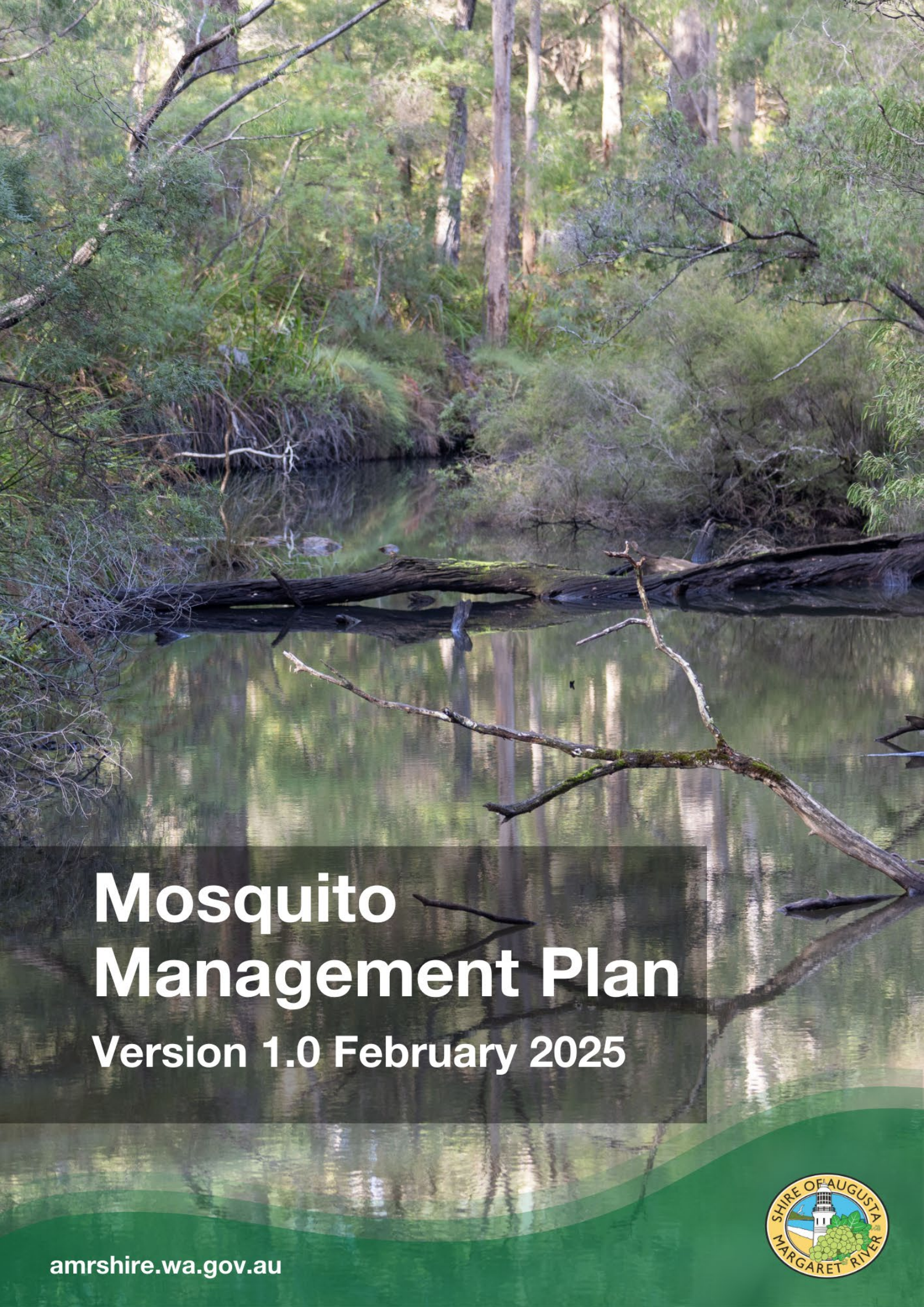


Mosquito Management Plan

Version 1.0 February 2025

amrshire.wa.gov.au

Acknowledgements

The Shire of Augusta Margaret River acknowledges we are on Wadandi and Pibelmen Boodja, whose ancestors and their descendants are the traditional owners of this country.

We acknowledge that the Wadandi and Pibelmen have been custodians since the land was soft (creation times) and continue to perform age-old ceremonies of celebration, initiation, and renewal. We acknowledge their living culture and their unique role in the life of this region.

The Shire is committed to Aboriginal Australians sharing fairly and equitably in the region's cultural, social, environmental and economic future.

Department of Health WA and Fight the Bite campaign

The Department of Health WA and the Fight the Bite campaign have been invaluable partners in the ongoing efforts to manage mosquito populations and raise public awareness. WA Health's Fight the Bite campaign plays a crucial role in educating the community about effective measures to prevent mosquito bites and reduce breeding around homes and holiday accommodations.

