# Arboviral diseases and malaria in Australia, 2007/08: Annual report of the National Arbovirus and Malaria Advisory Committee

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## Abstract

The National Notifiable Diseases Surveillance System (NNDSS) received 8,671 notifications of diseases transmitted by mosquitoes in Australia for the season 1 July 2007 to 30 June 2008. This represented a 39% increase from the annual average of 6,259 notifications for the previous 5 years. The alphaviruses, Barmah Forest and Ross River, accounted for 7,760 (89%) of these notifications during the 2007/08 season and represents an increase when compared with the mean of the past 5 seasons. Detection of flavivirus seroconversions in sentinel chicken flocks across Australia provides an early warning of increased levels of Murray Valley encephalitis virus (MVEV) and Kunjin virus activity. Unusual MVEV activity in mosquitoes and sentinel chicken flocks was reported in south-east Australia during the 2007/08 season. Two cases of MVEV were reported, one each from New South Wales and Western Australia. There were 365 notifications of dengue virus infection that were acquired overseas compared with an average of 164 overseas-acquired dengue cases per annum reported to NNDSS over the 5 seasons from 2002/03 to 2006/07. There were no reports of locally-acquired malaria notified in Australia and 505 notified cases of overseas-acquired malaria during the season 2007/08. The exotic dengue vector *Aedes aegypti* was first detected on Groote Eylandt, Northern Territory in October 2006 and led to a 2-year *Ae. aegypti* eradication project. The successful eradication of *Ae. aegypti* from Groote Eylandt was officially announced in May 2008. The success of the program was due to the selection of appropriate chemicals that were successful in treating mosquito adults, larvae and egg infested receptacles. This annual report presents information on diseases transmitted by mosquitoes in Australia and notified to NNDSS. *Commun Dis Intell* 2009;33:155–169.

Keywords: arbovirus, Barmah Forest virus, chikungunya, dengue, disease surveillance, epidemiology, flavivirus, Japanese encephalitis, Kunjin, malaria, mosquito-borne disease, mosquitoes, Murray Valley encephalitis virus, Ross River virus, yellow fever

## Introduction

This report describes the surveillance of nationally notifiable mosquito-borne disease in Australia for the season 1 July 2007 to 30 June 2008. It includes those diseases caused by alphaviruses (Barmah Forest and Ross River), flaviviruses (dengue, Murray Valley encephalitis, Kunjin, Japanese encephalitis and yellow fever) and malaria. Human cases of arbovirus infection and malaria are monitored using the National Notifiable Diseases Surveillance System (NNDSS).

The Australian Government Department of Health and Ageing established the National Arbovirus Advisory Committee (NAAC) in 2001 as a technical advisory group. In March 2003 the NAAC became the National Arbovirus and Malaria Advisory Committee (NAMAC) when malaria was included in its terms of reference. The NAMAC monitors arbovirus and malaria surveillance, strategic arbovirus and malaria disease management, and vector control, and has a key role in making recommendations on the management of mosquito-borne diseases. Currently, NAMAC provides expert technical advice on arboviruses and malaria to the Australian Health Protection Committee through the Communicable Diseases Network of Australia. It also assists in the detection, management and control of real or potential outbreaks of arboviral and malarial disease. Members of the committee have expertise in disease surveillance, virology, vector control and quarantine, and represent agencies with a substantial interest in this area.

## Methods

All Australian states and territories require doctors and/or pathology laboratories to notify cases of infectious diseases that are important to public health. State and territory health departments transfer these notifications regularly to NNDSS. The primary responsibility for public health action resulting from a notification resides with state and territory health departments. This report presents data extracted from NNDSS in November 2008 and analysed by date of diagnosis. The dataset represents a 'snap shot', and numbers in this report may vary slightly from those reported in other

NNDSS sources. Detailed notes on the interpretation of NNDSS and case definitions are available in the 2006 NNDSS annual report.[1] Case definitions are also available from http://www.health.gov.au/casedefinitions. The report includes information on the following diseases transmitted by mosquitoes:

- alphaviruses (Barmah Forest, Ross River, and chikungunya);
- flaviviruses (dengue, Japanese encephalitis, Kunjin, Murray Valley encephalitis, yellow fever and flavivirus not elsewhere classified; and
- malaria.

To compare notifications in 2007/08 to historical totals, crude numbers and rates of notification were compared either to the mean of the previous 5 years or to data from the previous year. The Australian Bureau of Statistics (ABS) estimated resident populations for Australia and each state or territory at June 2007 was used to calculate rates of notification.

Additional information was available from a survey conducted with some state and territory public health surveillance managers. The survey sought to determine the place of acquisition for overseas-acquired cases of dengue virus infections.

Maps were produced based on residential postcode and notifications were summed for their respective area (Statistical Division or NT Statistical Sub-Division). Rates were calculated using ABS estimated populations for Australia as at June 2007. Total notified cases per area and ranges for the disease rate are represented on each map. Detailed notes on the production of maps in this report are available from the 2007 NNDSS annual report.

