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

Medical Entomology Annual Report:

2019-2020

Contents

Glossary

ASR	age standardised rate
BAEHH	Biological and Applied Environmental Health Hazards
BFV	Barmah Forest virus
CHIKV	chikungunya virus
CLAG	Contiguous Local Authorities Group
CR	crude rate
DENV	dengue viruses
Department (the)	Department of Health
ENSO	El Niño–Southern Oscillation
ESD	enhanced surveillance data
FTB	Fight the Bite
JEV	Japanese encephalitis virus
KUN	Kunjin (disease)
LG	Local government
MAL	malaria protozoan parasite
ME	Medical Entomology
MVEV	Murray Valley encephalitis virus
PCR	polymerase chain reaction
Public Health Act	*Public Health Act 2016* (WA)
RRV	Ross River virus
RT-PCR	reverse transcriptase polymerase chain reactions
SOI	Southern Oscillation Index
TC	tropical cyclone
WA	Western Australia
WANIDD	Western Australian Notifiable Infectious Disease Database
WNV_{KUN}	West Nile virus Kunjin strain
ZIKV	Zika virus

Executive Summary

This Annual Report summarises the mosquito-borne disease case data from Western Australia (WA), as well as the varied and comprehensive activities undertaken by Medical Entomology (ME), with the WA Department of Health (the Department) for 2019-20 (1 July 2019-30 June 2020). Northern trapping data from 2018-19 has also been included, as mosquito identification took place during the reported financial year.

Briefly, 2019-20 was characterised by overall average numbers of mosquitoes and notified cases of mosquito-borne disease throughout the State. Neutral El Niño–Southern Oscillation (ENSO) conditions prevailed for most of the year, with gradual progression to a La Niña pattern predicted for the 2020-2021 season. These conditions were associated with generally below average rainfall patterns and a reduction in the frequency and magnitude of tidal surges.

Tropical Cyclone Damien was the only severe tropical cyclone to make landfall in WA's north west, while TC Blake, ex-TC Esther and a significant tropical low system influenced heavy rainfall and storm surges for the northern regions of WA. These events caused sporadic increases in storm surge levels, rainfall and localised flooding which resulted in localised mosquito population increases.

During June 2020, there was unseasonal late Ross River Virus (RRV) activity in the South West region, as routine processing of collected mosquitoes detected RRV at multiple locations. Although this activity did not translate to widespread increases in disease cases, some small disease case clusters were identified for further investigation and a media warning statement was issued for the Perth Metropolitan and South West regions as a timely reminder to protect against mosquito bites.

Restrictions related to the COVID-19 pandemic somewhat reduced the ability for the ME team and WA local governments (LG) to undertake mosquito surveillance activities for arbovirus detection from mid-March through to mid-June. This was predominantly due to regional travel restrictions prohibiting officers from undertaking adult mosquito trapping in areas considered high-risk for mosquito-borne disease. Some LG areas were able to continue mosquito collections on the Department's behalf to ensure virus detection processing was not interrupted.

Supporting local government

ME continued to support LG through the provision of training and technical advice and oversight of Fight the Bite, as well as the coordination of the Contiguous Local Authorities Group (CLAG) scheme and aerial treatment program. The Department approved CLAG funding requests, totalling $259,390.65, and spent a further $576,410.38 on the provision of aerial larviciding treatments across high risk regions of the State's South West.

Mosquito and arbovirus surveillance

The arbovirus surveillance program continued to play an important role in informing LG mosquito management activities and determining the need for, and timing of, media statements released by the Department in an effort to minimise the public health risk associated with mosquitoes throughout WA.

A total of 97,807 mosquitoes were collected across 21 routine surveillance sites between Mandurah and Busselton in WA's South West. In June 2020, there was unseasonal widespread detections of RRV in the Peel, Leschenault and Geographe subregions of the South West of WA. Ross River virus (RRV) was detected 17 times across the South West of WA. There were no detections of Barmah Forest virus (BFV).

A total of 3,529 blood samples were collected from sentinel chickens across 23 flocks throughout northern WA, before they were tested for flavivirus antibodies. 49 seroconversions were detected,

indicating that flavivirus activity was present in the Kimberley and Pilbara regions during 2019-20. Mosquitoes were also collected from the Kimberley region between 12-14 March 2020, during ME's annual northern surveillance trip. Unfortunately, the fieldwork was cut short due to the COVID-19 pandemic and Departmental officers were required to return to Perth immediately. It was estimated that 160,000 mosquitoes were collected over 132 traps set. The collected mosquitoes will be identified to species level and processed for detection of arboviruses during 2021 and reported in the 2020-21 annual report.

As a result of the surveillance program findings, 3 media warnings were issued to remind the WA public to take precautions to avoid mosquito bites.

Exotic mosquito surveillance

The Commonwealth Department of Agriculture Science Support Program detected two importations of exotic mosquitoes in 2019-20. ME confirmed the identifications as *Aedes aegypti* collected at Perth International Freight terminal; and *Aedes albopictus,* collected at an approved arrangement facility located in Bibra Lake.

MEDICAL ENTOMOLOGY

2019-20 SNAPSHOT

Surveillance efforts throughout WA are used to inform public health warnings and interventions

423 Mosquito traps set over 21 sites in the South West of WA

97,807

Adult mosquitoes collected

Adult mosquitoes trapped by region

17 Ross River virus detections

0 Barmah Forest virus detections

31 aerial larvicide applications totalling **4,246 ha**

23 **Sentinel chicken flocks managed throughout WA**

3,529
blood samples tested

49 Mosquito-borne virus infections detected in chickens

Stakeholder engagement

18 Local government funding applications assessed

3 Media statements issued related to mosquitoes

1 Mosquito identification course conducted

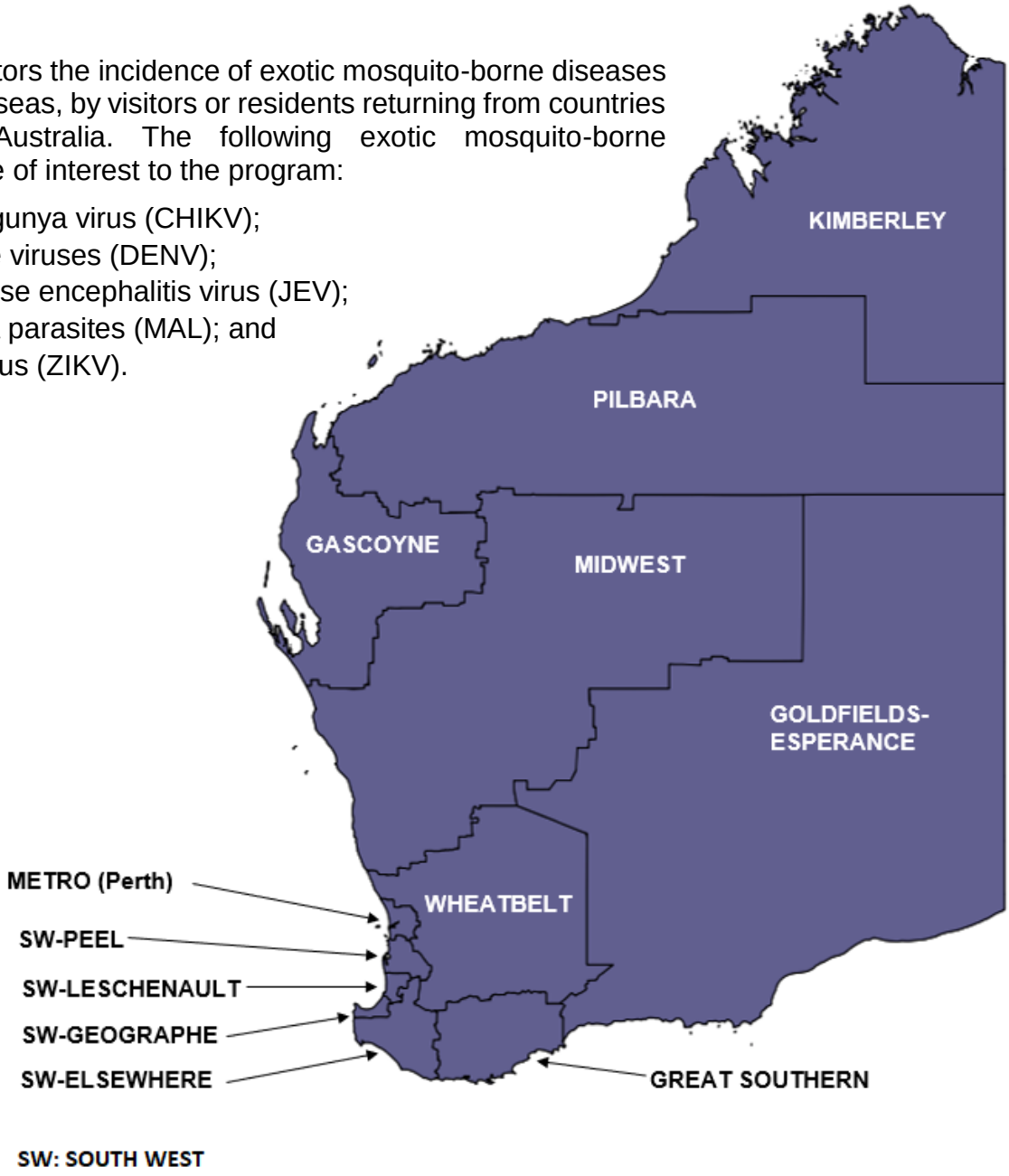
1.0 Introduction

There are 300 different species of mosquitoes in Australia, of which approximately 100 are known to occur in 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. Medical Entomology (ME) monitors the following four mosquito-borne viruses, which are all known to cause locally acquired, notifiable diseases in the following regions* of WA:

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 and Midwest regions); and
4) West Nile virus Kunjin strain (WNV_{KUN}) – northern WA (Kimberley, Pilbara, Gascoyne and Midwest regions).

ME also monitors the incidence of exotic mosquito-borne diseases acquired overseas, by visitors or residents returning from countries outside of Australia. The following exotic mosquito-borne pathogens are of interest to the program:

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



*Note: ME reports data according to the regional boundaries shown here. These boundaries differ slightly compared to WA Public Health Regions.

1.1. The role of Medical Entomology

ME 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, issue media statements and provide warnings to at-risk communities;
- provision of expert advice to the Minister for Health, senior Department executives, other State government agencies, local government authorities and members of the public on matters concerning mosquitoes and mosquito-borne disease risk;
- undertaking mosquito and arbovirus surveillance to monitor RRV and BFV activity in the South West, and surveillance of MVEV and WNV_{KUN} activity through sentinel chicken flocks in the northern two-thirds of WA;
- coordination of the aerial larviciding program in high mosquito-borne disease risk regions of WA's South West;
- coordination of the Contiguous Local Authorities Group (CLAG) funding scheme;
- resource development and coordination of the Department's public awareness campaign, Fight the Bite, to raise awareness of mosquitoes and improve prevention practices;
- issuing media statements when virus activity escalates, environmental conditions are suitable for vector breeding or surveillance activities identify potential public health risks;
- provision of training courses, forums, seminars and lectures to personnel involved in mosquito management and to disseminate information to stakeholders and the public;
- provision of specialist advice related to development applications through the identification of public health risk associated with proximity to existing mosquito breeding sites, and potential to create new breeding habitats as a result of the development itself;
- 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;
- assisting LG in field investigations and surveys of mosquito-breeding habitat related to disease outbreaks and public complaints;
- provision of technical assistance and advice on mosquito control treatments and ongoing monitoring related to exotic mosquito incursions throughout WA;
- 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;

For further information on a range other activities, projects and research initiatives undertaken by ME, please review the Environmental Health Directorate's Yearbook.

2.0 Endemic arbovirus diseases

Ross River virus disease case data summary

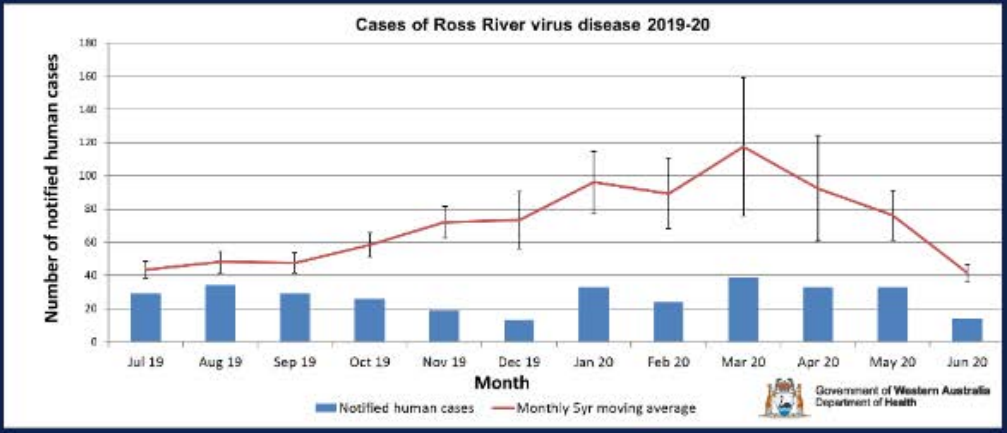
Western Australia 2019-20

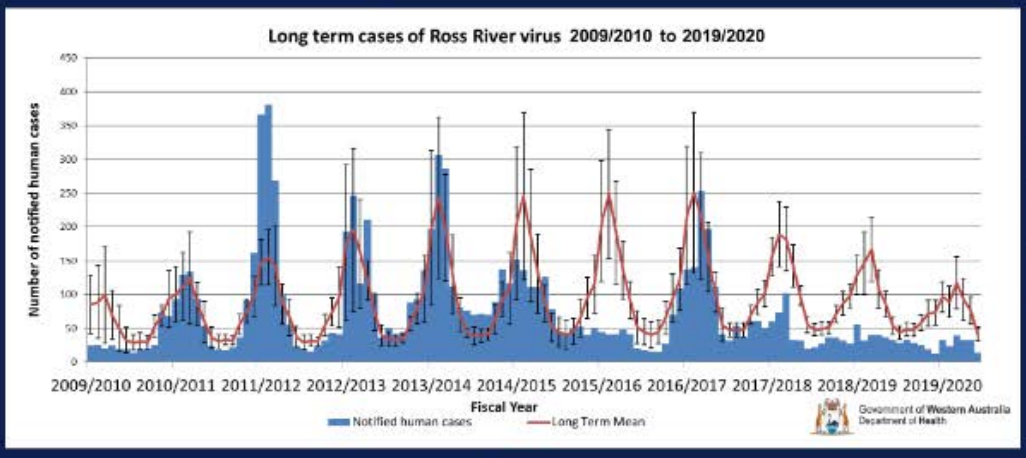
Data reflected in this summary of mosquito-borne disease is taken from the Western Australia Notifiable Infectious Disease Database (WANIDD) and includes enhanced surveillance data collected by Population Health Units and local governments (only locations with notified cases of disease are shown in tables and figures).