Additionally, the current Mosquito Management Plan has been developed with significant support from the Department of Health, Western Australia, utilising their comprehensive template. This collaboration has ensured that the plan is both scientifically sound and aligned with best practices in mosquito management. The continued support from the Department of Health and the Fight the Bite campaign is greatly appreciated, as it strengthens the Shire's approach to managing mosquito-related issues and protecting public health.

Summers Consulting

Summers Consulting brings expert knowledge and guidance on all aspects of mosquito management and the environments in which they breed. The team at Summers Consulting has been instrumental in supporting the Shire's previous mosquito management efforts, providing invaluable assistance throughout the process. Their contributions have included:

- Identifying mosquito breeding habitats
- Conducting mosquito trapping and environmental monitoring
- Assessing mosquito populations and recommending control measures
- Identifying nuisance species and ensuring regulatory compliance

The expertise of the Summers Consulting team has played a key role in improving the Shire's mosquito management strategies, contributing to both public health and environmental sustainability.

Contents

1. Introduction

Mosquitoes are insects that cause considerable annoyance and are carriers of various diseases affecting humans and animals. Australia boasts a wide variety of mosquito species, thriving in diverse habitats ranging from rainforests and bushlands, both wet and dry, to scrub plains, deserts, and mountainous regions (Western Australia Department of Health, 2024).

The discomfort and disruption caused by mosquitoes are challenging to quantify economically. For example, recreational areas may become uninhabitable, agricultural progress can be obstructed, and mosquitoes may lead to notable financial losses in industries like beef and dairy production due to their detrimental effects on livestock (Western Australia Department of Health, 2024).

However, mosquitoes are the most concerning vectors of disease. The parasites and pathogens they transmit have played a significant role in shaping human history. These insects have been instrumental in spreading illnesses that have influenced major events, contributing to the movement and development of human populations across the globe (Western Australia Department of Health, 2024).

In Australia, the most prevalent mosquito-borne diseases that affect humans include Ross River virus (RRV), Barmah Forest virus (BFV), Murray Valley encephalitis virus (MVEV), West Nile virus subtype Kunjin (WNV Kunjin), Japanese encephalitis virus (JEV), and Dengue viruses (DENV). (Western Australia Department of Health, 2024). A more detailed explanation of these mosquito-borne diseases will be provided in the following chapter of this document.

As urban development expands into areas close to natural mosquito habitats, there is an increased risk of exposure to these diseases, particularly in regions with abundant mosquito populations. One such area is the Shire of Augusta Margaret River (Shire AMR), which covers 2,243 km² and is located approximately 270 km south of Perth. The Shire consists of several small communities, with Margaret River being the main town. It is bordered by the City of Busselton and the Shire of Nannup, both of which also have notable mosquito populations.

The Shire has a population of approximately 16,791 people according to the 2021 Census (Australian Bureau of Statistics, 2021). It is home to diverse communities, from urban townsites to agricultural villages, mixed farming activities, and coastal nodes and forests. The population is expected to increase significantly to 27,000 in 2040 (Shire of Augusta Margaret River, n.d.). Several redevelopments and subdivisions, such as Symphony Waters, Karridale and Witchcliffe Eco village, have provided this potential local growth opportunities.

The mean annual rainfall is approximately 600mm, creating significant pooling in certain areas and providing natural breeding habitats. The Blackwood River is also subject to occasional flooding, inundating surrounding wetland and salt-marsh environments, particularly Molloy Island and East Augusta.

Finally, it is important to highlight the impact of climate change on mosquito-borne diseases, with RRV being the most prevalent in Australia. According to Damtew, Y. T. (et al., 2024), studies have demonstrated that global warming can enhance the transmission and increase the risk of RRV infection.

These factors are crucial to effective mosquito management and must be carefully considered during implementing the Mosquito Management Plan (MMP). The MMP aims to provide comprehensive guidance to the Shire of Augusta Margaret River on controlling and managing mosquitoes. The plan ensures that strategies are designed to meet the region's specific needs and environmental conditions.

2. Program objectives

The general objective of the Shire's MMP is to reduce the number of nuisance and disease vector species to a level where the impact on the human population is acceptable.

The specific objectives of this plan are to:

1. Identify existing and potential mosquito breeding areas;
2. Inform Shire officers and the general public of the Shire's mosquito management strategies;
3. Increase community awareness of MBDS and how to prevent them;
4. Protect the environment (natural habitat), whilst prioritising mosquito management;
5. Ensure information retention via documenting actions and data; and
6. Review the effectiveness of this plan and embed a cycle of improvement in the operations of the MMP.