## Results

During the 2007/08 season, there were 8,671 notifications of diseases transmitted by mosquitoes. This represented a 39% increase from the average of 6,259 notifications for the previous 5 years. A summary of the number and rates of these mosquito-borne diseases is shown in Table 1. There were no reported cases of Japanese encephalitis or yellow fever during the season.

### Alphaviruses

Alphaviruses are single-stranded RNA viruses, members of which can cause disease epidemics characterised by fever, rash and polyarthritis. There are a variety of mosquito vectors for Barmah Forest virus (BFV) and Ross River virus (RRV), which breed and transmit viruses in diverse environments (freshwater habitats, coastal regions, salt marshes, floodwaters, established wetlands and urban areas).[2]

During the 2007/08 season, there were 7,760 notifications of alphaviruses (BFV and RRV) of which RRV infections accounted for 74% (n = 5,747).

#### *Barmah Forest virus infections*

There were 2,013 notifications of BFV infections notified to NNDSS during the 2007/08 season. Fifty-eight per cent of BFV notifications were reported from Queensland (n = 1,160) and 27% from New South Wales (n = 550). The annual notification rate for the 2007/08 season (Table 1) was 9.6 cases per 100,000 population, which was a 34% increase over the mean rate for the previous 5 years (7.2 per 100,000 population). The highest age specific rate for males was 21 per 100,000 population; reported in the 55–59 year age group and the highest rate for females was 17 per 100,000 population; reported in the 45–49 year age group. A similar number of males and females with BFV were notified to NNDSS (M = 1,031:F = 981).

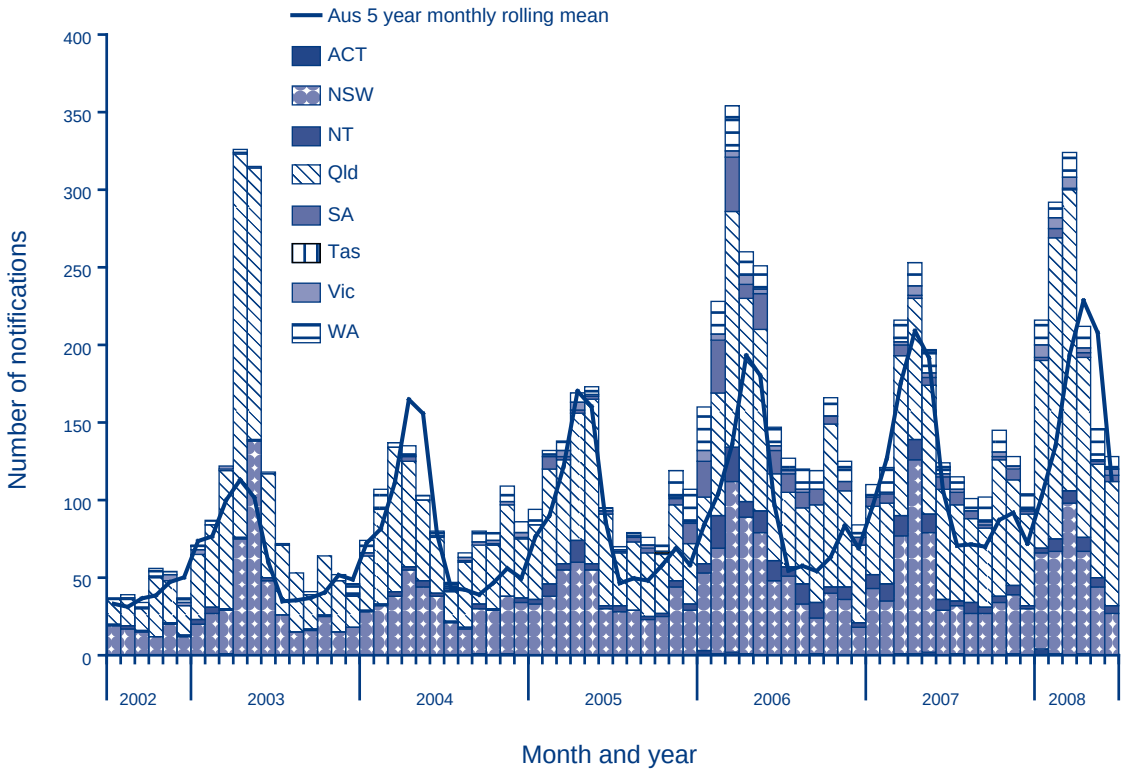
Figure 1 shows that as in previous years, there was a marked seasonal trend with the highest number of notifications being diagnosed in February (292) and March (324). The number of notifications per month exceeded the 5-year rolling mean from July 2007 to March 2008.

The highest rates of BFV notifications were reported by the Northern Territory (30 cases per 100,000 population), and Queensland (18.8 cases per 100,000 population). Cases were reported in all jurisdictions except for Tasmania. All jurisdictions apart from South Australia and Tasmania reported an increase in notifications when compared with the previous 5-year period. Queensland reported 1,160 notifications compared with a 5-year average of 732 cases. The Australian Capital Territory reported 8 notifications compared with a 5-year average of 3 cases. Notification rates for BFV by geographic location are shown in Map 1. These locations represent the place of residence of a notified case and not necessarily the place of acquisition of infection. The highest regional BFV notification rate was reported in the Central West Statistical division of Queensland (70 cases per 100,000 population). Six of the top 10 rates of BFV notification by region in Australia occurred in Queensland in the 2007/08 season.