318

cases of RRV

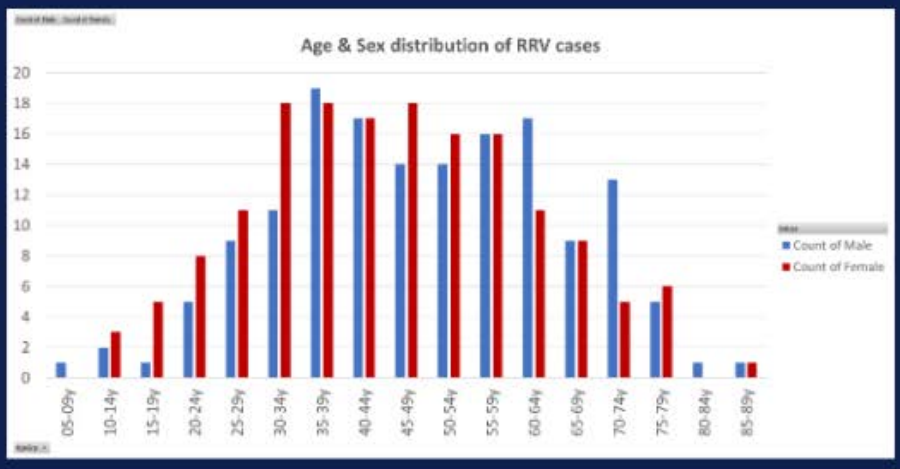
reported between 1 July and 30 June 2020 in WA





Overall, notified RRV disease cases have been below the long-term average since 2017-18

The median age was 47 years while the average age for males was 49 and the average for females was 45. Peak year groups were between 30-49 years for females; and 35-44 and 55-64 years for males.



2.1. Ross River virus

Ross River virus (RRV) 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. Serological testing is the only reliable way to definitively diagnose an active RRV infection.

2.1.1 Enhanced surveillance data response rates

There were 176 (55%) doctor notified cases of RRV that could be followed up for enhanced surveillance data (ESD). Completed ESD questionnaires were received from 70 of these, resulting in a response rate of 40%. This rate is in line with response rates from previous years. It is acknowledged that the proportion of doctors formally notifying mosquito-borne disease cases to the Department is low, resulting in limitations in following up on ESD. Efforts to improve doctor notification rates will a focus in 2020-21.

2.1.2 Regional summaries of Ross River virus cases

In 2019-20, a total of 318 cases of RRV were notified to the Department of Health (Table 1). Despite late virus activity in the South West and southern Perth Metropolitan regions in April/May 2020, overall cases remain below the long-term average; a trend that has continued since 2017.

Ross River virus disease case data summary

Western Australia: 2019-20

Data reflected in this summary of mosquito-borne disease is taken from the Western Australia Notifiable Infectious Disease Database (WANIDD) and includes enhanced surveillance data collected by Population Health Units and local governments

Table 1: Ross River virus disease cases per month between July 2019 and June 2020, with Crude and Age Standardised Rates.

REGION	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total	Crude Rate	Age Std Rate
KIMBERLEY	0	1	0	0	0	0	1	4	15	7	1	0	29	80.5	75.7
PILBARA	4	3	1	1	0	0	2	1	9	3	3	0	27	43.8	41.8
GASCOYNE	0	0	0	0	0	0	0	0	0	1	0	0	1	10.6	10.3
MIDWEST	4	0	1	0	0	0	1	0	2	1	0	0	9	14.8	13.8
WHEATBELT	0	1	0	0	0	0	1	1	1	1	2	0	7	10.2	9.5
METRO	8	13	17	13	9	3	13	10	6	6	0	2	100	5.6	5.4
PEEL	4	4	5	2	5	3	4	4	4	7	23	9	74	27.3	26.6
LESCHENAULT	3	2	2	2	1	1	1	0	0	1	2	0	15	20.3	19.5
GEOGRAPHE	1	4	2	2	3	3	4	2	0	3	0	0	24	42.1	47.6
ELSEWHERE SW	0	2	0	3	1	0	1	0	0	1	1	1	10	21.0	22.3
SOUTH WEST	8	12	9	9	10	7	10	6	4	12	26	10	123	27.3	
GREAT SOUTHERN	0	1	0	2	0	2	5	1	0	2	0	1	14	23.0	21.1
GOLDFIELDS-ESPERANCE	2	3	0	0	0	1	0	0	2	0	0	0	8	14.5	15.0
WA UNDETERMINED	0	0	0	0	0	0	0	0	0	0	0	0	0		
INTERSTATE	3	0	1	1	0	0	0	1	0	0	1	1	8		
WA TOTAL (does not include interstate)	**26**	**34**	**28**	**25**	**19**	**13**	**33**	**23**	**39**	**33**	**32**	**13**	**318**		

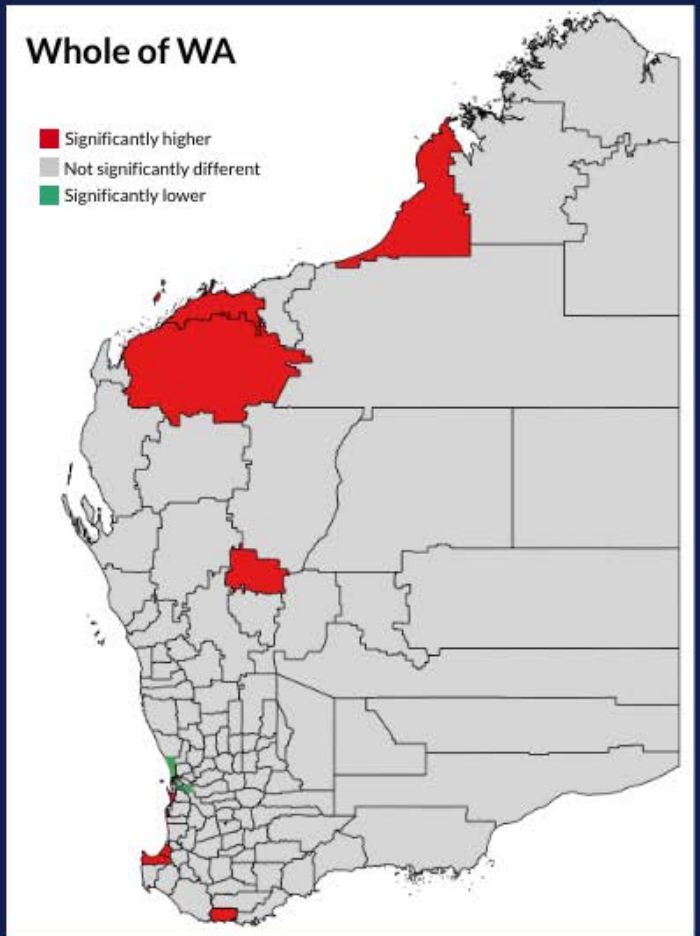
The highest number of RRV cases reported was from the South West and Perth Metropolitan regions, with 123 and 100 cases respectively. Data from WA's South West is further divided into four regions (Peel, Leschenault, Geographe and SW Elsewhere) to provide a more detailed breakdown of disease distribution. The majority of cases reported in the SW were notified from the Peel region (n=74).

For all disease data tables in this report, the Crude Rate (CR) represents the number of disease notifications per 100,000 population in each region and the Age Standardised Rate (ASR) adjusts for differences in the age distributiuon between the regions to enable direct comparison of the rates across regions. The highest CR and ASR of 80.5 and 75.7 per 100,000 respectively, was recorded from the Kimberley region.
Although the raw number of cases in Perth Metropolitan region appear high compared to other regions, the crude rate (CR) and age standardised rate (ASR) were actually the lowest in the State. This is a result of the large population living in Perth.

Ross River virus disease rates

Western Australia 2019-20

Whole of WA



Maps of WA showing Ross River virus disease cases by local government area

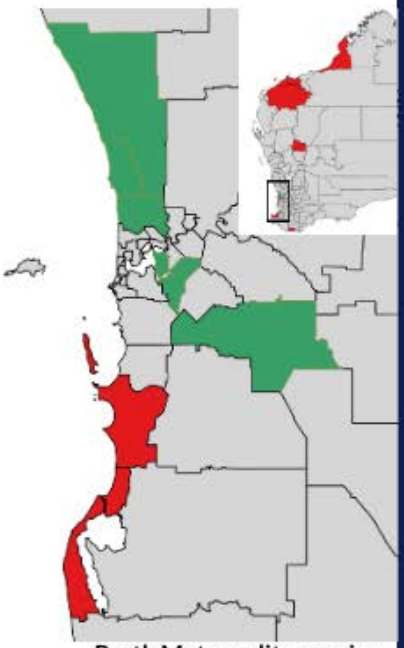
Cases per 100,000 people compared to the State average rate for 2019-20.

During 2019-20 the majority of LGs reported similar rates of RRV disease compared to the State average.

Only 9 of 137 LGs reported significantly higher rates compared to the State average.

In the Perth Metropolitan region Mandurah and Rockingham LGs were above.

Armadale, Canning, Joondalup, South Perth, Stirling, and Wanneroo LGs were below.

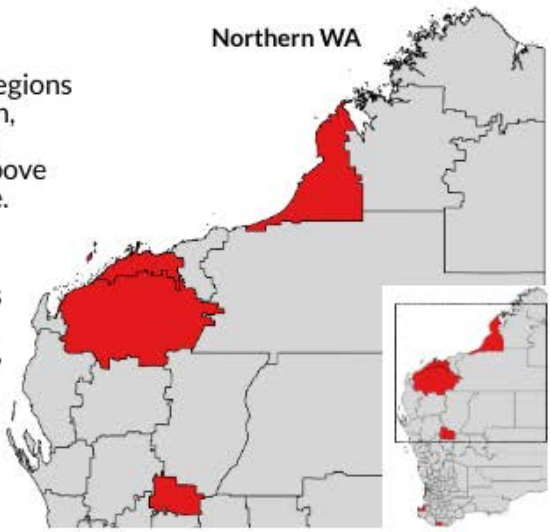


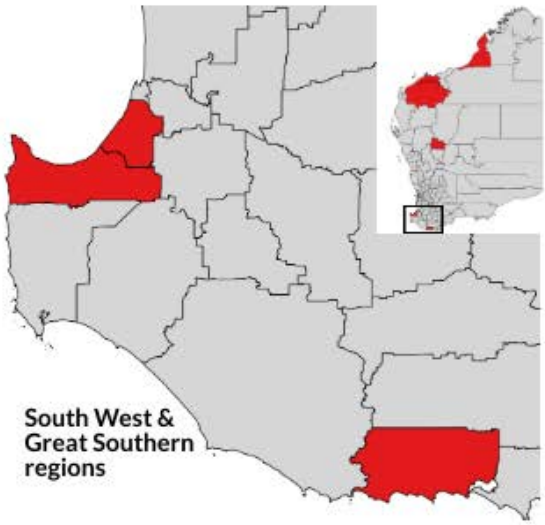
Perth Metropolitan region

In the northern regions of WA, Ashburton, Broome, Cue and Karratha were above the State average.

In the South West and Great Southern regions of WA, Busselton, Capel, and Denmark LGs were above.

Northern WA





South West & Great Southern regions

2.1.2.1 South West Region

The South West of WA is considered a risk region for RRV and often reports higher disease notification rates than the state average. Although the City of Mandurah and City of Rockingham are captured above in the southern Perth Metropolitan region map (RRV disease rates infographic) they are considered part of the broader South West region (as the Peel sub region) for the purposes of the arbovirus surveillance program.

In May 2020, there was a significant increase in the number of RRV cases acquired in the South West of WA, with the majority being notified from the Peel sub-region (n=23) (Figure 1). This increase was due to favourable environmental conditions in late autumn resulting in unusually late virus activity within the region.

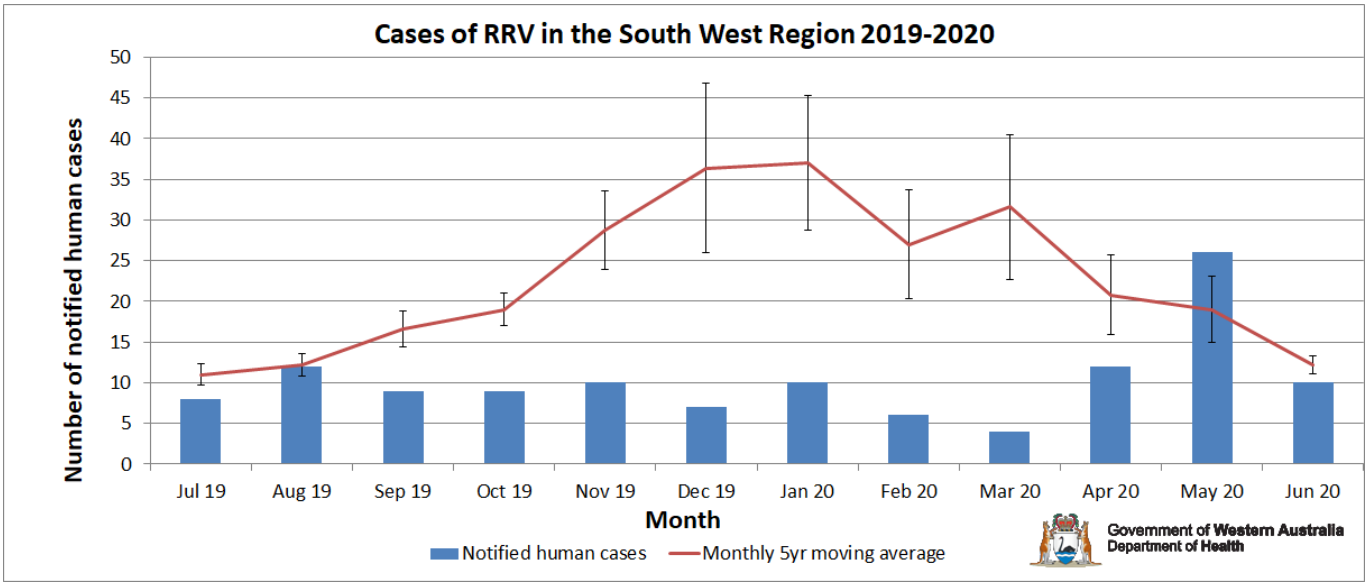


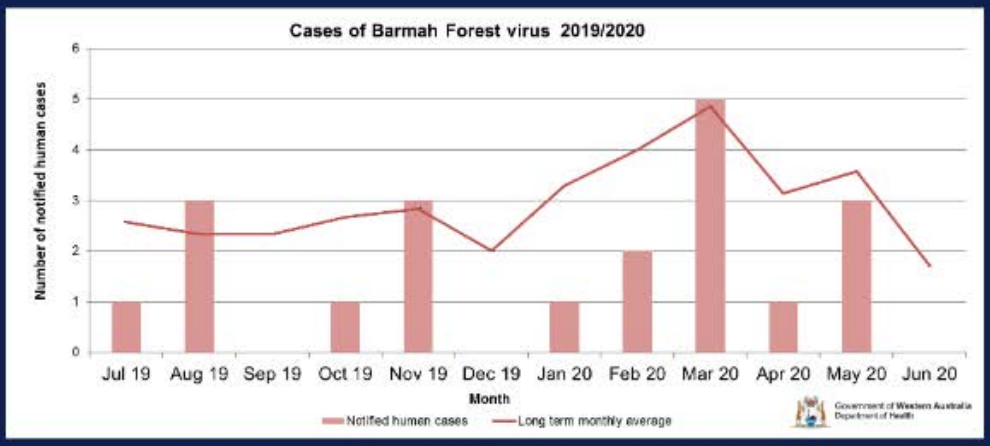
Figure 1: Total number of Ross River virus disease cases notified in WA's South West (including the Peel region), per month between 1 July 2019 to 30 June 2020.

