatus) ratcliffei	56	0.6	23	4		
Ae. (Ochlerotatus) vigilax	1550	16.4	1435	83	8RRV	5.8
An. (Anopheles) atratipes	9	0.1	5	4		
An. (Cellia) annulipes s.l.	165	1.7	165	16	2RRV	12.9
Cq. (Coquillettidia) species near *linealis*	31	0.3	27	10		
Cs. (Culicella) atra	1	<0.1	1	1		
Cx. (Culex) annulirostris	29	0.3	29	12	1RRV	35.4
Cx. (Culex) australicus	24	0.3	20	5		
Cx. (Culex) globocoxitus	25	0.3	25	8		
Cx. (Culex) quinquefasciatus	2	<0.1	2	2		
Unidentifiable (too damaged/features missing)	2	<0.1	2	1		
Unidentifiable *Aedes* sp. (too damaged/features missing)	18	0.2	12	1		
Male	**22**	**0.2**	**18**	**8**		
Ae. (Ochlerotatus) camptorhynchus	7	0.1	3	2		
An. (Cellia) annulipes s.l.	7	0.1	7	3	1RRV	159.5
Cx. species (unidentified) - new or difficult to ID species	8	0.1	8	3		
Bloodfed	**107**	**1.1**	**0**	**0**		
Ae. (Finlaya) alboannulatus	1	<0.1	0	0		
Ae. (Ochlerotatus) camptorhynchus	98	1.0	0	0		
Ae. (Ochlerotatus) clelandi	1	<0.1	0	0		
Ae. (Ochlerotatus) vigilax	7	0.1	0	0		
Grand Total	**9437**	**100**	**6970**	**472**	**16RRV**	**2.3**

Table 5: Mosquitoes collected and processed for virus isolation from Leschenault Inlet trap sites, Southwest WA, 1st July 2017 to 30th June 2018.

Species	Total	%	Processed	Pool Count	Pinned	Virus	MIR
Female	**26820**	**99.4**	**19082**	**1347**	**5**		
Ae. (Finlaya) alboannulatus	902	3.3	632	78	0		
Ae. (Finlaya) notoscriptus	228	0.8	190	55	0		
Ae. (Ochlerotatus) camptorhynchus	18336	67.9	12075	648	0	16BFV	1.3
Ae. (Ochlerotatus) clelandi	169	0.6	124	17	0		
Ae. (Ochlerotatus) hesperonotius	2151	8.0	1404	71	0		
Ae. (Ochlerotatus) nigrithorax	101	0.4	42	4	0		
Ae. (Ochlerotatus) ratcliffei	72	0.3	42	10	0		
Ae. (Ochlerotatus) turneri	3	<0.1	2	2	0		
Ae. (Ochlerotatus) vigilax	3401	12.6	3379	197	0		
An. (Anopheles) atratipes	7	<0.1	6	4	1		
An. (Cellia) annulipes s.l.	55	0.2	47	29	0		
Cq. (Coquillettidia) species near *linealis*	117	0.4	116	32	0		
Cs. (Culicella) atra	74	0.3	66	18	4		
Cx. (Culex) annulirostris	260	1.0	259	40	0		
Cx. (Culex) australicus	260	1.0	234	44	0		
Cx. (Culex) globocoxitus	530	2.0	334	55	0		
Cx. (Culex) quinquefasciatus	99	0.4	82	35	0	1BFV	12.3
Unidentifiable *Aedes* sp. (too damaged/features missing)	37	0.1	37	5	0	1BFV	29.7
Unidentifiable *Culex* sp. (too damaged/features missing)	18	0.1	11	3	0		
Male	**23**	**0.1**	**17**	**13**	**1**		
Ae. (Ochlerotatus) camptorhynchus	1	<0.1	1	1	0		
Ae. (Ochlerotatus) vigilax	2	<0.1	2	2	0		
Ae. species (unidentified) - new or difficult to ID species	4	<0.1	3	3	0	1BFV	333.3
Cs. (Culicella) atra	3	<0.1	2	2	1		
Cx. species (unidentified) - new or difficult to ID species	13	<0.1	9	5	0		
Bloodfed	**142**	**0.5**	**0**	**0**	**0**		
Ae. (Finlaya) alboannulatus	6	<0.1	0	0	0		
Ae. (Finlaya) notoscriptus	1	<0.1	0	0	0		
Ae. (Ochlerotatus) camptorhynchus	123	0.5	0	0	0		
Ae. (Ochlerotatus) vigilax	7	<0.1	0	0	0		
Cx. (Culex) annulirostris	3	<0.1	0	0	0		
Cx. (Culex) globocoxitus	2	<0.1	0	0	0		
Hermaphrodite	**1**	**<0.1**	**0**	**0**	**1**		
Cx. (Culex) annulirostris	1	<0.1	0	0	1		
Grand Total	**26986**	**100**	**19099**	**1360**	**7**	**19BFV**	**1.0**

Table 6: Mosquitoes collected and processed for virus isolation from Capel trap sites, Southwest WA, 1st July 2017 to 30th June 2018.