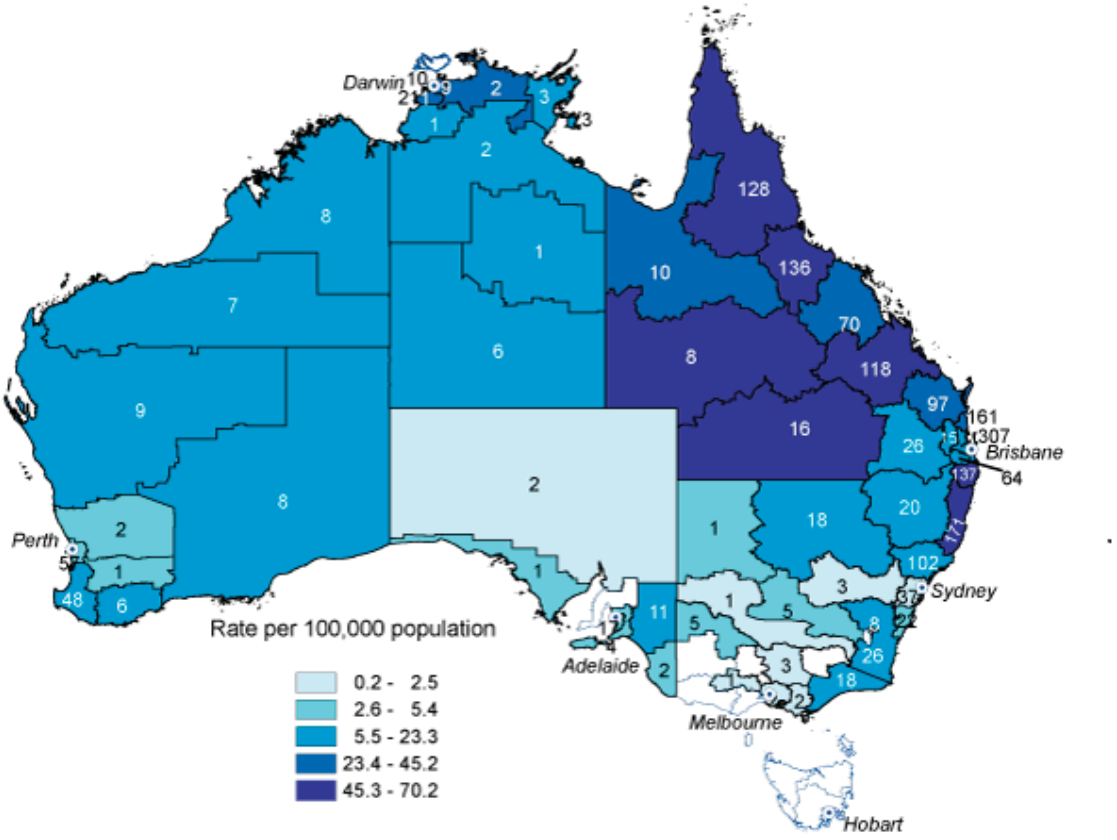
#### *Ross River virus infections*

There were 5,747 cases of RRV infection notified during the season 2007/08 (Table 1). The annual notification rate for the 2007/08 season was 27.3 cases per 100,000 population, which was a 47% increase over the mean rate of the previous 5 years (18.6 per 100,000 population). Fifty-one per cent of RRV notifications were reported from Queensland (n = 2,906)

Figure 1: Number of notified cases of Barmah Forest virus infection, Australia, 1 July 2002 to 30 June 2008, by date of diagnosis and state or territory




Map 1: Number of notified cases and rate of Barmah Forest virus infection, Australia, 1 July 2007 to 30 June 2008, by Statistical Division



## Table 1: Number of notified cases, rate and 5-year mean rate per 100,000 population of mosquito-borne diseases, Australia, 2002/03 to 2007/08, by date of diagnosis, disease and state or territory