3. Strategic implications

By the Shire's Strategic Community Plan 2040, the Shire of Augusta Margaret River exists to provide, facilitate and advocate for services, facilities and Boodja to improve the quality of life for everyone in the community. The MMP strives to address the following strategic directions:

a) a natural environment that is appreciated and cared for by locals and visitors, and that is internationally known for its healthy rivers and thriving coastal habitats;
b) a place where sustainable coastal land care and land-use planning will successfully manage people in the natural environment; and
c) provide, regulate and facilitate local community safety initiatives and animal management.

The MMP strives to contribute to the following key areas identified in the Shire of Augusta Margaret River Community Strategic Plan 2036:

a) valuing and protecting our environment and ensuring the sustainable management and use of natural resources; and
b) planning and encouraging our community to reduce its ecological footprint and enhance its quality of life simultaneously.

4. Statutory management and legislation

Department of Health:
Health (Miscellaneous Provisions) Act 1911

Public Health Act 2016

Department of Environment and Conservation:
Environmental Protection Act 1986

Shire of Augusta Margaret River
Shire of Augusta Margaret River Health Local Laws 1999

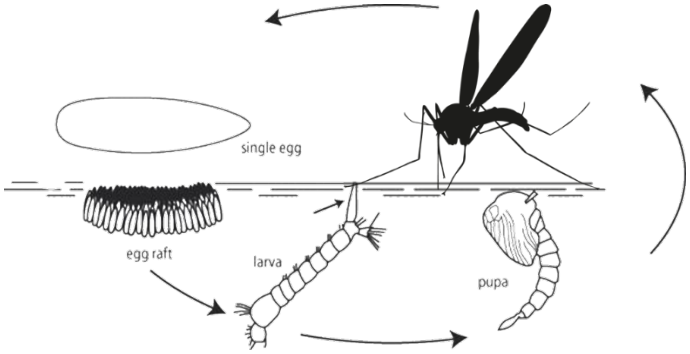
Planning and Development Act 2005
Aboriginal Heritage Act 1972

5. Mosquito biology and ecology

5.1 Mosquito Life Cycle

An understanding of the basic lifecycle of mosquitoes is important for effective control. Mosquitoes go through four development stages – egg, larva, pupa and adult.

Figure 1 – Life Cycle of the Mosquito



Source: Western Australia Department of Health. (n.d.).

Egg – laid either directly onto water surfaces or on moist surfaces, depending on the species. *Culex* and *Anopheles* species lay their eggs directly on the surface of a water body. *Aedes* species eggs can last long periods out of water when laid on moist surfaces and are often associated with temporary water bodies (Western Australia Department of Health, n.d.).

Larvae – hatch from the egg and live in aquatic environments. Larvae have four developmental stages referred to as instars. Late IV instars do not feed. Therefore, the timing of larvicide products targeting specific instars must be considered (Western Australia Department of Health, n.d.).

Pupa – are mobile in water but do not feed, as this stage is not affected by larvicides (Western Australia Department of Health, n.d.).

Adult – emerges from the pupa. Only the females disperse and seek out a blood meal, and the males usually stay close to the breeding site and do not bite. The average lifespan for an adult female mosquito is roughly two to three weeks (Western Australia Department of Health, n.d.).

This whole cycle from hatching egg to flying adult can take as little as 5-7 days in summer. During colder months, the life cycle may take several weeks. The preferred control method the State Government identifies is to act on larvae before they emerge into adults using larvicides (Western Australia Department of Health, n.d.).

5.2 Mosquito Species in the Region

There are approximately 100 species of mosquitoes in WA, and many of them can be serious pests. In addition to being a nuisance, mosquitoes can also pass on viruses when they bite (Western Australia Department of Health, n.d.). The main viruses transmitted by mosquitoes in WA are:

Ross River Virus (RRV) - This is the most common virus transmitted by mosquitoes in WA. Symptoms of RRV disease include joint pain and swelling, sore muscles, rash, fever and fatigue. Symptoms may persist for several weeks to months.

Barmah Forest Virus (BFV) – BFV disease has symptoms similar to RRV disease but is not as common.

Murray Valley Encephalitis Virus (MVE) – MVE is a rare but potentially fatal disease that occurs mainly in the northern two-thirds of WA. Symptoms include fever, drowsiness, confusion, headaches, stiff neck, nausea and vomiting, muscle tremors and dizziness. In severe cases, brain damage, paralysis or death may result.

West Nile Virus (Kunjin subtype) (WNVKUN) – This was previously known as Kunjin virus or KUNV. While the symptoms of this rare but serious disease can be similar to MVE, the illness is generally milder and not life-threatening.

There are no specific cures or registered vaccines for any of these diseases. Therefore, managing mosquitoes and human/mosquito interaction, via an integrated mosquito management program, is the only way to reduce the risk of mosquito-borne disease transmission.