2.2. Barmah Forest virus

Barmah Forest virus disease case data summary

Western Australia 2019-20

Data reflected in this summary of mosquito-borne disease is taken from the Western Australia Notifiable Infectious Disease Database (WANIDD) and includes enhanced surveillance data collected by Population Health Units and local governments (only locations with notified cases of disease are shown in tables and figures).

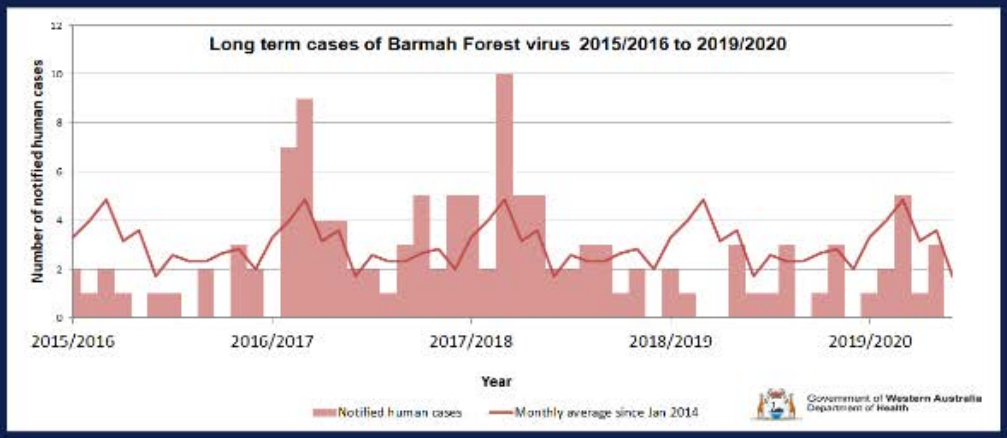


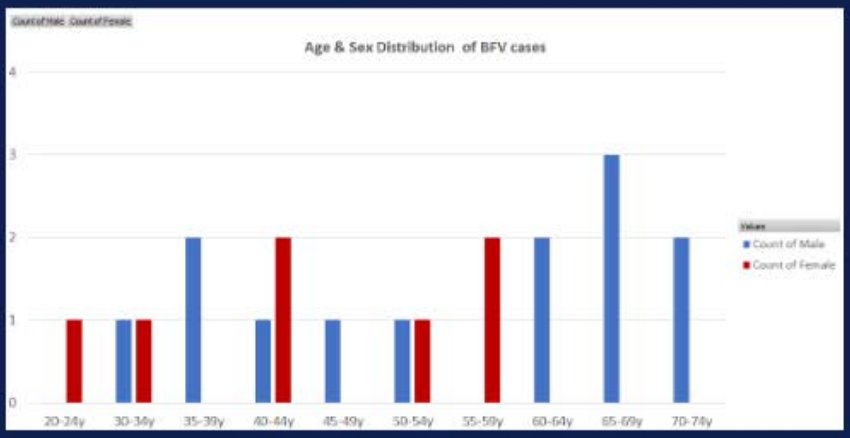
20

cases of BFV

reported between 1 July and 30 June 2020 in WA

Overall, notified BFV disease cases have been close to or below the long-term average since 2018-19





The median age was 51 years while the average age for males was 55 and the average for females was 43. Peak year groups were between 40-44 and 55-59 years for females; and 60+ years for males.

Barmah Forest virus (BFV) 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 fewer BFV cases are generally reported. Serological testing is the only reliable way to correctly diagnose the causative virus and differentiate an active infection from RRV.

2.2.2 Enhanced surveillance data response rates

In 2019-20, a total of 20 cases of BFV disease were notified to the Department of Health WA (Table 2). Of these, 12 (60%) were doctor notified cases that could be followed up for ESD. Completed ESD questionnaires were received from six individuals, resulting in a response rate of 50%.

Barmah Forest virus disease case data summary

Western Australia: 2019-20

Data reflected in this summary of mosquito-borne disease is taken from the Western Australia Notifiable Infectious Disease Database (WANIDD) and includes enhanced surveillance data collected by Population Health Units and local governments

Table 2: Barmah Forest virus disease cases per month between July 2019 and June 2020, with Crude and Age Standardised Rates.

REGION		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total	Crude Rate	Age Std Rate
KIMBERLEY		0	1	0	1	0	0	0	0	2	1	0	0	5	13.9	14.9
PILBARA		0	0	0	0	0	0	0	1	0	0	0	0	1	1.6	1.4
GASCOYNE		1	0	0	0	0	0	0	0	0	0	0	0	1	10.6	9.7
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	0	0	0	0.0	0.0
METRO		0	2	0	0	0	0	0	0	0	0	0	0	2	0.1	0.1
	PEEL	0	0	0	0	1	0	0	0	0	0	2	0	3	1.1	1.0
	LESCHENAULT	0	0	0	0	0	0	0	1	0	0	0	0	1	1.4	1.0
	GEOGRAPHE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
	ELSEWHERE SW	0	0	0	0	0	0	1	0	0	0	0	0	1	2.1	1.4
SOUTH WEST		0	0	0	0	1	0	1	1	0	0	2	0	5	1.1	
GREAT SOUTHERN		0	0	0	0	1	0	0	0	3	0	0	0	4	6.6	6.5
GOLDFIELDS-ESPERANCE		0	0	0	0	1	0	0	0	0	0	1	0	2	3.6	3.2
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)		**1**	**3**	**0**	**1**	**3**	**0**	**1**	**2**	**5**	**1**	**3**	**0**	**20**		

The highest number of BFV cases reported was from the Kimberley and South West regions, with 5 cases each. Data from WA's South West is further divided into four regions (Peel, Leschenault, Geographe and SW Elsewhere) to provide a more detailed breakdown of disease distribution. The majority of cases reported in the South West were notified from the Peel region (n=3).

For all disease data tables in this report, the Crude Rate (CR) represents the number of disease notifications per 100,000 population in each region and the Age Standardised Rate (ASR) adjusts for differences in the age distributiuon between the regions to enable direct comparison of the rates across regions. The highest CR and ASR of 13.9 and 14.9 per 100,000 respectively, was recorded from the Kimberley region.

2.3 Murray Valley encephalitis

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

Only 1 in 1000 people bitten by a mosquito carrying the virus will develop disease symptoms. In young children, symptoms of MVE 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, muscle tremors and dizziness. 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.

In 2019-20, there were no MVE cases notified in WA (Figure 2). The last confirmed case of MVE was acquired in June 2018, although it was not possible to definitively determine the location where the infection was acquired. This was likely to be either the Kimberley, Pilbara or Northern Territory. Prior to 2018, the last confirmed cases of MVE in WA occurred in 2011, with nine cases reported between January-May.

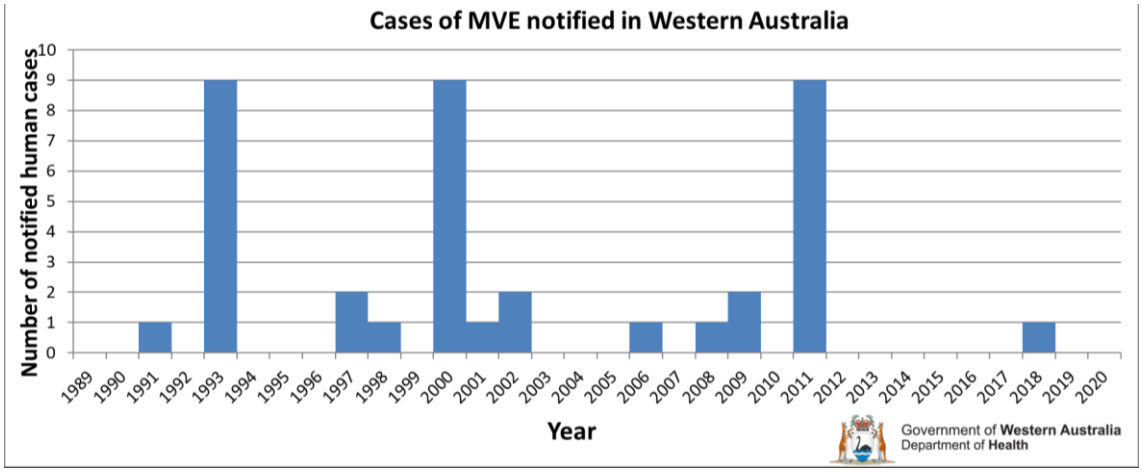


Figure 2: Total number of Murray Valley encephalitis cases notified in Western Australia by year between 1 January 1989 to 30 June 2020

2.4 West Nile virus Kunjin strain

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

In 2019-20, there were no KUN cases notified in WA (Figure 3). The most recent cases were acquired between April - June 2017, with five cases notified.

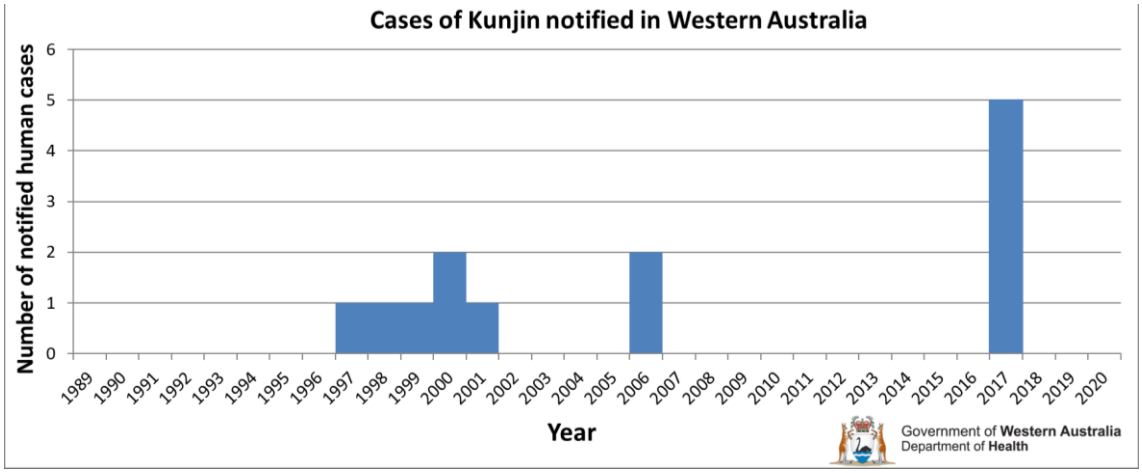


Figure 3: The total number of Kunjin cases notified per year in Western Australia from 1989 to 2020

3.0 Exotic mosquito-borne diseases

Exotic Mosquito-borne Diseases

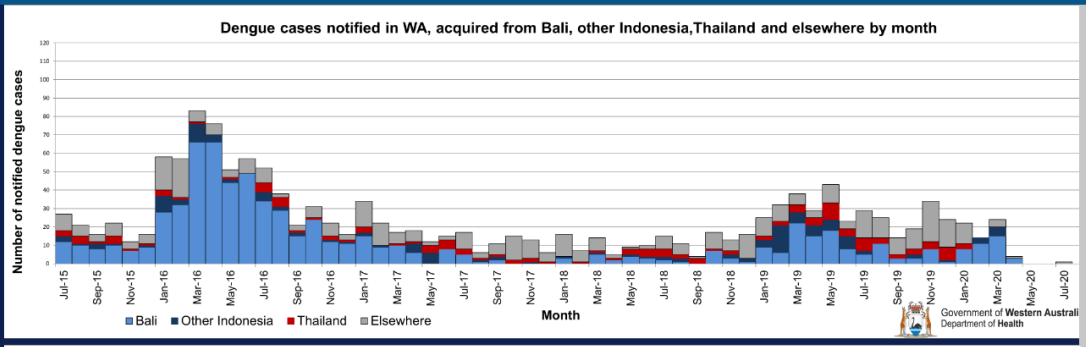
2019-20 Summary

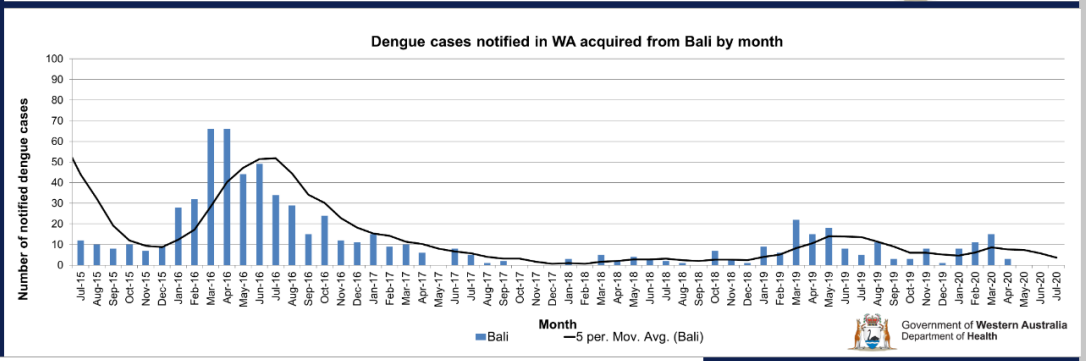
Data reflected in this summary is taken from the Western Australia Notifiable Infectious Disease Database (WANIDD) and includes enhanced surveillance data collected by Population Health Units. The displayed exotic diseases are not acquired in WA, but are typically notified from WA residents and others being diagnosed in WA after international travel.