| Disease | | State or territory | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ACT | NSW | NT | Qld | SA | Tas | Vic | WA | Aust |
| **Alphaviruses** | | | | | | | | | | |
| Barmah Forest virus infection | Notified cases 2007/08 | 8 | 550 | 65 | 1,160 | 44 | 0 | 40 | 146 | 2,013 |
| | Rate, 07/08 | 2.4 | 8.0 | 30.2 | 27.7 | 2.8 | 0.0 | 0.8 | 6.9 | 9.6 |
| | Mean rate, 2002/03–06/07 | 0.9 | 7.2 | 28.3 | 18.8 | 3.5 | 0.0 | 0.4 | 4.6 | 7.2 |
| Ross River virus infection | Notified cases 2007/08 | 20 | 1,220 | 255 | 2,906 | 196 | 77 | 237 | 836 | 5,747 |
| | Rate, 07/08 | 5.9 | 17.7 | 118.6 | 69.5 | 12.4 | 15.6 | 4.6 | 39.7 | 27.3 |
| | Mean rate, 2002/03–06/07 | 1.7 | 10.4 | 103.3 | 50.0 | 8.7 | 2.0 | 1.9 | 32.8 | 18.6 |
| **Flaviviruses** | | | | | | | | | | |
| Arbovirus infection (NEC*) | Notified cases 2007/08 | 0 | 0 | 0 | 13 | 0 | 0 | 3 | 0 | 16 |
| | Rate, 07/08 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 |
| | Mean rate, 2002/03–06/07 | 0.0 | 0.1 | 0.0 | 0.8 | 0.0 | 0.0 | 0.1 | 0.0 | 0.2 |
| Dengue virus infection | Notified cases 2007/08 | 4 | 104 | 26 | 105 | 35 | 4 | 14 | 95 | 387 |
| | Rate, 07/08 | 1.2 | 1.5 | 12.1 | 2.5 | 2.2 | 0.8 | 0.3 | 4.5 | 1.8 |
| | Mean rate, 2002/03–06/07 | 1.5 | 0.8 | 8.6 | 6.7 | 0.5 | 0.1 | 0.2 | 0.9 | 1.8 |
| Japanese encephalitis virus infection | Notified cases 2007/08 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Rate, 07/08 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Mean rate, 2002/03–06/07 | 0.0 | 0.0 | 0.0 | 0.01 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Kunjin virus infection | Notified cases 2007/08 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| | Rate, 07/08 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.02 | 0.0 | 0.0 |
| | Mean rate, 2002/03–06/07 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Murray Valley encephalitis virus infection | Notified cases 2007/08 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| | Rate, 07/08 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Mean rate, 2002/03–06/07 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Other** | | | | | | | | | | |
| Malaria | Notified cases 2007/08 | 14 | 111 | 23 | 165 | 18 | 9 | 88 | 77 | 505 |
| | Rate, 07/08 | 4.1 | 1.6 | 10.7 | 3.9 | 1.1 | 1.8 | 1.7 | 3.7 | 2.4 |
| | Mean rate, 2002/03–06/07 | 4.3 | 1.9 | 21.6 | 6.3 | 1.9 | 4.5 | 1.8 | 3.5 | 3.2 |

The Table does not include 2 chikungunya virus infections reported to the National Notifiable Diseases Surveillance System during the 2007/08 season.

* Flavivirus (NEC) replaced arbovirus (NEC) from 1 January 2004. arbovirus (NEC) replaced flavivirus (NEC) from 2008.

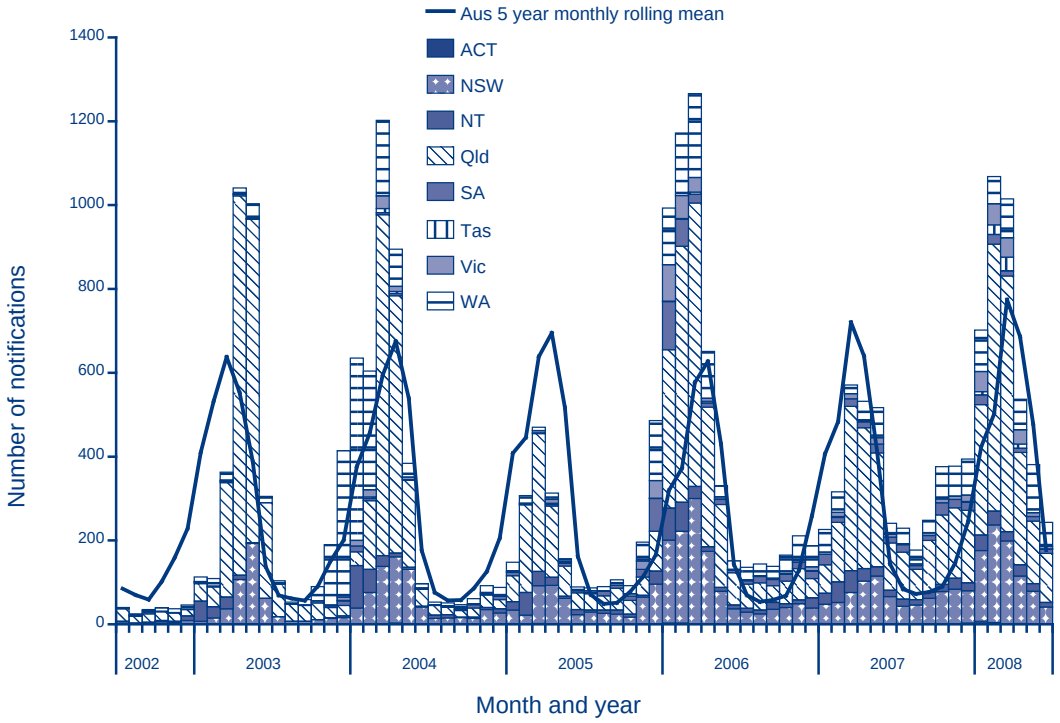
NEC Not elsewhere classified.

and 21% from New South Wales (n = 1,220). The highest age and sex specific rate was reported in the 40–44 year age group (males:49 per 100,000 population and females:48 per 100,000 population). A similar number of males and females with RRV were notified to NNDSS (M = 2,733:F = 3,014). Figure 2 shows that as in previous years, there was a marked seasonal trend with the highest number of notifications being diagnosed in February (n = 1,068) and March (n = 1,015). The number of notifications per month exceeded the 5-year rolling mean from July 2007 to March 2008.