Species	Total	%	Processed	Pool Count	Pinned	Virus	MIR
Female	**13117**	**99.3**	**8020**	**569**	**7**		
Ae. (Finlaya) alboannulatus	283	2.1	180	32	0		
Ae. (Finlaya) notoscriptus	173	1.3	132	18	0		
Ae. (Ochlerotatus) camptorhynchus	11968	90.6	7175	376	0	8BFV	0.11
Ae. (Ochlerotatus) clelandi	27	0.2	16	6	0		
Ae. (Ochlerotatus) ratcliffei	111	0.8	74	7	7		
Ae. (Ochlerotatus) turneri	3	<0.1	1	1	0		
Ae. (Ochlerotatus) vigilax	1	<0.1	1	1	0		
An. (Anopheles) atratipes	1	<0.1	1	1	0		
An. (Cellia) annulipes s.l.	88	0.7	76	23	0		
Cq. (Coquillettidia) species near *linealis*	26	0.2	25	18	0		
Cs. (Culicella) atra	10	0.1	8	5	0		
Cx. (Culex) annulirostris	102	0.8	102	23	0	1BFV	0.98
Cx. (Culex) australicus	63	0.5	47	18	0		
Cx. (Culex) globocoxitus	193	1.5	151	31	0		
Cx. (Culex) quinquefasciatus	10	0.1	5	4	0		
Unidentifiable *Aedes* sp. (too damaged/features missing)	55	0.4	24	3	0		
Unidentifiable *Culex* sp. (too damaged/features missing)	3	<0.1	2	2	0		
Male	**4**	**<0.1**	**4**	**3**	**0**		
An. (Cellia) annulipes s.l.	3	<0.1	3	2	0		
Cx. species (unidentified) - new or difficult to ID species	1	<0.1	1	1	0		
Bloodfed	**90**	0.7	**0**	**0**	**0**		
Ae. (Finlaya) alboannulatus	2	<0.1	0	0	0		
Ae. (Ochlerotatus) camptorhynchus	86	0.7	0	0	0		
Ae. (Ochlerotatus) clelandi	1	<0.1	0	0	0		
Cx. (Culex) annulirostris	1	<0.1	0	0	0		
Grand Total	**13211**	**100**	**8024**	**572**	**7**	**9BFV**	**1.1**

Table 7: Mosquitoes collected and processed for virus isolation from Busselton wetland trap sites, Southwest WA, 1st July 2017 to 30th June 2018.

Species	Total	%	Processed	Pool Count	Pinned
Female	**10492**	**99.0**	**5496**	**463**	**45**
Ae. (Finlaya) alboannulatus	155	1.5	146	28	0
Ae. (Finlaya) notoscriptus	71	0.7	57	16	0
Ae. (Ochlerotatus) camptorhynchus	8222	77.6	3657	208	0
Ae. (Ochlerotatus) clelandi	933	8.8	787	48	37
Ae. (Ochlerotatus) hesperonotius	340	3.2	300	22	0
Ae. (Ochlerotatus) nigrithorax	1	<0.1	1	1	0
Ae. (Ochlerotatus) ratcliffei	46	0.4	46	6	0
Ae. (Ochlerotatus) stricklandi	1	<0.1	0	0	1
Ae. (Ochlerotatus) turneri	11	0.1	1	1	3
Ae. (Ochlerotatus) vigilax	33	0.3	30	3	0
An. (Anopheles) atratipes	3	<0.1	0	0	3
An. (Cellia) annulipes s.l.	191	1.8	70	21	0
Cq. (Coquillettidia) species near *linealis*	39	0.4	32	11	0
Cs. (Culicella) atra	22	0.2	22	10	0
Cx. (Culex) annulirostris	47	0.4	45	17	0
Cx. (Culex) australicus	98	0.9	80	23	0
Cx. (Culex) globocoxitus	200	1.9	166	29	0
Cx. (Culex) quinquefasciatus	30	0.3	27	11	0
Cx. (Neoculex) latus	3	<0.1	2	2	1
Unidentifiable *Aedes* sp. (too damaged/features missing)	28	0.3	23	3	0
Unidentifiable *Culex* sp. (too damaged/features missing)	18	0.2	4	3	0
Male	**42**	**0.4**	**34**	**16**	**0**
Ae. (Ochlerotatus) camptorhynchus	7	0.1	5	4	0
Ae. (Ochlerotatus) clelandi	1	<0.1	1	1	0
Ae. species (unidentified) - new or difficult to ID species	4	<0.1	4	2	0
An. (Cellia) annulipes s.l.	1	<0.1	1	1	0
Cs. (Culicella) atra	6	0.1	6	2	0
Cx. species (unidentified) - new or difficult to ID species	23	0.2	17	6	0
Bloodfed	**61**	**0.6**	**0**	**0**	**0**
Ae. (Finlaya) alboannulatus	2	<0.1	0	0	0
Ae. (Ochlerotatus) camptorhynchus	46	0.4	0	0	0
Ae. (Ochlerotatus) clelandi	12	0.1	0	0	0
Ae. (Ochlerotatus) hesperonotius	1	<0.1	0	0	0
Grand Total	**10595**	**100**	**5530**	**479**	**45**

Table 8: Virus detections in mosquitoes collected in Southwest of WA: 1st July 2017 to 30th June 2018.