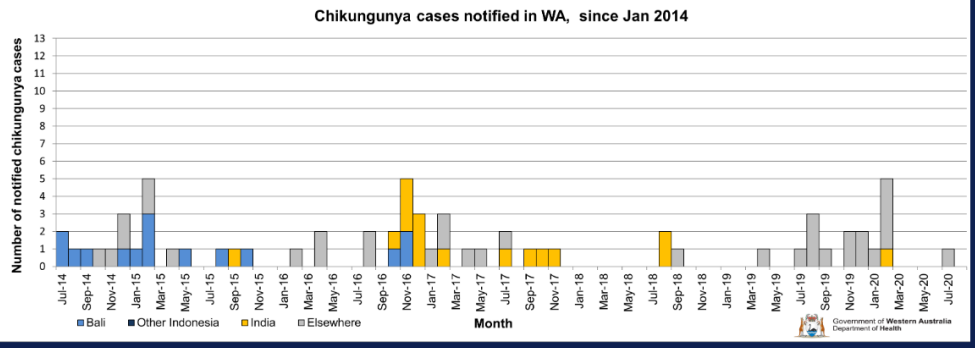
278

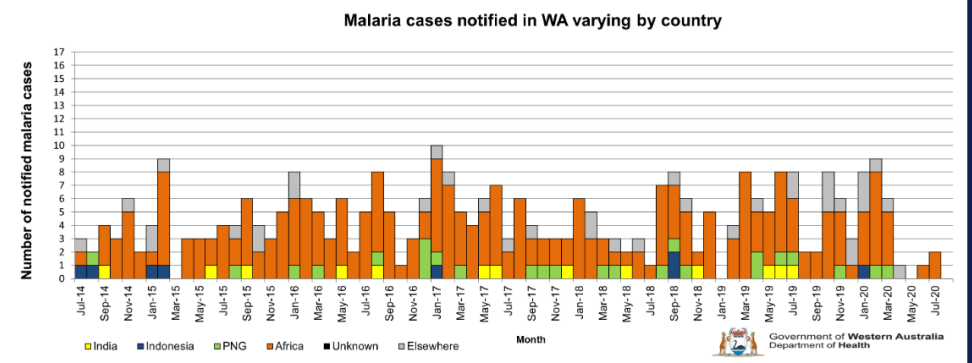
exotic mosquito-borne disease cases

have been reported between 1 July and 30 June 2020 in Western Australia









There were 209 cases of Dengue virus notified in WA in the 19-20 year; most of these indicated travel to Bali and other parts of SE Asia.
There were 54 cases of Malaria and 15 cases of Chikungunya, also notified during the same period.

For all below summary statements refer to Exotic Mosquito-borne Diseases summary infographic for corresponding graphs.

3.1 Chikungunya virus

The risk of infection with chikungunya virus (CHIKV) has traditionally been highest in Africa and Asia. Recently, the disease has emerged in countries in the Pacific and Indian Ocean regions, and south-east Asia and the Caribbean. CHIKV is exotic to Australia and the known mosquito vectors are not present in WA. It is suspected that some mosquito species native to WA, such as *Aedes vigilax, Aedes notoscriptus* and *Coquillettidia* species near *linealis,* may be capable of transmitting CHIKV. Consequently, should CHIKV be introduced to WA there is a possibility it may become established locally.

Symptoms of CHIKV disease are similar to RRV, including fever, chills, muscle aches, 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.

In 2019-20 there were 15 chikungunya cases notified in WA, all acquired overseas.

3.2 Dengue virus

Currently, there are four recognised dengue virus (DENV) serotypes. 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 serotype can lead to 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. DENV is spread by the bite of infected *Aedes aegypti* or *Aedes albopictus* mosquitoes, neither of which is established in WA.

In 2019-20 there were 209 dengue cases notified in WA, all acquired overseas. Most cases were acquired in Bali, with the majority of others originating from elsewhere in Indonesia and Thailand. The number began to taper off in May 2020 as overseas travel was significantly reduced as a result of travel restrictions related to COVID-19.

3.3 Japanese encephalitis virus

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

There were no cases of JE notified in WA during 2019/2020. The most recent case notified in WA in April 2018, was acquired in Thailand and was unfortunately fatal.

3.4 Malaria

Malaria (MAL) 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 transmitted through the bite of infected *Anopheles* mosquitoes. Infection risk exists predominantly in the tropical regions of Asia, Africa and Central or South America. MAL caused by *P. falciparum* and *P. knowlesi* can be fatal.

MAL 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.

In 2019-20 there were 54 MAL cases notified in WA, all acquired overseas. These cases were notified in international travellers and refugees from Africa. The monthly number of MAL cases was similar to past six years (Feb 2013 to Jun 2019), but lower compared to earlier years (Jan 2006- Jan 2013).

3.4 Zika virus

Zika virus (ZIKV) causes an illness known as Zika virus disease, characterised by mild fever, rash, conjunctivitis and muscle and/or joint pain. Research suggests that ZIKV 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, ZIKV activity was limited to parts of Africa, with occasional small outbreaks in Asia. However, since 2015, virus activity has spread to the Pacific Ocean, South America, Central America, the Caribbean and North America. There were no notifications of Zika virus disease in WA during the 2019-20 year.

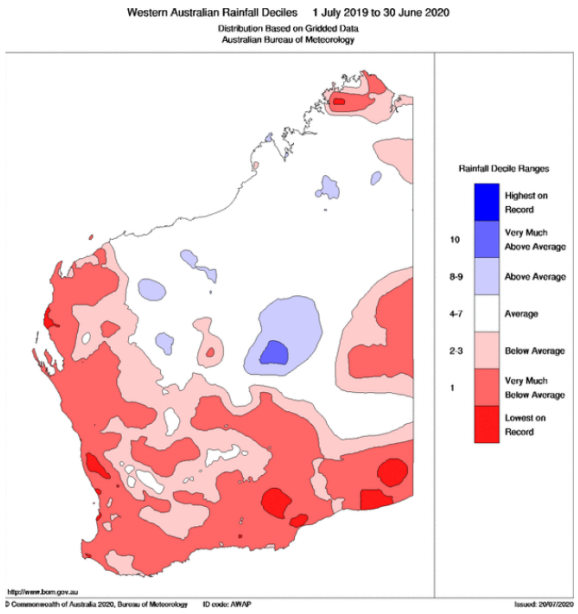
4.0 Climatic conditions

WA CLIMATIC CONDITIONS

2019-20 Summary

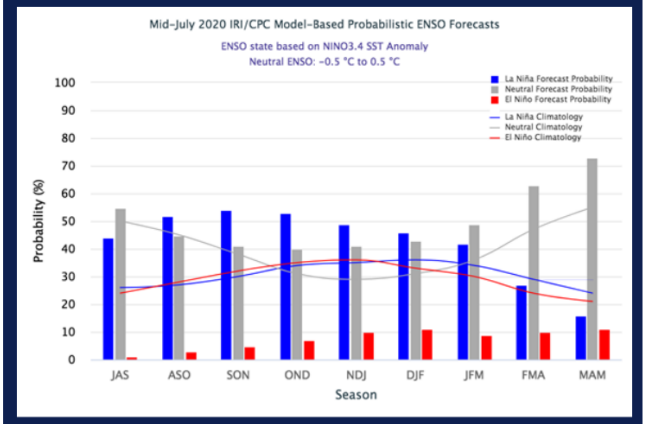
RAINFALL

Rainfall from July 2019 to June 2020 was below average, to very much below average, throughout most of Western Australia (WA). Coastal areas of the South West and the Perth metropolitan region recorded very much below average rain during this period. North West coastal and inland regions in most of the Pilbara and Kimberley experienced average rainfall patterns



EL NIÑO - SOUTHERN OSCILLATION (ENSO)

The Southern Oscillation Index has remained predominantly neutral since June 2019 but the likelihood of a La Niña event in the Spring of 2020 is over 50%. A La Niña event is often associated with increased rainfall and tidal events in some parts of Australia. The Indian Ocean Dipole reached its highest positive recording during October/November 2019 since at least 2015, but has since returned to neutral values. It is expected to remain neutral leading into Spring 2020.

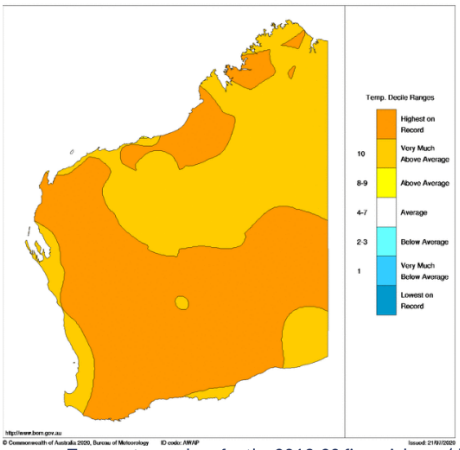


El Nino-Southern Oscillation (ENSO) prediction model forecast for the second half of 2019 and early 2020. Source: International Research Institute for Climate and Society.

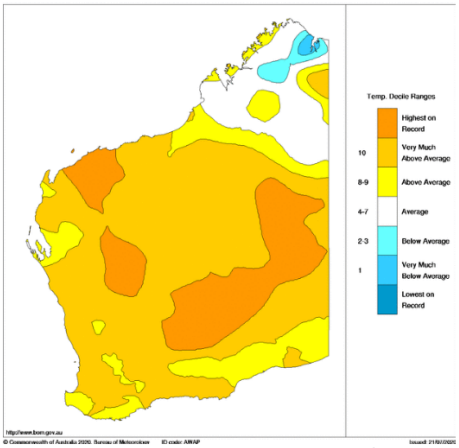
TEMPERATURE

The average temperature since July 2019 has been above average to the highest on record. The South West coastal regions, including Perth, experienced very much above average temperatures for the year, whilst coastal regions of the Pilbara and southern inland WA experience their hottest average temperatures on record.

Maximum temperature



Minimum temperature



Temperature values for the 2019-20 financial year (data source: Commonwealth Bureau of Meteorology)

4.1 El Niño-Southern Oscillation (ENSO)

El Niño refers to extensive warming of the central and eastern tropical Pacific 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 and 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 South West of WA, where the majority of mosquito egg-hatching is tidally driven.

During 2019-20, WA experienced mostly neutral, with sporadic El Niño, conditions. These conditions were associated with below average rainfall patterns and a reduction in the frequency and magnitude of tidal surges, with the exception of a few events related to cyclones and significant tropical low systems. Overall, mosquito populations were average in many of the high-risk areas of WA (including the South West and Kimberley regions).

4.2 Rainfall

During 2019-20, the overall rainfall pattern was average to very much below average across most of WA. There were a few exceptions in the Kimberley and Pilbara regions with the environmental effects following on from tropical cyclones (TC) Damien and Blake and other significant low-pressure systems.

The quarterly rainfall breakdown (Figure 4A-D) also indicates average to below average rainfall for much of the State, with the exception being summer. January-March brought above average rainfall to the central and south east regions of WA (Figure 4C).

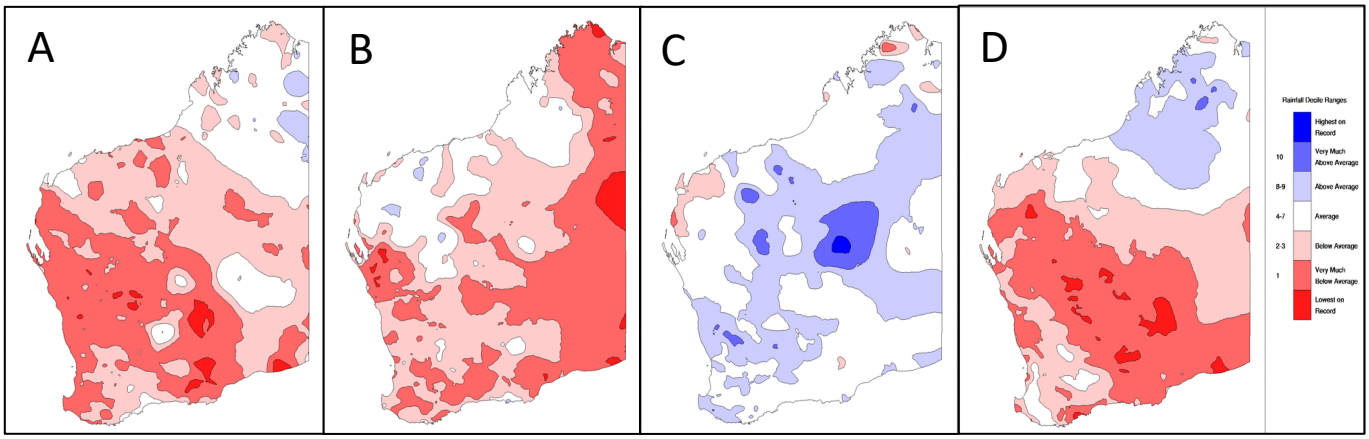


Figure 4 A-D: Three-monthly summaries of Western Australian rainfall deciles. A: July-September 2019; B: October-December 2019; C: January-March 2020; D: April-June 2020 (source: Commonwealth Bureau of Meteorology)

4.3 Temperature

4.3.1 Maximum temperature

Maximum temperature deciles were the highest on record for much of WA, with most of the State experiencing maximum temperatures above average, to the highest on record. This trend can be observed for the whole season with the exception of summer (Figure 5) when temperatures were close to average. Maximum temperatures remained high for the northern regions of WA during all quarters. Coastal and southern inland regions experienced some of the highest maximum temperatures on record during the 19-20 season. Combined with below average rainfall, WA experienced one of the driest, warmest winter and spring seasons on record.