Japanese Encephalitis Virus (JEV) – It is found across much of Asia and can cause Japanese encephalitis (JE) in humans and animals, including pigs and horses. The transmission cycle involves mosquito vectors and vertebrate hosts, with water birds and pigs being key amplifying hosts, while humans and other animals like horses are incidental hosts. While JEV was previously detected only in parts of Australia, such as the Torres Strait, far north Queensland, and the Tiwi Islands, it was first identified in southeast Australia in March 2022, affecting jurisdictions like New South Wales, Victoria, Queensland, and South Australia, particularly in piggeries.

Since December 2022, more than 45 confirmed or probable human cases of JE have been reported, though no cases were reported in 2023. In Western Australia, antibodies to JEV were detected in sentinel chickens and feral pigs in the Kimberley and Pilbara regions during 2023, signalling a potential public health risk, especially in the Kimberley. The Department of Health coordinates a national response with various agencies to address the threat.

Mosquitoes require an aquatic environment to breed; rainfall and the height and frequency of tidal inundation will heavily impact mosquito populations. Breeding habitat differs for each mosquito species. Table 1 below summarises the common mosquito species trapped throughout the concentrated surveillance areas of Molloy Island and Augusta.

Species	RRV/BFV vector	Pest species	Breeding habitat	Prevalent known locations
Aedes camptorhynchus	Yes	Yes	Coastal salt marshes and brackish swamps	Molloy Island, Augusta, West Bay, Flinders Bay
Aedes notoscriptus	Yes	Yes	Water holding containers in urban environments	Molloy Island, Augusta, Flinders Bay
Aedes ratcliffei	Unknown	No	Coastal regions Freshwater ground pools. Only one generation each year, around August to October	Molloy Island, Flinders Bay
Aedes alboannulatus	No	Yes	Bushland ground pools and creek line rockpools	Augusta

Table 1: Prevalent mosquito species throughout the Shire of Augusta Margaret River, according to Summers Consulting, dated 2021.

Adult mosquito monitoring has identified that Aedes camptorhyncus is the primary species of concern. This is due to its widespread and high abundance in the monitored sites and being a known virus vector. Aedes notoscriptus, although less common and not as widespread, is also a known virus vector.

Other species identified, however, not known to be disease vectors or biters, are Aedes ratcliffei and Aedes alboannulatus, which are prevalent but not in high numbers.

6. Sociodemographic, territorial, and environmental characteristics of the Shire of Augusta Margaret River

6.1 Sociodemographic

The demographic and socio-economic characteristics of the population are crucial in determining vulnerability to mosquito-borne diseases. This section presents the sociodemographic profile for the 2021 Census year (Australian Bureau of Statistics, 2021). With a total population of 16,791, a median age of 42 years, and an average household size of 2.5, the community is likely to have a significant proportion of adults who may be at risk of mosquito-borne diseases.

Additionally, 1.4% of the population identifies as Aboriginal and/or Torres Strait Islander, a group which can sometimes face higher health risks due to environmental and socio-economic factors.

The high percentage of the population (33.4%) with advanced qualifications may indicate a level of health literacy, which could influence the community's responsiveness to education on mosquito prevention.

Furthermore, 68.7% of the population born in Australia highlights the potential for well-established health communication strategies tailored to the local context (Australian Bureau of Statistics, 2021).

These sociodemographic factors, including age, income, education, and cultural background, are important health determinants that influence the community's susceptibility to and capacity to prevent mosquito-borne diseases.

People	16,791
Male	8,388 50.0%
Female	8,400 50.0%
Median age	42
Average number of people per household	2.5
Median weekly household income	$1,529
Aboriginal and/or Torres Strait Islander	231 1.4%
Advanced Diploma and above	33.4%
Australia - country of birth	68.7%

Table 2: Sociodemographic profile for the 2021 Census year

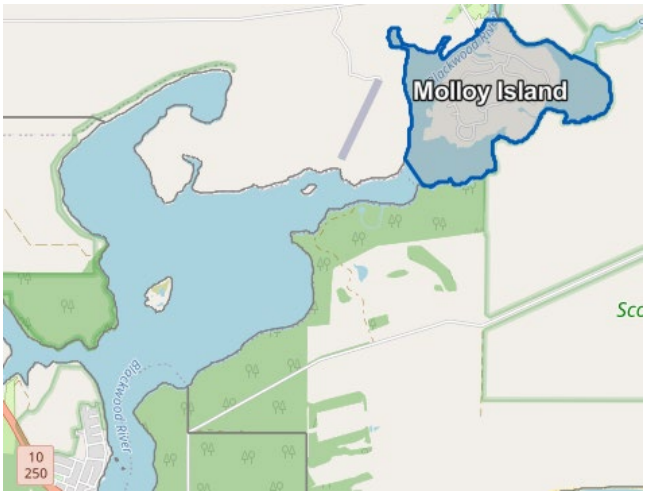
Source: Australian Bureau of Statistics. (2021). *QuickStats: Local Government Area (LGA) – Augusta Margaret River*. Australian Bureau of Statistics. Retrieved 28 January 2025, from https://abs.gov.au/census/find-census-data/quickstats/2021/LGA50280.