Date of collection	Trap location	Species	Virus	Number in Pool
	Peel region			
28.08.17	Lake Goegrup	*Aedes camptorhynchus*	BFV	20
"	Falcon	"	BFV	20
26.09.17	Furnissdale	"	BFV	20
"	"	"	BFV	20
"	"	"	BFV	20
"	"	"	BFV	20
"	"	"	BFV	20
"	Riverview	"	BFV	20
"	"	"	BFV	20
"	"	"	BFV	20
"	"	*Ae. notoscriptus*	BFV	18
5.10.17	Riverside Gardens	*Ae. camptorhynchus*	BFV	20
"	Coodanup	"	BFV	20
19.10.17	Furnissdale	"	BFV	20
30.11.17	Southern Estuary Road	"	RRV	20
"	"	"	RRV	20
"	"	"	RRV	20
"	"	"	RRV	9
"	"	*Ae. vigilax*	RRV	20
"	"	"	RRV	20
"	"	"	RRV	20
"	"	"	RRV	20
"	"	"	RRV	20
"	"	"	RRV	20
"	"	*Anopheles annulipes* s.l.	RRV	20
"	"	"	RRV	3
"	"	*An. annulipes* s.l. (male)	RRV	5
"	"	*Culex annulirostris*	RRV	2
08.02.18	Riverview	*Ae. notoscriptus*	RRV	20
22.02.18	Furnissdale	*Cx. quinquefasciatus*	RRV	2
	Riverview	*Ae. alboannulatus*	RRV	4
	"	*Ae. notoscriptus*	RRV	20
	"	"	RRV	20
	"	"	RRV	20
	"	"	RRV	9
	"	*Ae. vigilax*	RRV	4
	Southern Estuary Road	"	RRV	20
	"	"	RRV	18
16.04.18	Coodanup	*Ae. notoscriptus*	RRV	20
	Leschenault region			
26.9.17	Freshwater larval site	*Ae. camptorhynchus*	BFV	20
"	"	"	BFV	20
5.10.17	Belvidere	"	BFV	20
19.10.17	"	"	BFV	20
"	"	"	BFV	20
"	"	"	BFV	20
"	"	"	BFV	20
"	Freshwater larval site	"	BFV	20
"	"	*Aedes* species (male)	BFV	1
2.11.17	Point Douro	*Ae. camptorhynchus*	BFV	20
16.11.17	Belvidere	"	BFV	20
"	"	"	BFV	20
"	Freshwater larval site	"	BFV	20
"	"	"	BFV	20
"	"	"	BFV	20
"	"	"	BFV	20
"	"	*Cx. quinquefasciatus*	BFV	4
"	"	*Cx.* damaged female	BFV	7
"	Point Douro	*Ae. camptorhynchus*	BFV	20
	Shire of *Capel*			
19.10.17	Stirling/Higgins Road intersection	*Ae. camptorhynchus*	BFV	20
2.11.17		"	BFV	20
"	"	"	BFV	20
16.11.17	Woods Road, Gelorup	"	BFV	20
"	"	"	BFV	20
"	CALM Village	"	BFV	20
"	"	"	BFV	20
30.11.17		"	BFV	21
"	"	*Cx. annulirostris*	BFV	1

Mosquito abundance at Peel Inlet trap sites was generally below the long-term average for most of the fortnightly collections throughout the 2017/18 financial year (Figure 17). Of particular note was a substantial increase in mosquitoes collected on the 28th August 2017, which was most likely in response to high tides that occurred in the Peel Inlet on the 9th August 2017 reaching 1.10m above sea level. This is substantially above 0.79m that is known to lead to inundation of low lying land that stimulates egg hatching and a new generation of mosquitoes initiating development. The species composition was similar to previous years, being dominated by *Aedes camptorhynchus* (69.1%) in the cooler months prior to summer, when *Aedes vigilax* begins to dominate the saltmarsh sites (14.5%). These two species are dominant in the Peel Inlet region, making up a total of 83.5% of the mosquitoes collected across these sites.

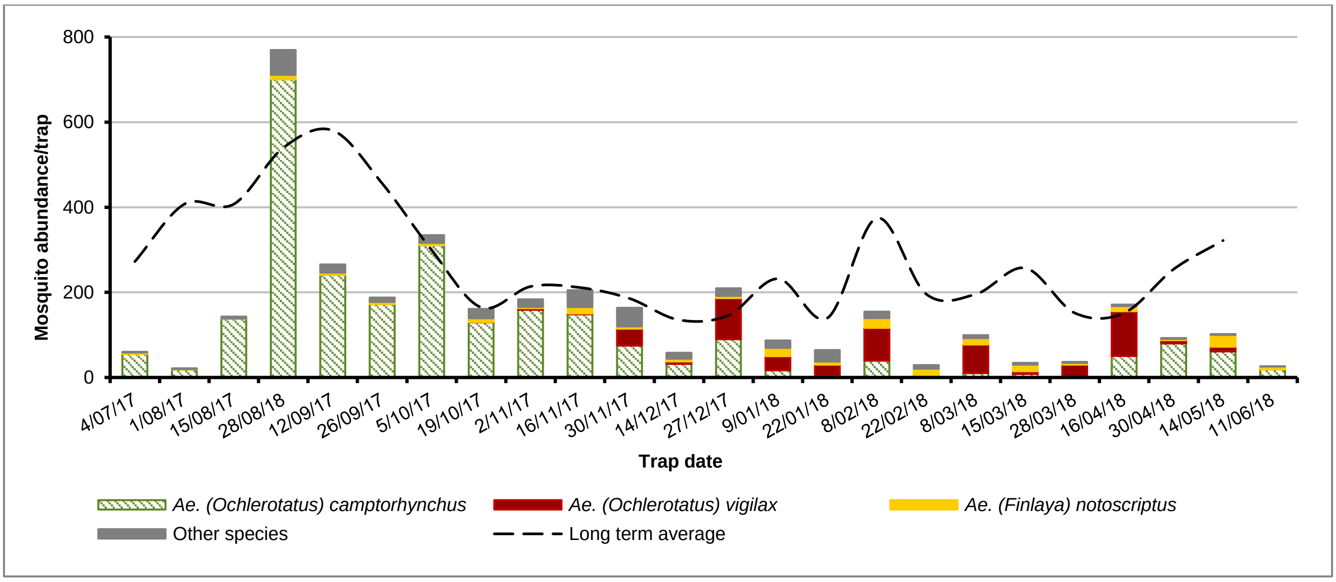


Figure 17: Mosquito abundance per trap night at the Peel Inlet trap sites, Southwest WA: 1st July 2017 to 30th June 2018.

Similar patterns were observed for the Harvey Estuary (Figure 18) with mosquito abundance being similar to or below the long term average except for November 2017. Once again, the mosquito populations were dominated by the saltmarsh species (*Aedes camptorhynchus* (73.9%) and *Aedes vigilax* (16.4%)). These two species dominate the Harvey Estuary making up 90.3% of the mosquitoes collected across these sites.