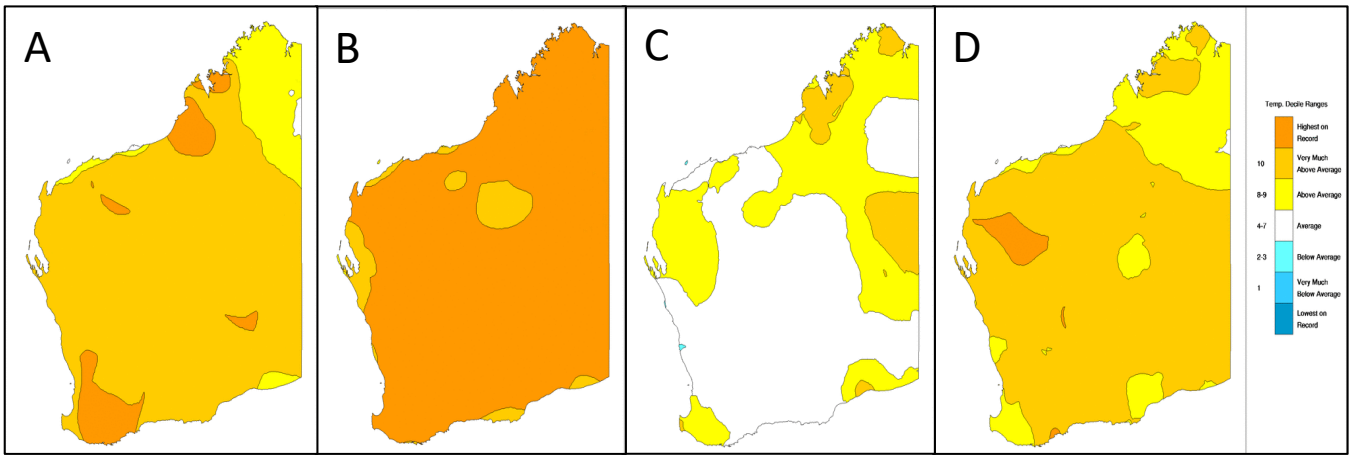


Figure 5 A-D: Three-monthly summaries of Western Australian maximum temperature deciles. A: July-September 2019; B: October-December 2019; C: January-March 2020; D: April-June 2020 (source: Commonwealth Bureau of Meteorology)

4.3.2 Minimum temperature

Minimum temperatures were typically average, to very much above average across WA during 2019-20 (Figure 6), while winter in the Kimberley region was below to very much below average.

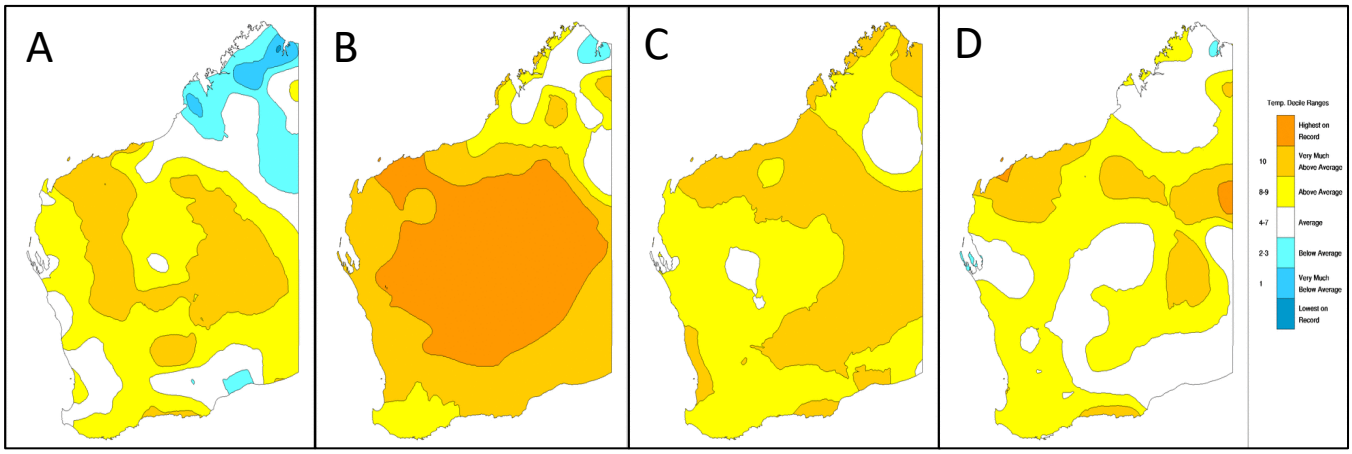


Figure 6 A-D: Three-monthly summaries of Western Australian minimum temperature deciles. A: July-September 2019; B: October-December 2019; C: January-March 2020; D: April-June 2020 (source: Commonwealth Bureau of Meteorology)

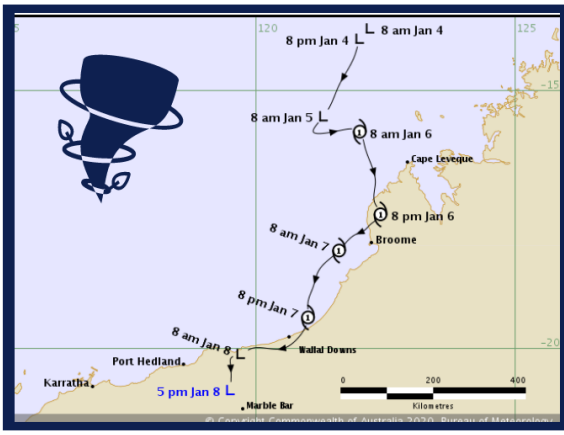
4.4 Australian tropical cyclone season summary

WA CLIMATIC CONDITIONS

2019-20 Summary

CYCLONES and WEATHER SYSTEMS

Tropical Cyclone (TC) Damien was the only **severe** tropical cyclone to make landfall in the northwest of WA in the 2019-2020 season. TC Blake, ex-TC Esther and Tropical Low 09U were other weather systems of note that influenced heavy rainfall and storm surges in the northwest regions of WA.



Tropical Cyclone Damien

A tropical low formed over the Kimberley in early February 2020 before developing into TC Damien off the Kimberley coast on 6 February 2020.

TC Damien moved over the Indian Ocean off the Kimberley coast, making landfall near Karratha, bringing heavy rain to much of the inland Pilbara.

Heavy rainfall caused flooding initially through the Kimberley when the system was a tropical low, then through the Pilbara and eastern Gascoyne.

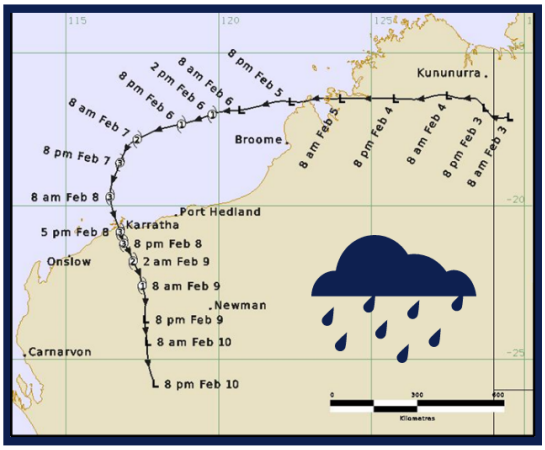
Widespread totals of 100 to 200mm and isolated falls up to 235mm were recorded near the Pilbara coast.

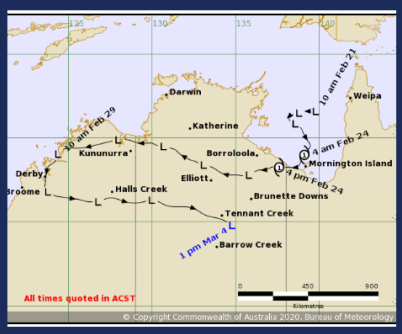
Tropical Cyclone Blake

In January 2020, TC Blake briefly moved over the Dampier Peninsula, where it remained a category 1 tropical cyclone. Derby recorded 152.8mm of rain, Broome recorded 148mm and roads were cut off by flood waters.

TC Blake then moved back over water and travelled parallel to the west Kimberley coast, crossing the Eighty Mile Beach 17 kilometres east of Wallal Downs on 7 January.

The remnant tropical low tracked through the Pilbara, resulting in heavy rainfall and flooding. Moderate to major flooding was recorded over numerous tributaries of the De Grey river catchment and there were widespread road closures. The Coongan River peaked at its highest level in over 30 years of records.



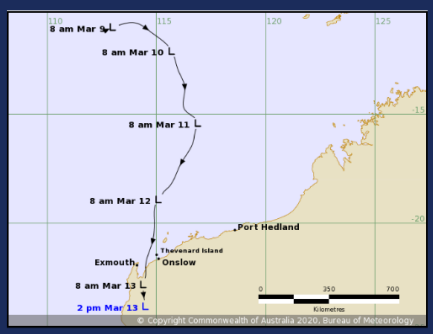


ex-TC Esther

From February 27 ex-tropical cyclone Esther crossed into WA from the NT and persisted for 4 days, bringing high rainfall to the northern Kimberley region.

Tropical Low 09U

Tropical Low 09U crossed the Pilbara coast between Exmouth and Onslow in March. Heavy rainfall was recorded in the Gascoyne but no flooding effects were experienced. The low caused a storm surge of about 0.3-0.4 metres recorded at Onslow and Exmouth.



Cyclone track maps and information summaries for the 2019-20 financial year (data source: Commonwealth Bureau of Meteorology)

5.0 Mosquito-borne disease surveillance programs

5.1 South West arbovirus surveillance program

MOSQUITO SURVEILLANCE PROGRAMS

2019-20 SUMMARY

SOUTHWEST WA Mosquito Trapping Data

82%

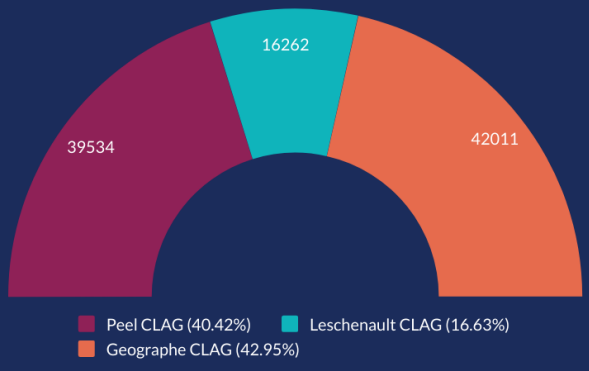
of all mosquitoes trapped were *Aedes camptorhynchus*

Fortnightly mosquito trapping at 21 permanent coastal trap sites between Mandurah and Dunsborough allows for the surveillance of RRV and BFV in mosquito populations across one of the highest risk areas for these diseases in WA.

97,807

Adult mosquitoes collected

Mosquito collections by CLAG region



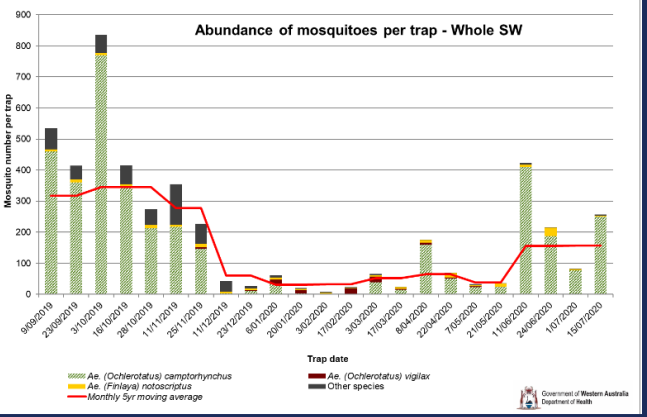
Contiguous Local Authority Groups (CLAGs) can be multiple or individual local governments that cooperate to more effectively manage mosquitoes in their jurisdictions.

Peel CLAG comprises - Mandurah, Murray, Rockingham, Waroona Shires

Leschenault CLAG comprises - Bunbury, Dardanup and Harvey Shires

Geographe CLAG comprises - Busselton and Capel Shires

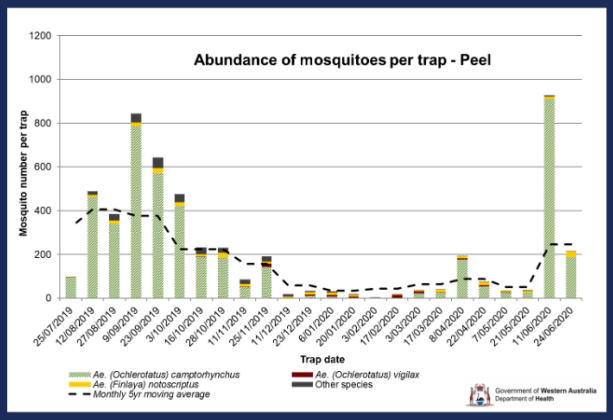
In June 2020, there was unseasonal, widespread detections of RRV in the Peel, Leschenault and Geographe regions of WA. RRV was detected at 6 different sites in 17 sample pools of Aedes camptorhynchus. No BFV was detected during the 2019-20 season from the mosquitoes collected by Medical Entomology and processed by PathWest Laboratory Medicine.

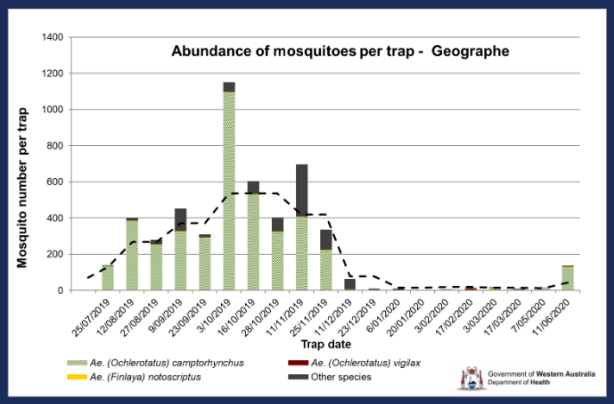


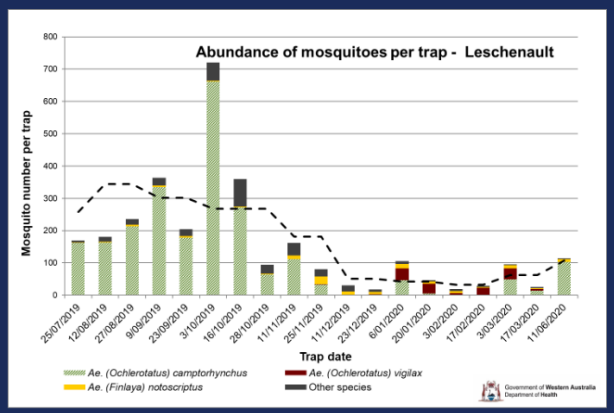
SOUTHWEST WA Mosquito Trapping Data

Outbreaks of RRV and BFV occur in the South West region every three to five years. The Department undertakes regular arbovirus surveillance in this region, from Mandurah to Busselton, to monitor virus activity and provide an early warning of increased disease risk. Monitoring of mosquitoes and mosquito-borne virus activity in the South West region commenced in 1987.