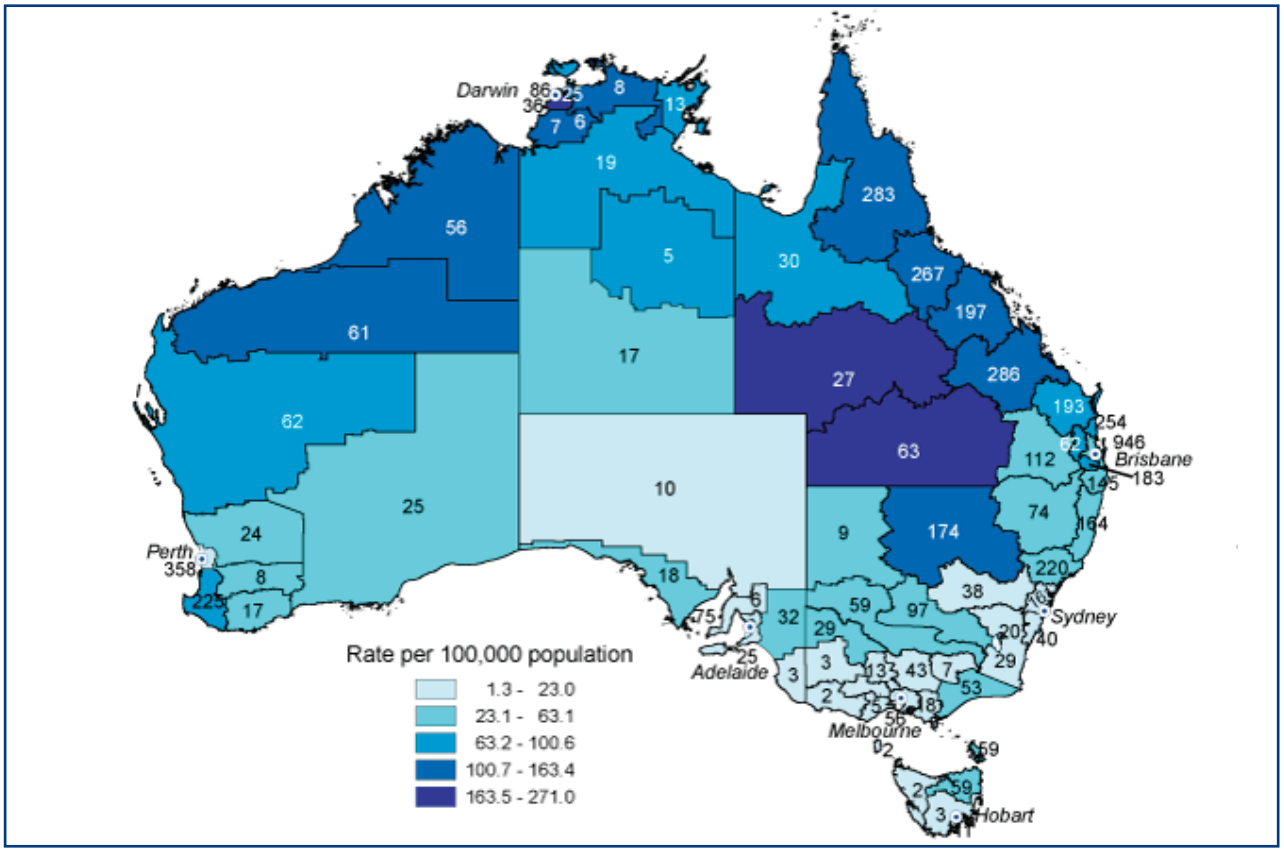
Notification rates ranged from 4.6 per 100,000 population in Victoria to 118 per 100,000 population in the Northern Territory. All jurisdictions reported an increase in notifications when compared with the previous 5-year period. Tasmania reported 77 notifications compared with a 5-year average of 10 cases. The Australian Capital Territory reported 20 notifications compared with a 5-year average of 6 cases.

Notification rates for RRV by the place of residence of a notified case are shown in Map 2. These locations do not represent the place of acquisition of infection. The highest regional RRV notification rates were reported in the Finniss area of the Northern Territory (271 cases per 100,000 population) and the South West region of Queensland (241 per 100,000

Figure 2: Number of notified cases of Ross River virus infection, Australia, 1 July 2002 to 30 June 2008, by date of diagnosis and state or territory




Map 2: Number of notified cases and rate of Ross River virus infection, Australia, 1 July 2007 to 30 June 2008, by Statistical Division



population). Four of the top 10 rates of RRV notification by region in Australia occurred in the Northern Territory during the 2007/08 season.