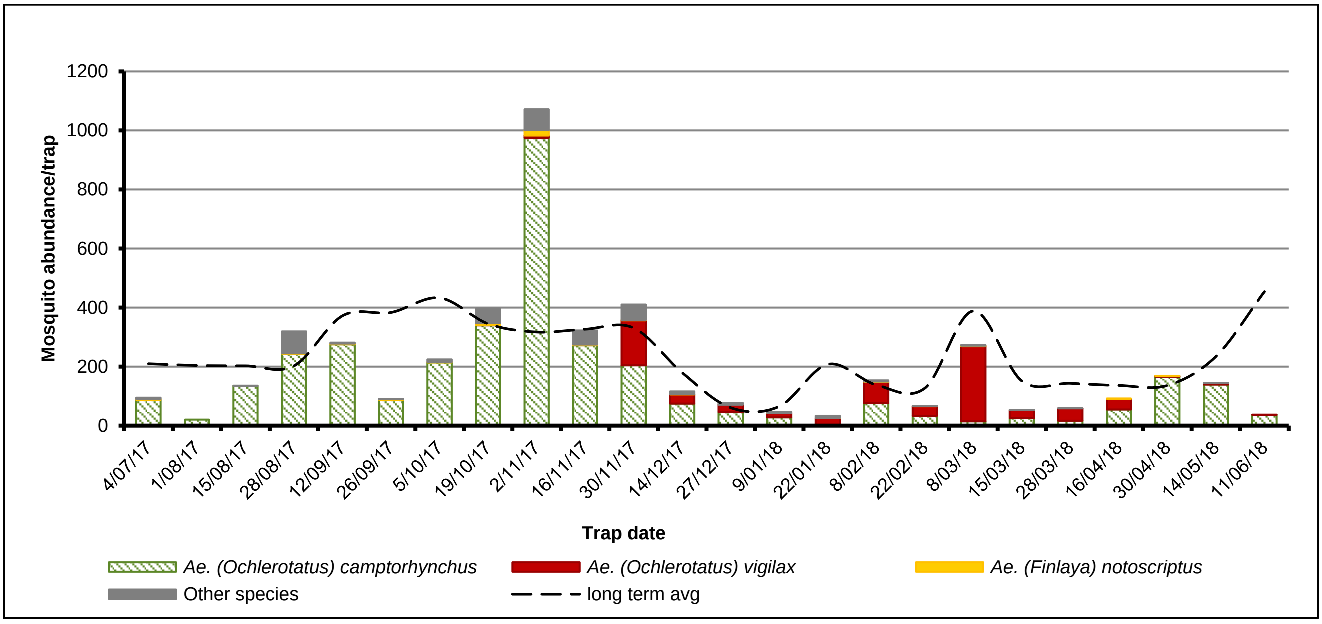


Figure 18: Mosquito abundance per trap night from the Harvey Estuary sites (Peel region), Southwest WA, 1st July 2017 to 30th June 2018.

Mosquito abundance in the Harvey Estuary was higher than the long term average for August, September and November 2017, dominated by *Aedes camptorhynchus* (68% of all mosquitoes collected at these sites (Figure 19). *Aedes vigilax* was the second most common species occurring in trap counts from November 2017 to March 2018 and making up a further 12.6% of all mosquitoes collected at these sites. *Aedes hesperonotius* was the third most common species across the Leschenault region at 8% of all mosquito species collected (Figure 3). The increase in mosquito abundance appears to be related to rainfall with a three to four week lag after the winter rainfall peaks (Figure 3).

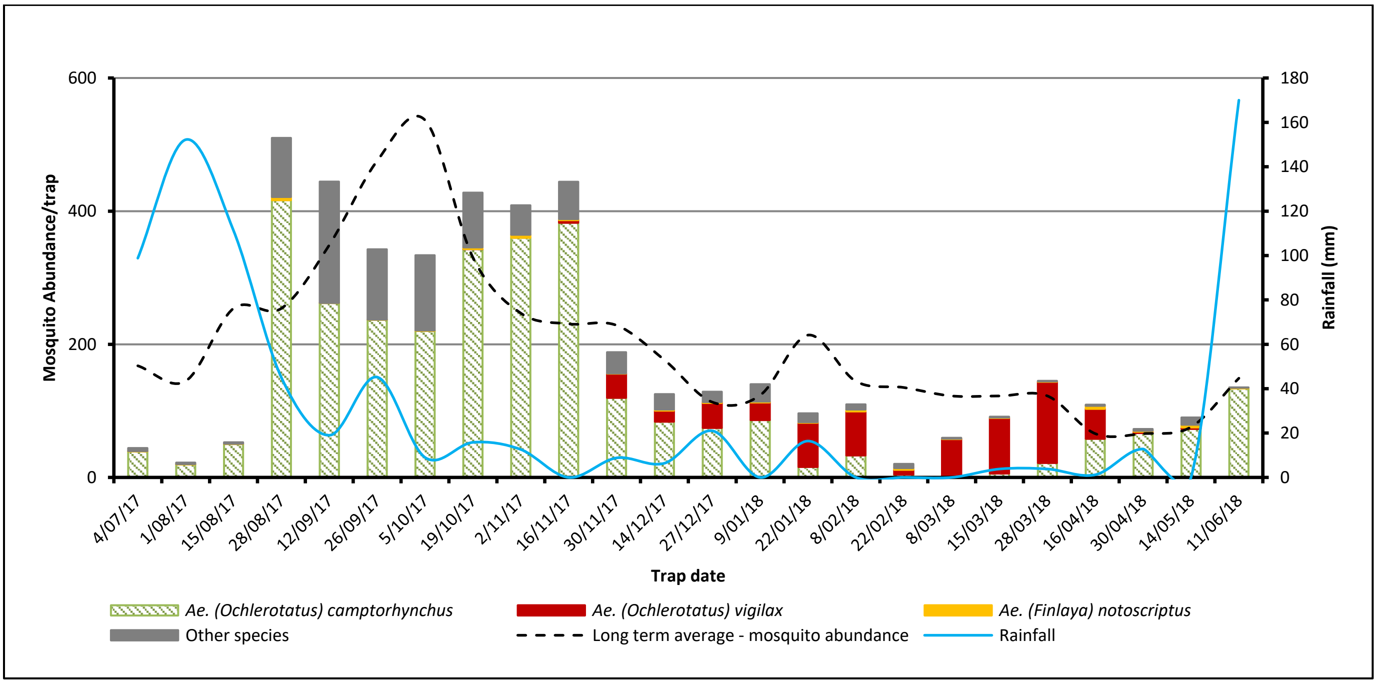


Figure 19: Mosquito abundance per trap night at the Leschenault region trap sites, Southwest WA, 1st July 2017 to 30th June 2018.