The wetland and salt marsh environments (explained in detail below) within the Shire host two of the most significant mosquito breeding sites: the Molloy Island and East Augusta.

Augusta has been a key townsite within the Shire since its formation. Augusta is now a popular holiday destination for swimming, kite-surfing, fishing, diving and boating, and scenic trips to discover wildlife such as whales, dolphins, seals and pelicans. The Blackwood River, Flinders Bay swimming area and Hamelin Bay are notable places and attractions.

Augusta's demographic characteristics are unique. Fifty-two per cent of the population is over the age of 60. It also has a lower occupancy rate than other settlements within the Shire, at approximately 52 per cent, due partly to a higher-than-average proportion of secondary dwellings.

Molloy Island, located on the Blackwood River in the South West region of Western Australia, is a small townsite with an estimated population of 163 as of 2021 (Australian Bureau of Statistics, 2021). The projected population for 2040 is 133 (Australian Bureau of Statistics, 2021).



6.2 Environmental characteristics and mosquito breeding sites

The wetland and salt marsh environments in the Shire are home to two of the most significant mosquito breeding sites: the Molloy Island and East Augusta.

Wetland and salt marsh environments are critical for mosquito breeding due to their unique ecological characteristics, which provide ideal conditions for mosquito larvae to thrive. These habitats typically feature stagnant or slow-moving water, essential for mosquito reproduction. Female mosquitoes lay their eggs on or near water surfaces, and the larvae require standing water to hatch and develop.

Water accumulation in wetlands and salt marshes, especially after rainfall or tidal changes, creates numerous breeding sites such as pools, puddles, and shallow ponds. The vegetation in these areas, including grasses, reeds, and shrubs, offers shelter for mosquito larvae, protecting them from predators and environmental fluctuations.

Additionally, wetlands and salt marshes are often nutrient-rich environments, supporting diverse organisms, including microorganisms that serve as food for mosquito larvae. These abundant resources create a favourable environment for mosquito populations to grow and multiply.

Given these factors, wetland and salt marsh habitats are key contributors to mosquito populations, making them significant areas for mosquito control and management efforts. Effective management strategies must consider preserving and modifying these environments to mitigate the risk of mosquito-borne diseases and reduce the impact of high mosquito numbers on local communities.

Between 2019 and 2021, key surveillance sites in the vicinity of Molloy Island were identified by the Summers Consulting: Molloy Caravan Park, Molloy Boat Ramp, and Molloy Ferry.

During the same period in Augusta, the identified surveillance sites were Turner Caravan Park, Westbay Caravan Park, Finders Bay Caravan Park, and Hardy Inlet.

The next pages present some images that demonstrate the Environmental characteristics of the Shire and the potential mosquito breeding sites.

Photo: Hardy Inlet, Mosquito Surveillance location from October 2018

Photo: Turner Caravan Park, Mosquito Surveillance location from 2016

Molloy Island

Photo: Molloy Island, Arial photo.

7. Epidemiological Characterisation and Nuisance

7.1 Ross River virus and Barmah Forest virus

These 167 cases were from the South West (SW) region, accounting for approximately 54% of the total RRV cases statewide. The long-term average annual incidence of RRV cases in WA is 737, with 123 cases on average in the SW region. In contrast, during the same period, there were 24 reported cases of BFV across the state, 10 of which were from the SW region. The long-term average for BFV cases in WA is 29 annually, while the SW region typically reports 6 cases yearly.

Between July 2023 and June 2024, the Shire of AMR reported 18 RRV cases and no BFV cases. This represents 17.3% of the total RRV cases reported in the SW region during the same period. Based on its share of the total regional population, the proportion of RRV cases expected from the Shire AMR is 16.4%. However, as noted above, the Shire contributed 17.3% of the cases. This indicates that the Shire of AMR experienced a slightly higher burden than expected of RRV cases. This suggests the need for further investigation into local transmission dynamics, environmental factors, or demographic influences contributing to the elevated incidence.

This contrast shows that RRV incidence in WA, particularly in the SW region, is significantly lower than the long-term average, and the Shire of AMR contributed a significant share of the SW regional RRV burden. On the other hand, BFV cases are lower than the long-term average for WA, with the SW region and Margaret River reporting few or no cases.

In January 2025, the Shire received one notification for the Ross River virus in Shire AMR.