The neutral weather conditions resulted in mostly average mosquito abundance average across the South West with significant increases in some months. These increases were due to spring weather conditions and tidal activity causing larger than usual hatching events.
The dominant species collected around the Peel region were Aedes camptorhynchus, *Ae. notoscriptus and Ae. vigilax*.
Aedes camptorhynchus and the spring species *Ae. clelandi* and *Ae. hesperonotius* were the dominant species at sites further south.
High numbers of *Ae. vigilax* are usually observed from December onward, however this did not occur during the 2019-20 summer.







RRV and BFV virus detections

In June 2020 there was unseasonal, widespread detections of RRV in the Peel, Leschenault and Geographe regions. RRV was detected at 6 different sites in 17 pools of *Aedes camptorhynchus*. In response, a media statement (26 June) was released to inform residents and tourists within the region of the need to take additional personal protection measures to avoid mosquito bites.

No BFV was detected during the 2019-20 season from the mosquitoes collected by Medical Entomology and processed by PathWest Laboratory Medicine.

5.2 MVE and WNV_{KUN} virus surveillance

In WA, the Department monitors flavivirus activity primarily via its sentinel chicken program. This surveillance program is also supported by an annual mosquito survey.

The aim of this program is to provide an early warning system for the detection of MVEV and WNV_{KUN} activity in WA's north. This in turn helps to inform LG mosquito management efforts, as well as the development and release of media statements advising the general public to take personal protection measures against mosquito bites.

5.2.1 Sentinel chicken flavivirus surveillance program

Chickens are bled by trained environmental health officers, veterinarians or volunteers 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 Department to issue a media statement warning residents and travellers to the affected regions of the increased risk to public health and the need to take personal protection measures to prevent mosquito bites. The confirmation of virus activity is reported to LGs, who can then undertake appropriate management activities to reduce mosquito numbers and the potential for virus transmission.

It is only through the integrated program involving the Department, 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.

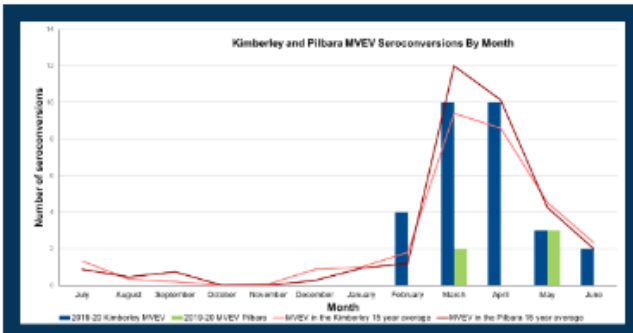
Photo courtesy of ME – Officers inspecting and setting mosquito traps near a sentinel chicken flock in the Kimberley region of WA.

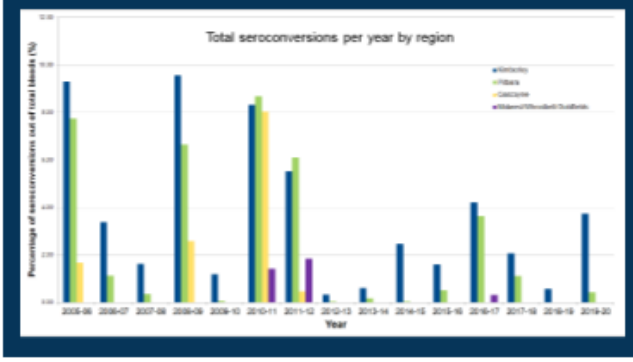
2019-20 Sentinel Chicken surveillance data

23 Sentinel chicken flocks located throughout WA

3,529 Blood samples taken

48 Seroconversions detected

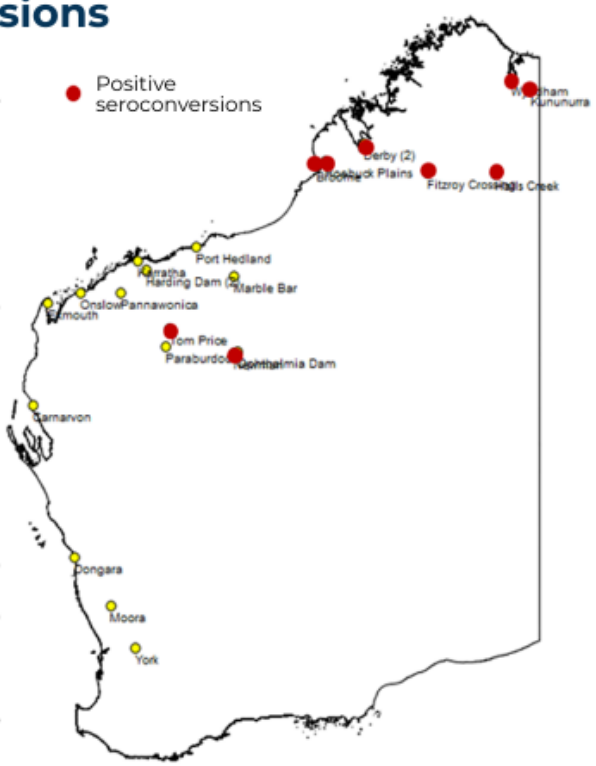




2019-20 Seroconversions

1 July 2019 - 30 June 2020

	Site	MVEV	KUN	MK	FLAVI	Total
KIMBERLEY	Wyndham	6	0	0	1	7*
	Kununurra	7	1	2	1	11
	Halls Creek	5	1	1	1	8
	Fitzroy Crossing	8	0	0	0	8
	Derby site 1	1	0	0	0	1
	Derby site 2	0	0	0	0	0
	Broome	2	0	0	0	2
	Roebuck Plains	3	0	0	0	3
PILBARA	Pt. Hedland	0	0	0	0	0
	Marble Bar	0	0	0	0	0
	Karratha	0	0	0	0	0
	Harding Dam	0	0	0	0	0
	Pannawonica	0	0	0	0	0
	Onslow	0	0	0	0	0
	Tom Price	2	0	1	0	3
	Paraburdoo	0	0	0	0	0
	Newman	0	0	0	0	0
	Ophthalmia Dam	3	0	1	0	4
GASC.	Exmouth	0	0	0	0	0
	Carnarvon	0	1	0	0	1**
MIDWEST-WHEATBELT	Dongara	0	0	0	0	0
	Moora	0	0	0	0	0***
	York	0	0	0	0	0
	TOTAL	37	3	5	3	48



* One seroconversion preliminary positive, excluded from total as confirmatory sample not submitted; ** Mature chicken from private flock, undetermined virus exposure timeframe; ***Flock retired April 2020, no samples submitted during 2019/20 season

5.2.2 Northern arbovirus surveillance program

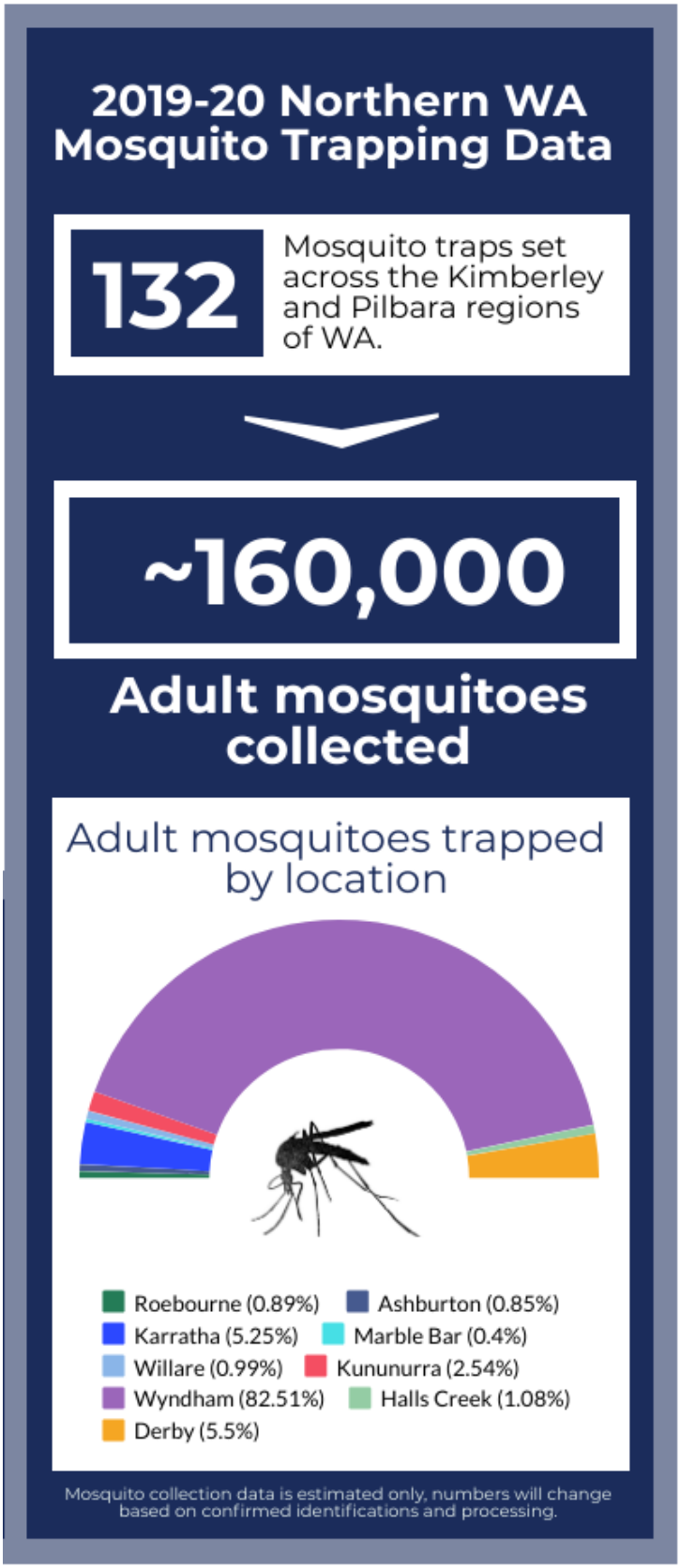
2019-20 northern mosquito trapping

During 2019-20, mosquito collections were conducted in the Kimberley region of WA from 12-24 March 2020. Unfortunately, the trip was cut short due to the COVID-19 pandemic and the fieldwork officers were required to return to Perth ASAP. The trip was timed to coincide with the end of the wet season in the region. The trap sites were selected based on historical data of mosquito abundance, virus detection, proximity to sentinel chicken flocks and proximity to mosquito breeding habitats.

Traps were set at Onslow, Roebourne, Cossack, Karratha, Dampier, Marble Bar, Willare, Kununurra, Wyndham, Parry's Lagoon, Halls Creek and Derby, and surrounds. The mosquitoes were collected using dry ice (carbon dioxide) baited EVS (encephalitis virus surveillance) traps. The traps were set at or before sunset and retrieved close to or after sunrise the following morning. The mosquitoes were then frozen on dry ice and transported to the ME laboratory in Perth. It is estimated that almost 160,000 mosquitoes were collected over 132 traps. Mosquito numbers were higher than 2018-19 due to increased rainfall from from several cyclones during the 2019-20 wet season.

The mosquitoes are still being identified to species level in the ME laboratory. They will then be screened for detection of specific arboviruses of public health significance including RRV, BFV, MVEV and WNVKUN. Additionally, detection of a range of other alpha and flaviviruses, that may or may not cause illnesses in humans, can be screened.

The 2019-20 mosquito collections are still being processed and results will be reported in the 2020-21 Annual Report



Results from 2018-19 northern surveillance are included in this report as the mosquito identification was undertaken during the reported period.

2018-19 Northern WA Mosquito virus Data

Pathwest virus testing summary

1,099 mosquito pools
mosquito pools collected in 2019 in Northern WA were tested by PCR

5 pools positive
for a virus

12 mosquito pools
pending gene sequencing

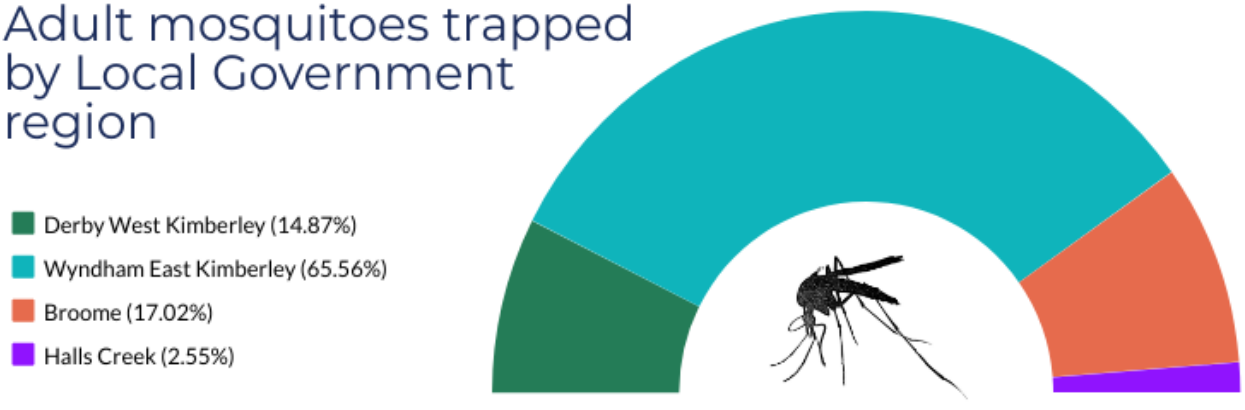
0 MVEV detections
in 2018-19 Northern WA mosquito collections

12 Flavivirus unknown
detections throughout Kimberley and Pilbara regions

169
Mosquito traps set across the Kimberley, Pilbara and Midwest regions of WA.

19,036*
Adult mosquitoes collected

Adult mosquitoes trapped by Local Government region



*The lower mosquito numbers were mostly attributed to reduced rainfall in the Kimberley region during the 2019 wet season

Table 3: Total numbers of collected mosquitoes during 2018-19 northern fieldwork 22 March to 5 April 2019, by mosquito species per locality. Grey rows are the 5 most prevalent mosquito species collected.