Mosquito abundance at Capel sites showed similar patterns to previous years with the highest densities recorded early in the season (Figure 20). These sites are largely driven from rainfall patterns and once again show increased abundance after a three to four week lag from the peak winter rainfall period. However, abundances were mostly below the five year average. *Aedes camptorhynchus* made up 90.6% of the mosquitoes collected at these sites, followed by *Aedes alboannulatus* at 2.1%.

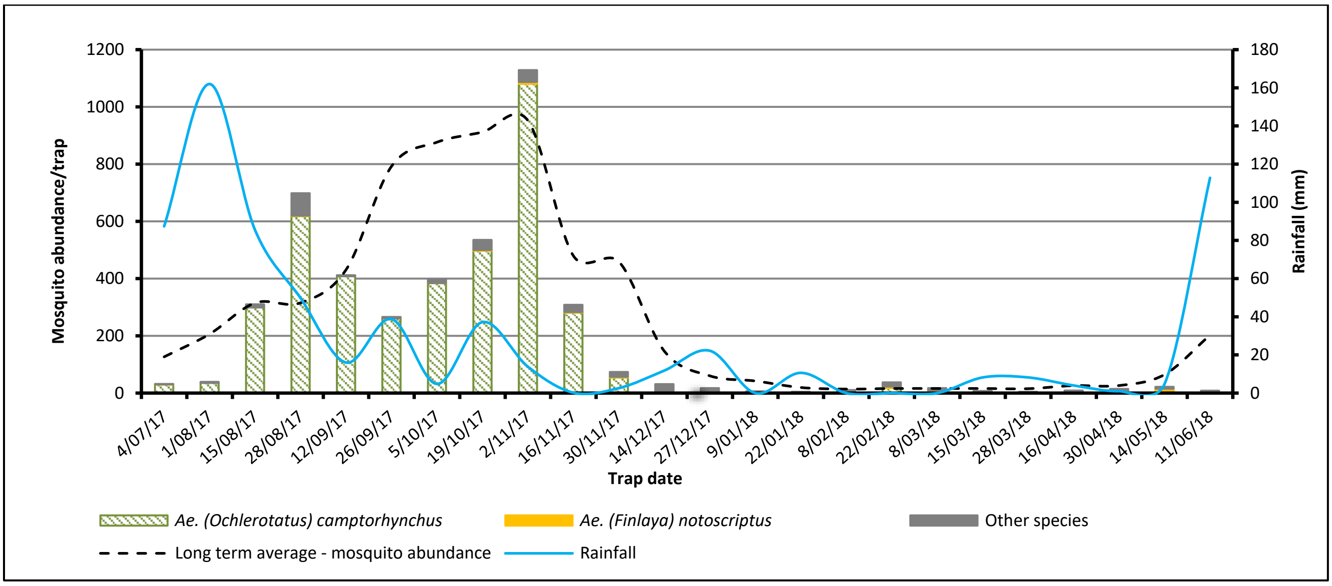


Figure 20: Mosquito abundance per trap night at the Shire of Capel, Southwest WA, 1st July 2017 to 30th June 2018.

Mosquito collections at Busselton trap sites waere similar to Capel with almost all months below the five year average (Figure 21). The abundances were greatest early in the 2017/18 season, being greatest in September through to November, before declining to very low numbers throughout the rest of the financial year. The dominant species recorded at these sites included *Aedes camptorhynchus* (77.6%); *Aedes clelandi* (8.8%); and *Aedes hesperonotius* (3.2%).