Period of July 2023 to June 2024	Cases RRV - WA	Cases RRV - SW	Cases BFV - WA	Cases BFV - SW	Cases RRV - Shire of AMR	Cases BFV - Shire of AMR
Jul-23	12	3	1	0	0	0
Aug-23	9	5	1	0	0	0
Sep-23	15	8	4	2	1	0
Oct-23	26	21	1	0	0	0
Nov-23	40	34	4	3	0	0
Dec-23	41	32	0	0	0	0
Jan-24	24	17	1	0	2	0
Feb-24	47	16	2	1	5	0
Mar-24	31	15	4	3	7	0
Apr-24	31	9	4	1	2	0
May-24	23	5	1	0	0	0
Jun-24	9	2	1	0	1	0
Total	**308**	**167**	**24**	**10**	**18**	**0**
Expected: average yearly	737	123	29	6		

Source: DoH Quarterly Reports - Online
Source for Shire AMR: DoH Shire of Augusta-Margaret River Mosquito-borne Disease Data - report provided by DoH.
Shire of AMR = Shire of Augusta Margaret River / WA = Western Australia / SW = South Western region
RRV = Ross River virus / BFV = Barmah Forest virus

Table 3 Number of Notified Cases of Ross River Virus and Barmah Forest Virus in Western Australia, South Western Region, and Shire of AMR from July 2023 to June 2024

Graphic 1 below from the Department of Health shows the reported cases of RRV for 1 year between October 2023 and September 2024 for the Shire of AMR. The data confirms the trend expected in Australia, where mosquito-borne diseases typically increase during the warmer months, particularly from November to April. This period aligns with the warmer, wetter seasons (summer and early autumn), creating favourable conditions for mosquito breeding.

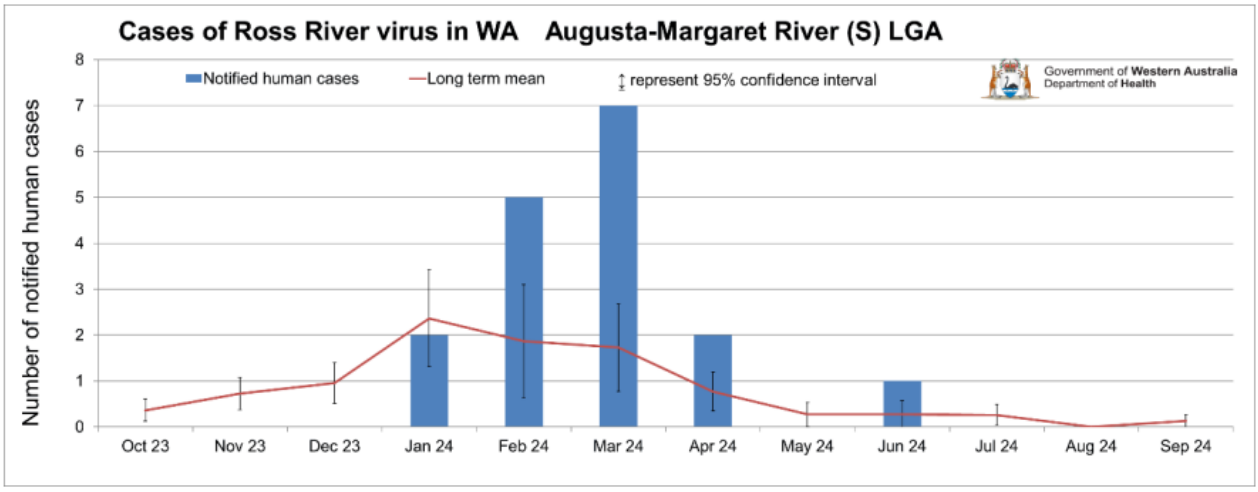
Additionally, the data show that RRV cases in the Shire of AMR were higher than the long-term average for 1 year.

Note that the red line in both graphics below represents the long-term average, which shows the typical number of reported RRV cases over a long period. This line serves as a reference point, assisting in comparing current data to see if the number of cases is higher or lower than expected for this time of year.