Mosquito species	Broome	Coconut Wells	Derby	Fitzroy Crossing	Fitzroy river floodplain	Geikie Gorge	Halls Creek	Kununurra	Roebuck plain	Willare	Willie Creek	Wyndham	Total
Ad. (Aedeomyia) catasticta							1	212			1	3	217
Ae. (Chaetocruiomyia) elchoensis	1							3					4
Ae. (Finlaya) new undescribed species						15							15
Ae. (Finlaya) notoscriptus	392		11					8				2	413
Ae. (Finlaya) pecuniosus			1					2					3
Ae. (Macleaya) species	*862*	*2*	*77*	*20*	*9*	*17*	*36*	*16*	*12*	*31*	*9*	*26*	*1117*
Ae. (Macleaya) tremulus	102	6	4			1			11		3		127
Ae. (Mucidus) alternans			7				1	1				6	15
Ae. (Neomellanoconion) lineatopennis								2				1	3
Ae. (Ochlerotatus) E.N. Marks' species No. 159								8					8
Ae. (Ochlerotatus) E.N. Marks' species No. 85							1						1
Ae. (Ochlerotatus) normanensis			*36*	*13*	*1*	*6*	*31*	*19*		*552*		*4*	*662*
Ae. (Ochlerotatus) pseudonormanensis							46						46
Ae. (Ochlerotatus) vigilax	*2*		*316*					*41*	*1*		*6*	*6506*	*6872*
Ae. (Pseudoskusea) bancroftianus							72						72
Ae. (Subgenus Nov.) daliensis			10										10
Ae. species (unidentified) - new or difficult to ID species	226		74	20		1	11	9	2	2	2	50	397
An. (Anopheles) bancroftii								35				23	58
An. (Cellia) amictus		1	6	17				20	7	23		18	92
An. (Cellia) annulipes s.l.			*1*	*33*	*8*	*31*	*22*	*725*		*132*		*470*	*1422*
An. (Cellia) farauti								1					1
An. (Cellia) hilli												146	146
An. (Cellia) novaguinensis								2					2
An. species (unidentified) - new or difficult to ID species				2		1		2				2	7
Cq. (Coquillettidia) xanthogaster								30				20	50
Cx. (Culex) annulirostris	*184*	*41*	*122*	*22*		*3*	*84*	*1975*	*71*	*332*	*13*	*3225*	*6072*
Cx. (Culex) bitaeniorhynchus								55				48	103
Cx. (Culex) crinicauda								8					8
Cx. (Culex) gelidus								3					3
Cx. (Culex) palpalis	1							109				9	119
Cx. (Culex) quinquefasciatus	14		9	5			13	7	2		26	5	81
Cx. (Culex) sitiens	9	9	2					20	10		32	30	112
Cx. (Culex) squamosus								3				1	4
Cx. (Culex) starckeae								2					2
Cx. (Culiciomyia) pullus								43		4			47
Cx. (Lophoceraomyia) cylindricus	18			1		1	6						26
Cx. (Lophoceraomyia) fraudatrix							7	1					8
Cx. (Lophoceraomyia) hilli								5					5
Cx. (Lophoceraomyia) species	1												1
Cx. (Lutzia) halifaxii									1				1
Cx. species (unidentified) - new or difficult to ID species							5	25	1	1	111	15	158
Ma. (Mansonioides) uniformis								28					28
Mimomyia (Eto) elegans								5					5
Tripteroides (Polylepidomyia) punctolateralis	25	2	9	1			11	5		1		3	57
Unidentifiable *Aedes sp.* (too damaged/features missing)									1				1
Unidentifiable *Anopheles sp*. (too damaged/features missing)												6	6
Unidentifiable *Culex sp.* (too damaged/features missing)		1					1	26				373	401
Ur. (Uranotaenia) albescens								13					13
Ve. (Verrallina) reesi								15					15
Total	**1837**	**62**	**685**	**134**	**18**	**76**	**348**	**3484**	**119**	**1078**	**203**	**10992**	**19036**

2018-19 Northern mosquito trapping

43

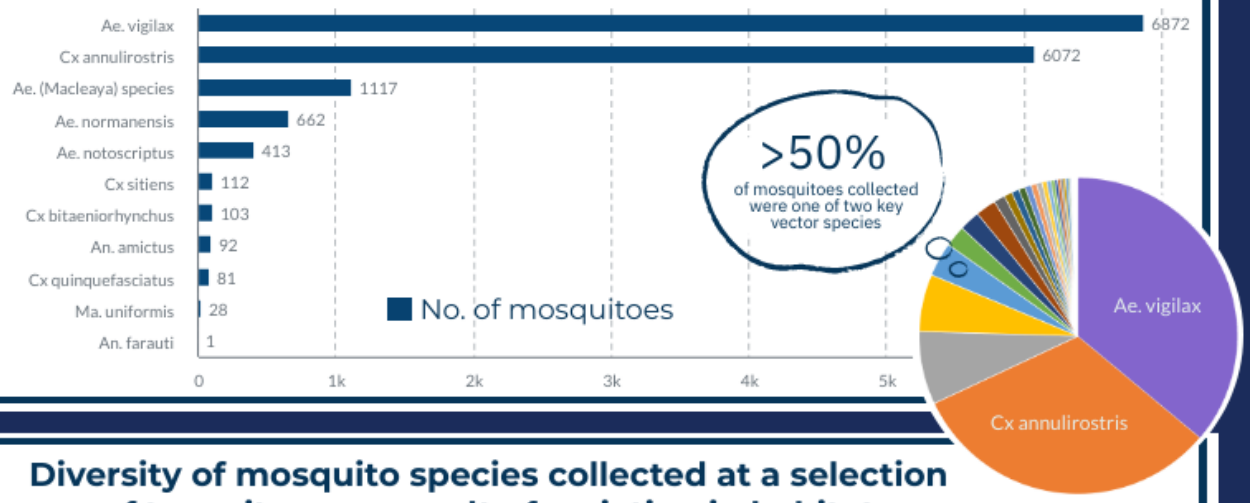
mosquito species collected during trapping period from Kimberley region only.

(Trapping period 22 Mar - 5 Apr 2019)

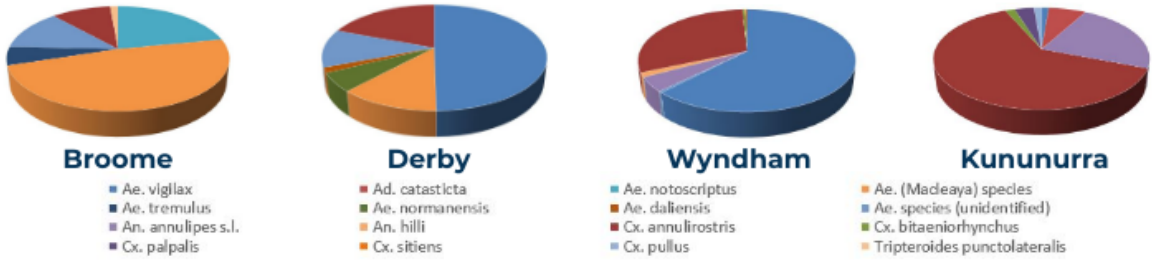
10

mosquito species are significant disease vectors or major pests impacting amenity.

Mosquitoes of public health significance collected in 2018-19



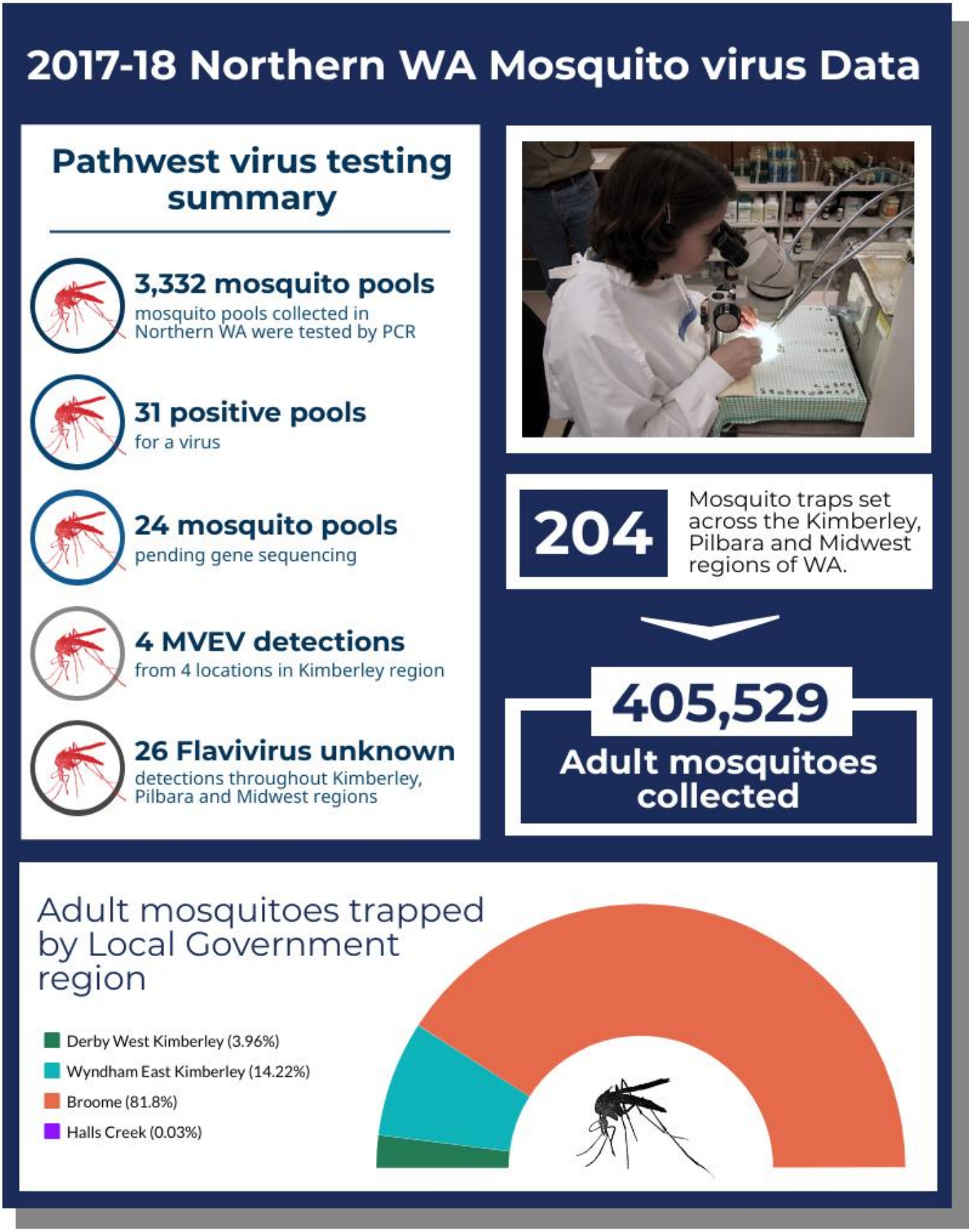
Diversity of mosquito species collected at a selection of trap sites as a result of variation in habitat



5 MOST COMMON MOSQUITOES COLLECTED in NORTHERN WA (2018-19)

Aedes normanensis — *Aedes notoscriptus* — *Culex sitiens* — *Aedes vigilax* — *Culex annulirostris*

Virus isolation data from the 2017-18 year have been finalised by Pathwest and also included in this report.



6.0 Exotic mosquito detections at Perth International Airport

During 2019-20, the exotic mosquito surveillance program employed by the Commonwealth Department of Agriculture Science Support Program detected two importations of exotic mosquitoes in 2019-20. ME confirmed the identifications as *Aedes aegypti* collected at Perth International Freight terminal; and *Aedes albopictus,* collected at an approved arrangement facility located in Bibra Lakes. ME provided technical assistance and advice on mosquito control treatments and ongoing monitoring.

7.0 Aerial larviciding program across the South West of WA

The Department funds the use of a helicopter for aerial application of mosquito larvicide in high mosquito-borne disease risk areas in the South West of WA. The aerial larviciding program is an important preventative public health activity.

Annually, the coastal South West region experiences RRV and BFV activity. In some years this can lead to significant outbreaks of disease among local residents and visitors. By controlling vector mosquito populations with larvicide, the program aims to reduce the number of cases of both diseases.

Mosquito breeding is determined by environmental and climatic factors such as temperature, rainfall and tidal activity. LG staff monitor mosquito breeding habitat within their jurisdictions and assess when mosquito numbers need to be controlled. LG request aerial larvicide treatments by submitting a pre-treatment form to the Department.

The Department reviews the data and notifies the helicopter contractor of the proposed treatment date. LG staff record treatment details and conduct a post-treatment survey to confirm that the treatment was effective.

In 2019-20, the Department spent $576,410.38 (including contractor retainer cost) on the provision of aerial larviciding treatments through the procurement of helicopter services in the South West region. This involved a total of 31 aerial larvicide treatments covering over 4,200 hectares (Table 4). The larvicide products used were granulated forms of S-methoprene and *Bacillus thuringiensis israelensis* (Bti), and liquid Bti.

Table 4: The number of aerial larvicide treatments and area treated, by region, during 2019-20

Region	Treatments	Area treated (ha)
Peel	21	2,920
Leschenault	4	119
Geographe	6	1,207
Total	**31**	**4,246**

8.0 Contiguous Local Authorities Group (CLAG) funding scheme

The Contiguous Local Authorities Group (CLAG) funding scheme is a mechanism to assist LGs with management, funding and advice on the technical aspects of health-driven mosquito control, in an effort to reduce the risk of mosquito-borne disease throughout WA.

CLAGs are comprised of one or more (contiguous or adjacent) LGs that share a common mosquito problem, usually in the form of natural or man-made habitat that breed mosquitoes which subsequently impact on surrounding communities.