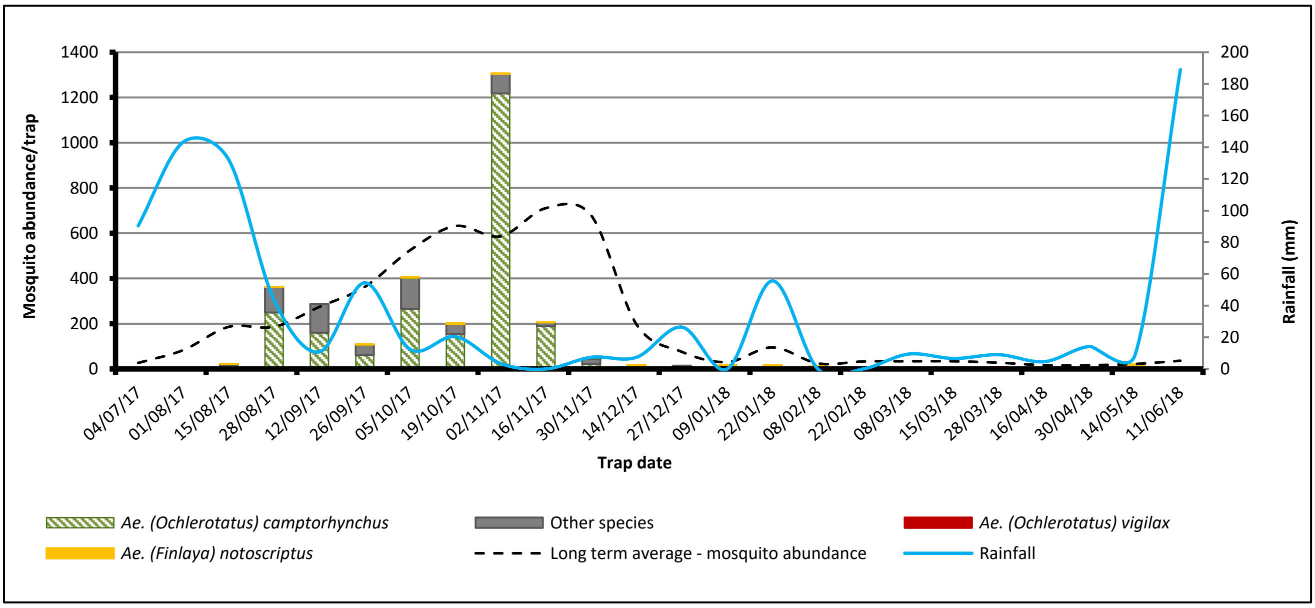


Figure 21: Mosquito abundance per trap night at Busselton wetland sites, Southwest of Western Australia, 1st July 2017 to 30th June 2018.

MVE virus and WNV_{KUN} surveillance

In WA, the DoH monitors flaviviruses via a sentinel chicken program and mosquito collections and virus detections. The aim of these programs is to provide information on the mosquito fauna following the wet season and to provide historical detection of MVEV and WNV_{KUN} activity.

Northern mosquito surveillance

Mosquito collections were conducted in the Kimberley and Pilbara regions of WA between 21st March and 20th April 2018.The trap sites were selected based on historical mosquito abundance data, virus detection, proximity to sentinel chickens and proximity to mosquito breeding habitats. Traps were set in the following locations:

- Halls Creek
- Kununurra
- Parry's Creek
- Wyndham
- Billiluna
- Fitzroy Crossing
- Derby
- Broome
- Willie Creek
- Roebuck Plains
- Pt Hedland
- Tom Price
- Newman
- Paraburdoo and
- Mount Magnet

The mosquitoes were collected in dry ice (carbon dioxide) baited EVS (encephalitis vector surveillance) traps. The traps were set at or before sunset and retrieved close to sunrise the following morning. The mosquitoes were then frozen on dry ice and transported to Perth.

The mosquitoes were identified to species level in the laboratory and will be tested for arboviruses. Four specific arboviruses of public health significance are detected from mosquitoes: RRV, BFV, MVE virus and $WNV_{(KUN)}$.

The 2017-18 mosquito collections are still being processed and results will be reported in the 2018-19 Annual Report.

2016/2017 northern mosquito trapping data

Results from 2016-17 northern surveillance are included in this report as the mosquito identification was undertaken during the reporting period. A total of 138 adult mosquito traps were set in the East Kimberley region at Halls Creek, Billiluna, Wyndham (including Parry's Creek) and Kununurra (Table 9). A further 94 adult mosquito traps across the West Kimberley region, set at Fitzroy Crossing, Derby, Broome (including Willie Creek) and Roebuck plains.

Culex annulirostris was the dominant species caught in traps across the Kimberley region, which accounts for 58% from the total mosquitoes collected (Table 10). The next most abundant species were *Aedes normanensis* (26%); *Anopheles annulipes* s.l. (2.9%); and *Aedes vigilax* (2.0%).

Table 9: Mosquito collections and number of traps set in the Kimberley region, WA, in March - April 2017.

Region	Locality	Total
East Kimberley		**3496**
	Halls Creek	3496
North east Kimberley		**52236**
	Kununurra	34180
	Wyndham	18056
South East Kimberley		**24958**
	Billiluna	24958
Upper Fitzroy River Floodplain		**3616**
	Fitzroy river crossing	2056
	Geikie Gorge	1560
Lower Fitzroy River Floodplain		**14052**
	Derby	8794
	Willare	5258
West Kimberley		**93124**
	Broome	7755
	Coconut Wells	4707
	Roebuck plain	79297
	Willie Creek	1365
Grand Total		**191483**

Table 10: Details of mosquitoes collected Kimberley region, WA, March - April 2017.