*Chikungunya virus infection*

Chikungunya virus is a member of the alphavirus genus in the family *Togaviridae*. It belongs to the Semliki Forest virus complex. It is found epidemically in many parts of South East Asia and in Africa. Chikungunya causes illness characterised by an abrupt onset of fever, rash and severe joint pain (chikungunya is Bantu of the Makonde people of south-east Tanzania for 'that which bends up', reflecting the bent over appearance of those with severe joint pain). The acute disease lasts one to 10 days, but convalescence may include prolonged joint swelling and pain lasting months. It has clinical similarities to dengue, including occasional cases with haemorrhagic manifestations.[3]

In Australia, the known competent vectors for chikungunya virus include *Ae. aegypti*, which occurs in northern Queensland, and *Ae. albopictus*, which is found on Cocos, Christmas and the Torres Strait Islands. Other Australian mosquitoes are possible vectors, but there are no data on the competence of these at present.

There have been confirmed cases of imported chikungunya virus infection into Australia from viraemic travellers during the recent epidemic in the Indian Ocean. Outbreaks in near neighbouring countries such as Indonesia and Papua New Guinea could potentially increase the numbers of viraemic travellers returning to Australia and hence introduce the disease. Northern Australia has a suitable climate and environmental parameters for its introduction. Chikungunya virus infection is a notifiable disease in all jurisdictions other than Queensland and Tasmania. There were 2 cases of overseas-acquired chikungunya infection reported to NNDSS during the 2007/08 season.

**Flaviviruses**

There were 406 notifications of flavivirus infection during 2007/08 of which dengue virus (DENV) infections accounted for 95% (n = 387). Arbovirus infections not elsewhere classified (NEC), accounted for 16 notifications and included 5 cases of Kokobera. The remaining flavivirus notifications included 2 cases of Murray Valley encephalitis (MVEV) and a single case of Kunjin (KUNV) (Table 1).

*Sentinel flavivirus surveillance programs*

The sentinel chicken program is a program involving Western Australia, New South Wales, Victoria and the Northern Territory that is designed to detect flavivirus activity including the endemic arboviruses MVEV and KUNV, as well as exotic arboviruses such as Japanese encephalitis. Sentinel chicken flocks provide an early warning of increased flavivirus activity in 4 Australian states.[4] The location of sentinel chicken sites during the season is shown in Map 3.

Northern Territory

The current Northern Territory sentinel chicken program commenced in January 1992 and replaced an earlier program run by the Australian Quarantine and Inspection Service (AQIS). Sentinel chicken flocks in the Northern Territory are maintained, bled and analysed for flavivirus antibodies in a combined program between the Northern Territory Department of Health and Families, the Northern Territory Department of Primary Industry, Fisheries and Mines (DPIFM), and volunteers.

Sentinel chicken flocks are presently located at Leanyer, Howard Springs, Coastal Plains Research Station, Katherine, Nhulunbuy, Tennant Creek, Jabiru, Alice Springs (2), Nathan River, Robinson River and Alyangula (Map 3). DPIFM officers or volunteers usually bleed flocks once a month and the samples are tested for MVEV and KUNV. When chickens from a flock show new antibodies to MVEV during a prime risk period, a media warning is issued for the general area for the risk period. These warnings advise residents of the need to take added precautions to avoid mosquito bites.

Chickens are replaced at least annually and more frequently if birds die or a large proportion seroconvert. They are well positioned to detect flavivirus activity near the principal towns of the Northern Territory and hence provide a timely and accurate indication of risk to people in those towns.

During the 2007/08 season, MVEV activity was detected in the Adelaide River region in February and April, in Katherine in March and April, in Nathan River in February and March and in Robinson River in May (last bleed prior to MVE detection was in December 2007).

KUNV activity occurred in all regions except in East Arnhem and the Barkly region, with chickens seroconverting to KUNV between August 2007 and May 2008. It is notable that probable KUNV activity recorded in the Alice Springs flocks in February and April 2008 were the first since the last seroconversions in 2000/01. However, the titres for both seroconversions were low and could not be confirmed as KUNV with certainty. The lack of MVEV and the low KUNV activity in Alice Springs is thought to be

associated with the draining of the Ilparpa Swamp, as well as the relatively low summer rainfall in Alice Springs.

There were no cases of locally-acquired flavivirus infections notified in the Northern Territory during the 2007/08 season despite the activity reported above in sentinel chicken flocks.