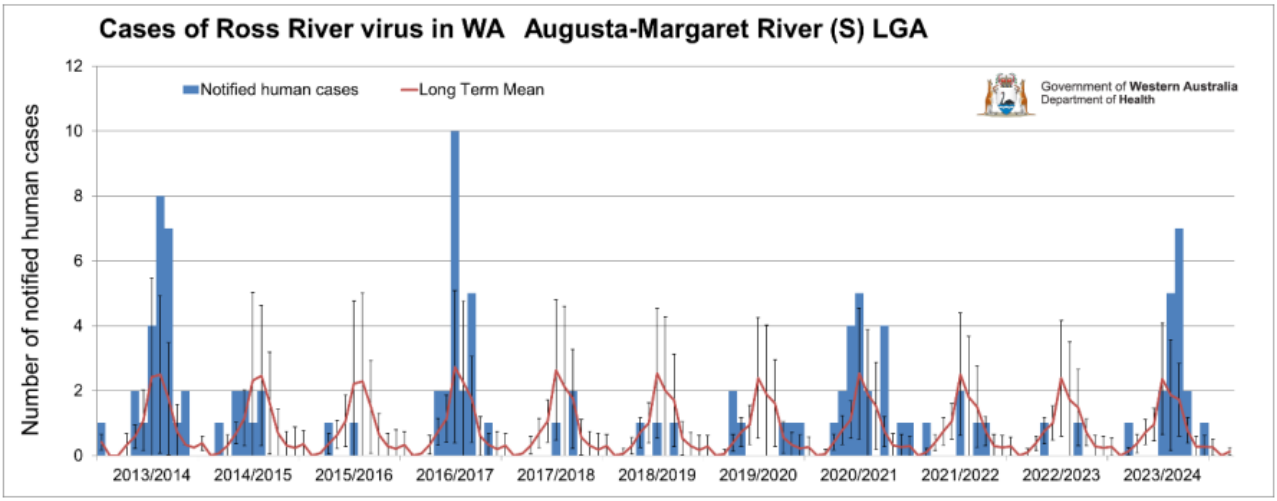
Graphic 2 shows the number of reported RRV cases from 2014 to 2024, a period of 10 years. It highlights that in 2013/2014, 2016/2017, 2020/2021, and 2023/2024, RRV cases in the Shire of AMR were higher than the long-term average for those years.

It highlights that RRV cases in the Shire of AMR were higher than the long-term average in:

- 2013/2014
- 2016/2017
- 2020/2021
- 2023/2024



Graphic 1: Number of Notified Cases of Ross River Virus in the Shire of AMR from October 2023 to September 2024



Graphic 2 Number of Notified Cases of Ross River Virus in the Shire of AMR from 2014 to 2024 – 10 year period

7.2 Murray Valley

There have been no reported cases of Murray Valley encephalitis virus (MVEV) in the Shire of AMR. However, it is important to note that during the 2022–2023 Australian summer, 26 human cases were documented, which were linked to an increase in mosquito populations and water birds following prolonged flooding events.

In Western Australia, MVEV was detected in mosquitoes and/or sentinel chickens in the Pilbara, Kimberley, and Midwest regions, leading to the first human case of MVE in 2024 being recorded in the Pilbara. An additional case was reported in the Midwest, and two more in the metropolitan Perth area, bringing the total to four human cases in Western Australia by June 2024. The resurgence of MVEV in humans in 2023 (5 cases) and 2024 (4 cases as of June 17, 2024) highlights the importance of these incidents and the ongoing threat that mosquito-borne flaviviruses pose to public health in the state (Srivastava, S. et al., 2021).

7.3 Nuisance

Between June 2024 and January 2025, the Shire of AMR received four formal complaints regarding mosquito nuisance. These complaints highlight growing concerns from residents and visitors about the increasing presence and discomfort caused by mosquitoes in the area. Given the Shire's proximity to natural mosquito habitats, this issue may be exacerbated by environmental factors such as seasonal changes, local water bodies, and urban expansion.

Addressing these concerns is crucial to improving public health and enhancing the overall quality of life for those living and visiting the Shire.

8. Baseline survey

The Shire lacks a recent baseline survey, with the last one conducted by Summers Consulting in 2021. The current MMP will establish a comprehensive framework for future mosquito monitoring and surveillance to ensure consistent control and monitoring. This framework will be outlined in detail in Section 10 of this document.

Baseline investigations are crucial when establishing a new program or assessing the risk of mosquito nuisance and mosquito-borne disease in new developments.

The data obtained will inform initial control strategies and compare future surveys against those assessing the impact of management activities.

9. Mosquito management strategies

Mosquito management strategies will vary depending on the situation, nature and extent of the mosquito problem, environmental constraints and available resources (Western Australia Department of Health, n.d.).

Key strategies include:

- physical (e.g. source reduction by filling, draining or removing breeding sites)
- biological (e.g. introduction of aquatic predators to reduce mosquito larvae)
- chemical (e.g. application of insecticides, including adulticides or larvicides)
- cultural (e.g. land use planning considerations, promoting community awareness and encouraging the general public to adopt practices to avoid mosquito bites).

The Shire participates in the Agricultural Show annually as part of its cultural management strategies. The stall at the event is designed to raise community awareness and encourage community engagement.

Mosquito management strategies will be reviewed and potentially expanded following the completion of a baseline survey. This survey will assess the current mosquito population, identify problem areas, and gather data on the specific challenges faced by the community. Once this information is collected, suitable management strategies will be developed and tailored to the area's unique needs. These strategies may include targeted control measures, public education, and ongoing monitoring to reduce mosquito populations and mitigate the associated health risks.