Species	East Kimberley	North east Kimberley	South east Kimberley	Fitzroy River floodplain	Lower Fitzroy River floodplain	Upper Fitzroy River floodplain	West Kimberley	Total
Ad. (Aedeomyia) catasticta		166		5				**171**
Ae. (Aedimorphus) alboscutellatus	9	69						**78**
Ae. (Chaetocruiomyia) elchoensis		15					2	**17**
Ae. (Finlaya) britteni	1	6			1			**8**
Ae. (Finlaya) kochi group		36						**36**
Ae. (Finlaya) mallochi				1				**1**
Ae. (Finlaya) notoscriptus	1	181			71	1	288	**542**
Ae. (Finlaya) pecuniosus		8			4	2	1	**15**
Ae. (Macleaya) species	11	133	205		88	1	356	**794**
Ae. (Macleaya) tremulus				1	65	3	2	**71**
Ae. (Mucidus) alternans	17	456	26	11	104	12	23	**649**
Ae. (Neomellanoconion) lineatopennis	57	1023			2			**1082**
Ae. (Ochlerotatus) normanensis	2968	24757	10625	1640	9200	1674	271	**51135**
Ae. (Ochlerotatus) phaecasiatus		52						**52**
Ae. (Ochlerotatus) pseudonormanensis	2	33	1					**36**
Ae. (Ochlerotatus) vigilax	37	426	5		1669		1639	**3776**
Ae. (Ochlerotatus) vittiger	2							**2**
Ae. (Stegomyia) katherinensis		2						**2**
Ae. species (unidentified) - new or difficult to ID species	8	2	1		5		1	**17**
An. (Anopheles) bancroftii	17	233			1			**251**
An. (Cellia) amictus		210	116		60	3	6	**395**
An. (Cellia) annulipess.l.	19	1113	2753	36	1279	58	330	**5588**
An. (Cellia) farauti		63						**63**
An. (Cellia) hilli		73		1	86		2615	**2775**
An. (Cellia) meraukensis		3						**3**
An. species (unidentified) - new or difficult to ID species		10	38					**48**
Cq. (Coquillettidia) xanthogaster	50	1397						**1447**
Cx. (Culex) annulirostris	76	17156	10691	27	1168	32	81869	**111019**
Cx. (Culex) bitaeniorhynchus	2	510						**512**
Cx. (Culex) palpalis							4	**4**
Cx. (Culex) quinquefasciatus	9		11	1	11	19	63	**114**
Cx. (Culex) sitiens		21	6		33		254	**314**
Cx. (Culex) squamosus	1							**1**
Cx. (Culex) starckeae		2	77					**79**
Cx. (Culiciomyia) pullus	4	458					1	**463**
Cx. (Lophoceraomyia) fraudatrix			5					**5**
Cx. (Lophoceraomyia) hilli	128	243						**371**
Cx. (Lophoceraomyia) species			1					**1**
Cx. species (unidentified) - new or difficult to ID species		2					2	**4**
Ma. (Mansonioides) uniformis	14	70						**84**
Tripteroides (Polylepidomyia) punctolateralis	2				27	2	13	**44**
Unidentifiable *Aedes* sp. (too damaged/features missing)		3	6	39	117	4	12	**181**
Unidentifiable *Anopheles* sp. (too damaged/features missing)		40	44	4	39	37	1061	**1225**
Unidentifiable *Culex* sp. (too damaged/features missing)	4	1022	347		22	3	4213	**5611**
Unidentifiable *Uranotaenia* sp. (too damaged/features missing)							4	**4**
Ur. (Uranotaenia) nivipes	2	3						**5**
Ve. (Verrallina) funerea	1	37					94	**132**
Ve. (Verrallina) reesi	54	2202						**2256**
Grand Total	**3496**	**52236**	**24958**	**1766**	**14052**	**1851**	**93124**	**191483**

In 2016/17, mosquito trapping was also undertaken at various locations in the Pilbara including the towns of Tom Price, Port Hedland, Newman and Meekatharra (Table 11). A total of 10,567 adult mosquitoes were collected and identified from these sites.

The dominant mosquito species at the Pilbara sites were *Culex annulirostris* (64%); followed by *Aedes normanensis* (20%); *Anopheles amictus* (4.2%) and *Culex quinquefasciatus* (3.2%) (Table 12).

Table 11: Mosquito collection summary and number of traps set in the Pilbara and Midwest regions, WA, in March - April 2017.

Region	Locality	Total
Pilbara	Tom Price	469
	Port Hedland	7224
	Newman	1186
Midwest	Meekatharra	1688
Grand Total		**10567**

Table 12: Details of mosquitoes collected Pilbara region, WA, March - April 2017.

Species	Newman	Port Hedland	Tom Price	Grand Total
Ae. (Finlaya) notoscriptus	2		4	**6**
Ae. (Macleaya) species	7	4		**11**
Ae. (Macleaya) tremulus	7			**7**
Ae. (Mucidus) alternans		82		**82**
Ae. (Ochlerotatus) normanensis	5	1757	13	**1775**
Ae. (Ochlerotatus) pseudonormanensis	10			**10**
Ae. (Ochlerotatus) vigilax	4	306		**310**
Ae. (Ochlerotatus) vittiger	4			**4**
Ae. (Pseudoskusea) bancroftianus	5			**5**
Ae. species (unidentified) - new or difficult to ID species	3	14		**17**
An. (Cellia) amictus	59	318	3	**380**
An. (Cellia) annulipes s.l.	95		3	**98**
An. (Cellia) annulipes species D	1			**1**
Cq. (Coquillettidia) xanthogaster	25			**25**
Cx. (Culex) annulirostris	752	4585	408	**5745**
Cx. (Culex) australicus	1	1		**2**
Cx. (Culex) bitaeniorhynchus	1		2	**3**
Cx. (Culex) E.N. Marks' species No. 92			3	**3**
Cx. (Culex) quinquefasciatus	184	80	22	**286**
Cx. (Culex) sitiens		75		**75**
Cx. (Culex) starckeae	1		1	**2**
Cx. (Lophoceraomyia) cubiculi	4		1	**5**
Cx. (Lophoceraomyia) cylindricus	1		1	**2**
Cx. (Lophoceraomyia) species			2	**2**
Cx. species (unidentified) - new or difficult to ID species	4	2		**6**
Unidentifiable *Aedes* sp. (too damaged/features missing)	1		1	**2**
Unidentifiable *Culex* sp. (too damaged/features missing)	10		5	**15**
Grand Total	**1186**	**7224**	**469**	**8879**

Sentinel chicken flavivirus surveillance program

Murray Valley encephalitis virus (MVEV) and West Nile virus Kunjin strain ($WNV_{(KUN)}$) are maintained in a bird – mosquito – bird cycle in the northern two-thirds of WA. The DoH manages a sentinel chicken flavivirus surveillance program, which provides an early warning for activity of these viruses.

In 2017/18, 24 sentinel chicken flocks were located in major towns and communities in the Kimberley, Pilbara, Gascoyne, Midwest and Wheatbelt regions of WA (Figure 22). Chickens are bled by trained EHO's and the blood samples are sent to PathWest to detect antibodies to these viruses. When MVEV or WNV_{KUN} virus is detected, the information is used by the DoH to issue media releases, warning residents and travellers to the affected regions of the increased risk of severe mosquito-borne diseases and the need to take precautions against being bitten by mosquitoes. In addition, the confirmation of virus activity is reported to LGs, who undertake mosquito control efforts in an attempt to reduce mosquito numbers and the potential for disease spread. It is only through the integrated program involving the DoH, PathWest and LGs that the system can be effective in providing an early warning detection of these mosquito-borne viruses and protect the public from potentially fatal mosquito-borne diseases.