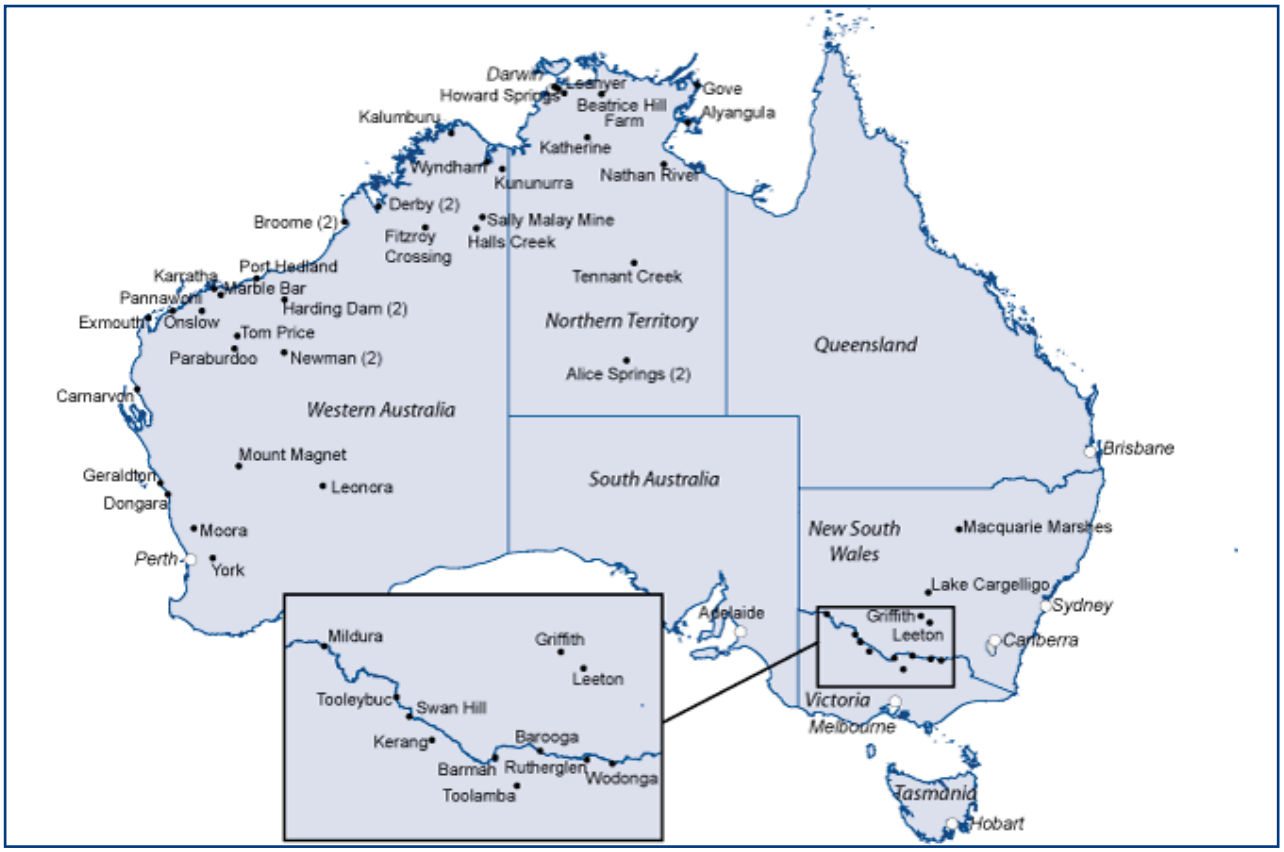
### Western Australia

The flavivirus sentinel chicken program in Western Australia is undertaken by the Arbovirus Surveillance and Research Laboratory (ASRL) at The University of Western Australia, on behalf of the Western Australia Department of Health. Many state and local government authorities and community volunteers also take part in the program. Twenty-nine sentinel chicken flocks are located at major towns and communities in the Kimberley, Pilbara, Gascoyne, Goldfields, Midwest and Central Coastal regions of Western Australia (Map 3). Blood samples from the chickens are collected by environmental health officers or trained volunteers at fortnightly intervals during the peak MVEV risk season (December to June). At other times of the year monthly blood samples are collected, unless prolonged flavivirus activity warrants continued fortnightly sampling. Samples are transported to the ASRL where they are tested for antibodies to flaviviruses using an epitope blocking ELISA.[5]

In general, rainfall was average to below average between July and November 2007. Seasonal wet season rainfall and the passage of several tropical cyclones through northern Western Australia resulted in above average to well above average rainfall in the Kimberley, Pilbara and Gascoyne regions between December 2007 and March 2008. The western Pilbara and Gascoyne regions also experienced above average rainfall in April. Elsewhere, generally average to below average rainfall was recorded between April and June 2008.

A total of 3,499 serum samples from the 29 Western Australia sentinel chicken flocks were tested for antibodies to flaviviruses during 2007/08.[6] Seroconversions were detected in 48 (1.4%) of the samples. Twenty-three seroconversions detected between July and September 2007 were associated with prolonged flavivirus activity from the previous (2006/07) wet season. KUNV and MVEV were responsible for seven and eight of the seroconversions, respectively. MVEV was more active in the Kimberley region, whereas KUNV was more prevalent in the Pilbara region.

## Map 3: Sentinel chicken testing sites, Australia, 2007/08



Overall, the level of MVEV activity during 2007/08 was lower than the previous year, however the level of MVEV activity in the Pilbara region was higher between January and June 2008 than the corresponding period in the previous year. KUNV activity was lower than the previous year in the Kimberley and Pilbara regions. The first activity associated with the 2007/08 wet season occurred in February 2008 when MVEV was detected at Kununurra in the north-east Kimberley region. MVEV activity was subsequently detected at Wyndham, Fitzroy Crossing, Derby and Broome, and the low-level activity continued through to June. KUNV was detected at Kununurra and Broome in May 2008.