The CLAG funding guidelines were revised in 2018-19, to reflect the importance of integrated mosquito management. The scheme now provides:

- 50% funding towards mosquito management costs related to chemicals, equipment, physical and cultural control (public education) strategies,
- up to 100% mosquito management related training costs, and
- 100% of the helicopter costs associated with the aerial larviciding program in high risk regions of WA's South West.

During 2019-20, there were 18 active CLAGs in WA (Figure 7);

- Ashburton (Shire of Ashburton),
- Broome (Shire of Broome),
- Carnarvon (Shire of Carnarvon),
- Derby-West Kimberley (Shire of Derby-West Kimberley),
- East Pilbara (Shire of East Pilbara),
- East Swan River (Towns of Bassendean and Victoria Park, and Cities of Bayswater, Belmont and Swan),
- Esperance (Shire of Esperance),
- Exmouth (Shire of Exmouth),
- Geographe (City of Busselton and Shire of Capel),
- Halls Creek (Shire of Halls Creek),
- Leschenault (City of Bunbury and Shires of Dardanup and Harvey),
- Karratha (City of Karratha),
- Peel (Cities of Mandurah and Rockingham and Shires of Murray and Waroona),
- Port Hedland (Town of Port Hedland),
- South Coastal (City of Albany),
- South Metropolitan (Cities of Cockburn and Kwinana),
- Swan-Canning Rivers (Primary members - Cities of South Perth, Canning, Melville and Perth; Secondary members – Cities of Nedlands and Subiaco), and
- Wyndham/East Kimberley (Shire of Wyndham East Kimberley).

WESROC (Western Suburbs Regional Organisation of Councils) began the process of forming the WESROC CLAG (City of Nedlands, City of Subiaco and City of Claremont), however, it will not be formally endorsed by the MCAC until 2020-21.

In 2019-20, the Department approved $259,390.65 in CLAG funding.

Due to carryover funds held by CLAGs from 2018-19, the Department was only required to provide $204,101.54 in new funding for the financial year. The amount each CLAG received was dependent on their unique requirements.

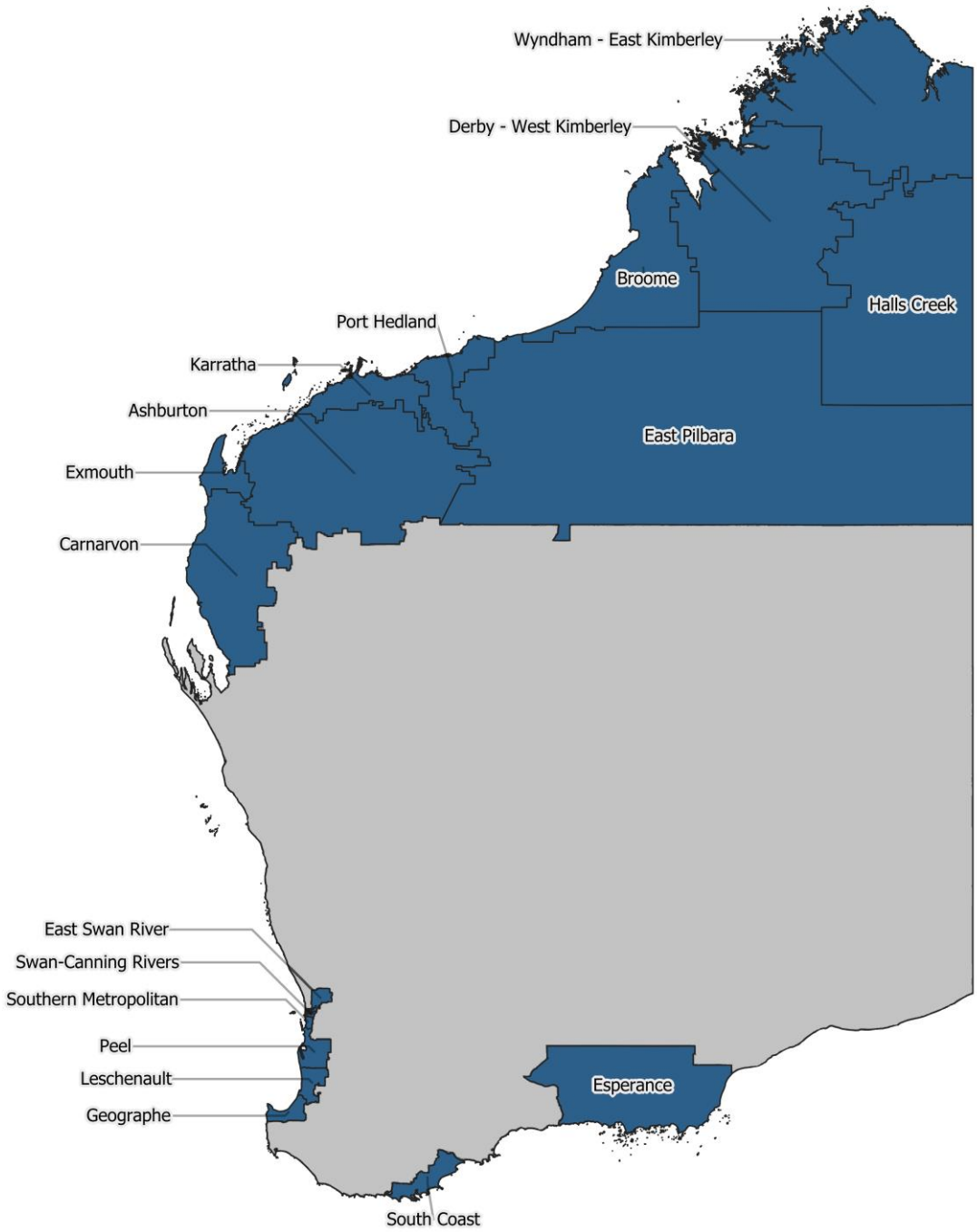


Figure 7: Map of Western Australia showing Contiguous Local Authorities Group (CLAG) boundaries of local governments participating in the CLAG funding scheme during 2019-20

9.0 Fight the Bite

Fight the Bite (FTB) is a public awareness campaign coordinated by the Department, and promoted by LG, to actively raise awareness of mosquitoes and mosquito-borne disease in WA. The campaign was launched during 2015-16 and has evolved in the years since that time. A large number of LGs both in and outside of the CLAG scheme proactively work to promote the campaign throughout the State.

During 2019-20, FTB advertising was rolled out at a range of outdoor cinemas across metropolitan and regional WA. Hard copy and electronic campaign resources were available to all LGs via the Department's website.

10.0 Other projects

10.1 Tide gauges

During 2019-20, the installation and activation of strategically placed tide gauges on the Swan and Canning Rivers was finalised. The project was a capability building project from the Funding Initiative for Mosquito Management in Western Australia (FIMMWA), which began in 2015. Despite logistical challenges delaying the progress during this time, the project is now complete, online and providing tidal data to local government (see Fig 8).

Previously, tidal influence on saltmarsh mosquito breeding sites along the Swan and Canning Rivers was extrapolated from the Barrack Street jetty tide gauge, which is a significant distance downstream. The new tide gauges have been positioned close to saltmarsh mosquito breeding sites to provide highly accurate data on inundation events and environmental triggers for mosquito breeding. This information assists LGs in determining when to conduct site visits for larval mosquito monitoring, ensuring appropriate management strategies are undertaken to reduce the public health risk associated with mosquitoes. Examples of the data outputs available to LGs are provided in Figure 8.

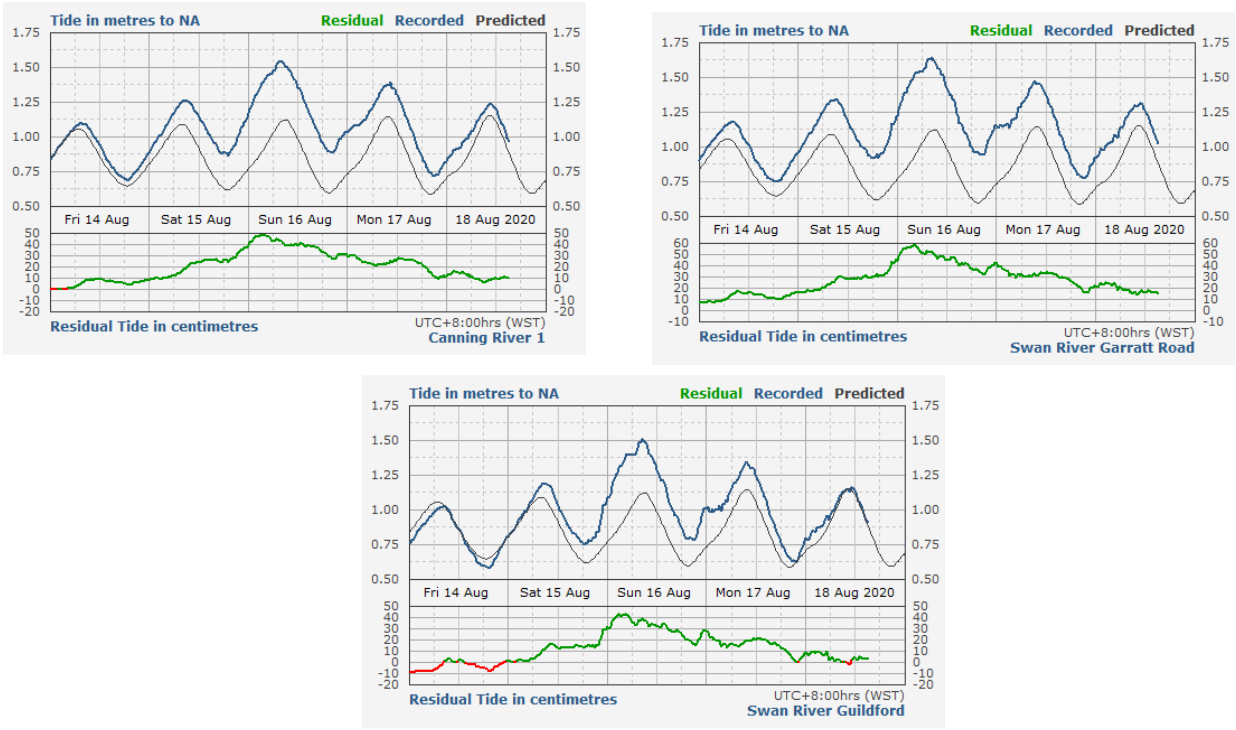


Figure 8: Examples of data outputs of predicted and actual tide heights for a period of time at the three new DOH tide gauge locations – Canning River, Swan River Garratt Rd and Swan River Guildford Rd

10.2 Sentinel chicken pen review

Pilbara sentinel chicken flocks were visited during August 2019 by ME officers with the aim of reviewing the infrastructure and husbandry practices at each site. The last pen review was carried out in 2015. From those findings, a risk matrix was developed for determining the critical features of pen design to improve animal welfare standards.

Officers documented a significant improvement in the welfare of sentinel chickens across the Pilbara since the original review undertaken in 2015. Over the past 4 years, heat-related deaths have dropped by 25%. This improvement is attributed to the inclusion of additional shade and sprinklers to keep the flocks cooler on days when the temperature is above average and a during heatwave.

The team met with local flock carers and environmental health practitioners at each location to discuss pen improvements and deliver training in blood collection techniques. Carers showed dedication and commitment to constantly improving their pens and practices, including automating their sprinkler cooling systems and adding environmental enrichment such as pools and feeder toys.

Photo courtesy of ME – Senior Scientific Officer Craig Brockway undertaking a pen design assessment at a sentinel chicken flock site.

Pen design guidelines and an accompanying checklist have been developed to promote consistent standards for new pens that are constructed and to assist flock carers improve existing pen designs.

The ME team continues to provide ongoing support and advice in animal husbandry, pen maintenance and animal welfare. By optimising chicken health and welfare, we are ensuring that the sentinel chicken program continues to deliver a reliable early warning system for MVEV and WNV_{KUN}.

11.0 Training workshops and forums

11.1 Mosquito management Course

ME conducted a 5-day mosquito management course in Mandurah, between 16-20 September 2019. The course included theoretical and practical components, providing participants with the knowledge and skills required to develop and implement a mosquito management program for their jurisdictions.

The course was well attended by 50 individuals from across WA, the Northern Territory, New South Wales, Victoria, China, and New Zealand. This included staff from Federal, State and local government, public health units, the defense force, and pest control companies as well as tertiary students.

Lectures were presented on topics such as mosquito biology, mosquito-borne diseases, mosquito control, and mosquito surveillance. Participants used the knowledge they gained from these lectures to develop sustainable, integrated management programs. Participants also gained hands-on experience during practical demonstrations of surveillance and control equipment, chemical treatment exercises, field site visits to collect adult and larval mosquitoes, laboratory mosquito identification sessions, and group work on specific mosquito management scenarios.

Presenters at the course included experts from ME, the NSW Health Department, the Northern Territory, local government mosquito management personnel, and the pest control industry. There was a great deal of interest and focus among the participants with a very high level of satisfaction expressed in evaluations.

Photo courtesy of ME – Group photo of the 2019 Department of Health Mosquito Management Course participants and some presenters.

12.0 Impact from COVID-19 pandemic

Restrictions related to COVID-19 somewhat reduced the ability for the ME team and LGs in WA to undertake mosquito surveillance activities for arbovirus detection from mid-March through to mid-June. This was predominantly due to regional travel restrictions prohibiting officers from undertaking adult mosquito trapping in areas considered high-risk for mosquito-borne disease. Whilst surveillance in the Leschenault and Geographe regions ceased during this time, LGs within the Peel region collected mosquitoes on the Department's behalf, to ensure virus detections were not interrupted. Laboratory resources were also affected during this time with staff and consumables being redirected to COVID testing.

Two senior ME staff members were seconded to COVID-19 related projects. The remaining team continued to work from the Department's office premises. Whilst the reduction in staff number stretched the team's resources, mosquito control activities were largely unaffected. LGs continued to access the aerial larviciding program and helicopter treatments were conducted, as required.

Opportunities for LG to actively engage with the community and promote *Fight the Bite* was very limited between March and June, due to the cancellation of events in WA under COVID-19 restrictions. This has been more of an issue for the north of the State, where the timing coincided with a higher risk period for mosquito-borne disease within the region.

The flow on effect of COVID-19 into 2020-21 has already become apparent. Mosquito management budgets within LG are generally more conservative, with funding reserved predominantly for chemical control. Planned community engagement opportunities remain limited – a consequence of the uncertainty surrounding how COVID-19 will impact the State over the coming year.

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