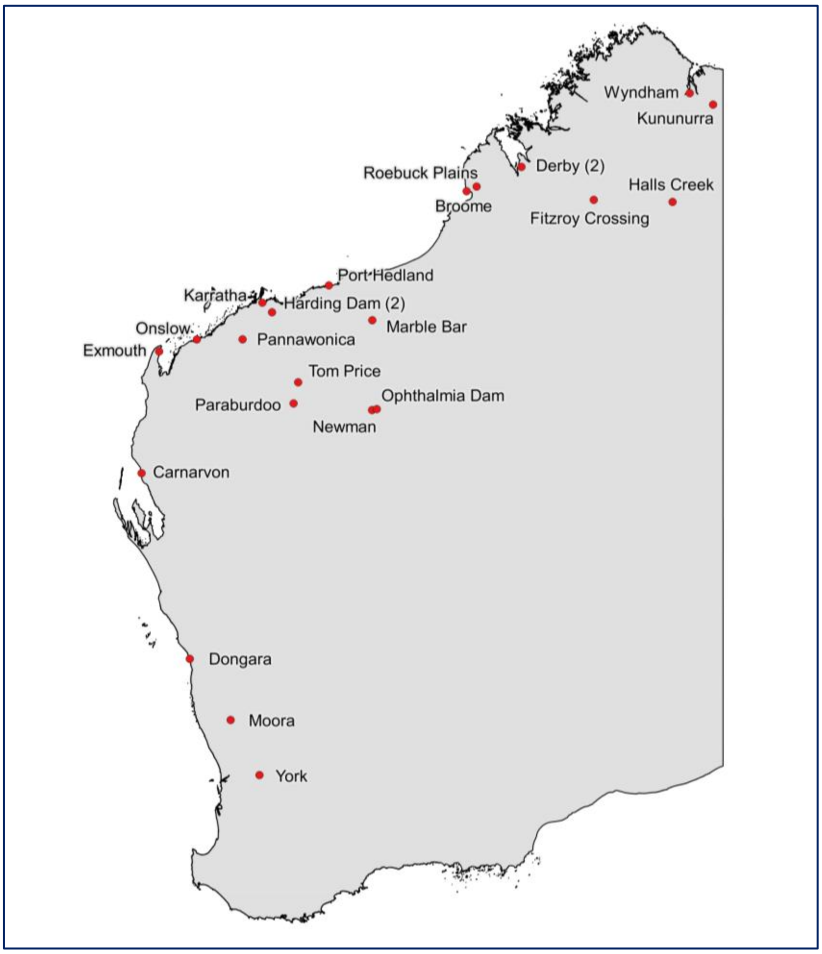


Figure 22: Locations of the sentinel chicken flocks for flavivirus detection across WA in 2017/18.

A total of 62 flavivirus detections were recorded from sentinel chicken flocks across northern WA during the 2017/18 financial year (Table 13). This was approximately half that compared to the

2016/17 financial year when 128 flaviviruses were detected from sentinel chickens. During 2017/18, seroconversions were detected in 62 of the 3930 samples tested (1.57%).

Murray Valley encephalitis virus (MVEV) activity was similar to last financial year with 49 confirmed detections from sentinel chickens (Table 11). This is similar to 2016/17 when 42 seroconversions to MVE were detected. Murray Valley encephalitis virus was detected throughout multiple locations across the Kimberley and Pilbara regions of WA.

Only six sentinel chickens seroconverted to $WNV_{(KUN)}$ during 2017/18 which is substantially lower than that recorded in the previous 12 months (a total of 64 chickens seroconverting during 2016/17). West Nile virus, Kunjin strain, was detected at multiple locations in the Pilbara, but was only detected at Halls Creek in the Kimberley region.

Interestingly, MVEV and $WNV_{(KUN)}$ were only detected the Kimberley and Pilbara during 2017/18, compared to records from the previous year indicating these viruses to be more widespread in these two regions, but also in the Midwest/Wheatbelt.

Table 13: Number of sentinel chickens that developed antibody to flaviviruses during 2017/18. M - Positive for MVEV (Murray Valley encephalitis virus) antibodies; K-Positive for $WNV_{(KUN)}$ antibodies; MK - Positive for MVEV and $WNV_{(KUN)}$ antibodies; and F- Positive for FLAVIVIRUS antibodies only.

			Months 07/2017-06/2018										
Region	**Site**	**Antibody**	**7**	**8**	**9**	**11**	**1**	**2**	**3**	**4**	**5**	**6**	**Grand Total**
Kimberley	Broome	F			1								**1**
	Derby Site 1	M								1			**1**
	Derby Site 2	M							1	1			**2**
	Halls Creek	K	1										**1**
	Kununurra	M							3	4			**7**
	Roebuck Plain Station	M										4	**4**
	Wyndham	M					1	1	3		2	1	**8**
		MK					1						**1**
Pilbara	Harding Dam Site 1	F	1			1							**2**
		K	1	1									**2**
	Harding Dam Site 2	F	1	2									**3**
		K		1									**1**
		M								2		3	**5**
	Marble Bar	M								4	1		**5**
	Ophthalmia Dam	M									3		**3**
	Pannawonica	M									4		**4**
	Paraburdoo	K	1										**1**
		M								1			**1**
	Port Hedland	K	1										**1**
		M	1							2			**3**
	Tom Price	M								2	4		**6**
Grand total			**7**	**4**	**1**	**1**	**2**	**1**	**7**	**17**	**14**	**8**	**62**

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