10. Ongoing monitoring and surveillance

This section of the MMP outlines the strategies and procedures for continuous mosquito monitoring and surveillance throughout the mosquito season, ensuring that effective control measures are implemented at the right time. The primary objectives of ongoing monitoring are to track mosquito populations and breeding sites, assess key environmental conditions, and inform the timely implementation of control measures based on real-time data.

Monitoring Period

Monitoring begins in September and continues until late March, depending on winter rainfall. Mosquito populations fluctuate throughout the season, often spiking following summer rainfall events. Environmental conditions, nutrient availability, and changes in the abundance of natural predators can influence these fluctuations. It is essential to note that some environmental conditions are conducive to the increased abundance of specific mosquito species.

Adult Mosquito Trapping

Aims to monitor adult mosquito populations and assess species distribution.

- Frequency: Fortnightly at historically established sites.
- Timing: Traps are set late in the afternoon and retrieved the following morning, with a trapping duration of 14 to 16 hours.
- Localised Complaints: When complaints are received from residents, traps are deployed either at the property in question or at a nearby protected area.
- Environmental Considerations: Before setting traps, key environmental factors such as wind speed, wind direction, and predicted rainfall will be carefully considered.
- Data Collection and Analysis:
    - Trapped mosquitoes will be identified to species and counted.
    - Data will be recorded in a central spreadsheet for further analysis.
    - The data will be used to generate graphical representations that will help monitor trends and inform management decisions.

Larval Monitoring

Aims to assess larval populations and identify species before control measures are applied. The sites will be monitored from September and will continue until late March. Surveys will occur following rainfall events during spring/summer.

- Pre-Control Monitoring: Larval surveys are conducted prior to any physical, biological, or chemical control measures. This ensures that control actions are based on accurate data and are applied effectively.
- Key Survey Locations: Stormwater infrastructure and privately-owned properties are important areas for larval surveys, as they can serve as mosquito breeding sites.
- Identification Methods:
    - The survey involves taking a water sample with a larval dipper to gather information on both the number of larvae per m2 and what stage the larvae have reached in their life cycle.
    - Larvae are collected onsite and identified using a microscope for species identification.
    - Alternatively, pupal samples may be reared in a collection container, with emergent adults identified to determine species.

The findings of these surveys will determine if there is a need for the application of larvicides to minimise mosquito larvae numbers.

Timing and Effectiveness of Control Measures

Ongoing monitoring is critical to ensure that chemical control measures are applied at the correct time to maximise their effectiveness. Surveillance data also helps evaluate the success of the control program, ensuring that adjustments are made as needed to address any changes in mosquito populations or environmental conditions.

By combining adult and larval monitoring techniques with real-time environmental data, this plan ensures that mosquito management is proactive, targeted, and responsive to emerging mosquito activity.

11. Stakeholders

Internal Stakeholders

The Environmental Health Department is responsible for overseeing this document; however, the successful implementation of its strategies relies on the active involvement of all Shire departments, especially Planning and Building and Holidays Park. Achieving the health goals outlined in this plan requires a collaborative, interdepartmental approach.

External Stakeholders

- Department of Health
- Summers Consulting
- Residents of the Shire

12. Record Keeping

Monitoring and surveillance data will be systematically recorded in a central spreadsheet, with annual reports generated to summarize findings and assess trends.

13. Budget and Resourcing

The current health budget has sufficient allowance to cover the purchase of treatment products, traps, and related items under several cost codes. These include:

- HI17.19 (Consumables)
- HI58.09 (Minor Equipment)
- HI16.16 (Sample Testing Costs)

Should additional funding be required, a dedicated budget line could be established specifically for mosquito management expenses. Personal protective equipment (PPE) has already been acquired and is covered under the protective clothing budget.

If the mosquito management program proves effective, the Shire may consider applying for funding through the WA State Department of Health's Contiguous Local Authority Group (CLAG) program. Further details on CLAG funding can be found at: WA Health CLAG Program.

14. Training and Staff Development

The Department of Health conducts a mosquito management course every two years at the City of Mandurah. The Shire's environmental team ensures staff participate in this week-long training to ensure adequate knowledge and capability exists within the team.

15. Operational Procedures and Reference Material

In the first year of the Mosquito Management Plan (MMP), the operational manuals from the Department of Health will serve as a primary guide. The use of these manuals will be reviewed annually as part of the MMP's ongoing evaluation and update process.

16. Review

The MMP will be reviewed and amended on an annual basis for the first three years to allow for the incorporation of seasonal variation and to adjust management strategies as trends begin to emerge over time.

17. Reference

Australian Bureau of Statistics. (2021). *QuickStats: Local Government Area (LGA) – Augusta Margaret River*. Australian Bureau of Statistics. Retrieved 28 January 2025, from https://abs.gov.au/census/find-census-data/quickstats/2021/LGA50280

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