In total there were 17 seroconversions to MVEV and 2 seroconversions to KUNV in the Kimberley region between January and June 2008. In the Pilbara region, 3 MVEV seroconversions were detected in the Pannawonica sentinel chicken flock in March 2008, and 2 MVEV infections were detected in the Ophthalmia chickens (near Newman) in April. No KUNV activity was detected in the Pilbara sentinel chickens between January and June 2008, and no flavivirus activity was detected south of Newman during 2007/08. This is the 2nd consecutive season of very low MVEV activity and the 4th year since there was a moderately high number of seroconversions to KUNV in Western Australia, in 2003/04.[7] A number of unidentified flavivirus infections were detected at several locations in the Kimberley and Pilbara regions between July and September 2007. These were possibly due to activity of other flaviviruses that were isolated from mosquitoes collected in northern Western Australia in past seasons.

Media releases were issued by the Western Australia Department of Health on 19 March and 7 April 2008, following the initial detections of MVEV in the Kimberley and Pilbara regions, respectively. A 3rd media release was issued on 29 April 2008 following the death of a resident at Kununurra, in the north-east Kimberley region, after developing MVE. This is the 1st fatal case of MVE in Western Australia since a large outbreak of MVE in 2000.[8]

### New South Wales

A total of 1,601 samples were received from 7 sentinel chicken flocks in New South Wales over a 6-month period in 2007/08. There were 4 seroconversions to MVEV and four to KUNV.[9]

There was one human case of MVEV reported from the Macquarie Area Health Service in a 60 + year-old male who developed minor symptoms and made a full recovery. This was the 1st case of MVEV in New South Wales since 1974.[10] The onset date of symptoms was reported as 16 March 2008. The last reported case of KUNV from New South Wales was notified in May 2001.[9]

### Victoria

Approximately 3,200 samples were received from 10 sentinel chicken flocks in Victoria over a 4-month period in 2007/08. In March 2008, 2 sentinel chickens in Kerang and 5 chickens in Mildura seroconverted to MVEV. By the end of April another 5 chickens from Kerang, 16 chickens from Mildura and one from Barooga were positive for MVEV.[11] These were the 1st detections of the virus in sentinel chickens since the mid-1970s.

There were no human cases of MVEV reported from Victoria in 2007/08 and none recorded in NNDSS. One human case of KUNV was notified from Victoria in late 2007 in a male tourist who had arrived from Israel with a 5-day history of illness. Further investigations resulted in the reclassification of the diagnosis as West Nile Virus (WNV). This is the first report of a laboratory- confirmed West Nile Virus (New York 99) infection in Australia. Although KUNV is a sub-type of WNV, it does not occur in Israel. The case was almost certainly infected in Israel where WNV is endemic.[12]

#### *Japanese encephalitis virus infections*

The AQIS Northern Australia Quarantine Strategy continues to undertake limited surveillance for transmission of Japanese encephalitis virus (JEV) in the Torres Strait and mainland Australia. A sentinel pig herd at Injinoo airport near Bamaga in Cape York, Queensland has not shown any serological evidence of mainland transmission since early 2004.[13] These animals provide more reliable information than feral or backyard survey samples as they are considered naïve to flaviviruses and can be sampled repeatedly to demonstrate any change in titre.[14] Pigs sampled during a survey of antibodies to JEV in animals in the Torres Strait in 2008 also showed no serological exposure to JEV. AQIS continues to work closely with Queensland Health in relation to the risks of JEV in the region.[13] There were no cases of JEV notified to NNDSS in Australia during 2007/08.

#### *Dengue virus infection*

There were 387 cases of dengue virus infection notified during the season of 2007/08. The annual notification rate for the season was 1.8 per 100,000 population, which was similar to the mean rate of the previous 5 years (Table 1). In Australia, imported cases of dengue virus infection are reported each year with occasional local transmission. Local transmission is restricted to areas of northern Queensland

where the key mosquito vector, *Ae. aegypti*, is present. In early 2004, 2 deaths were reported in Australia due to dengue virus infection. These were the 1st deaths attributed to dengue in over 100 years.[15] Figure 3 shows the number of notifications reported by jurisdictions.

### Locally-acquired dengue virus infection

Dengue outbreaks in Australia in recent times have been due to importation of the virus by a viraemic tourist or returning resident from a dengue endemic area overseas. Dengue is spread from person to person via the mosquito vector *Aedes aegypti*. Cases of dengue acquired from overseas are of particular importance in north Queensland because of the presence of the *Ae. aegypti* mosquito species that can transmit dengue infection to humans. *Ae. aegypti* is a common mosquito species in north Queensland but dengue is not endemic. A female mosquito can only become infected with dengue after biting an infected human who is viraemic with dengue. It is important to rapidly diagnose the disease in returning residents and tourists to prevent local spread in Queensland.[16] Table 2 shows that 22 cases were locally acquired in north Queensland during the season 2007/08. The Mossman/Port Douglas dengue fever outbreak started in February 2008 and included 22 confirmed cases. The DENV serotype for this outbreak was Type 3 in 19 of the 22 cases.

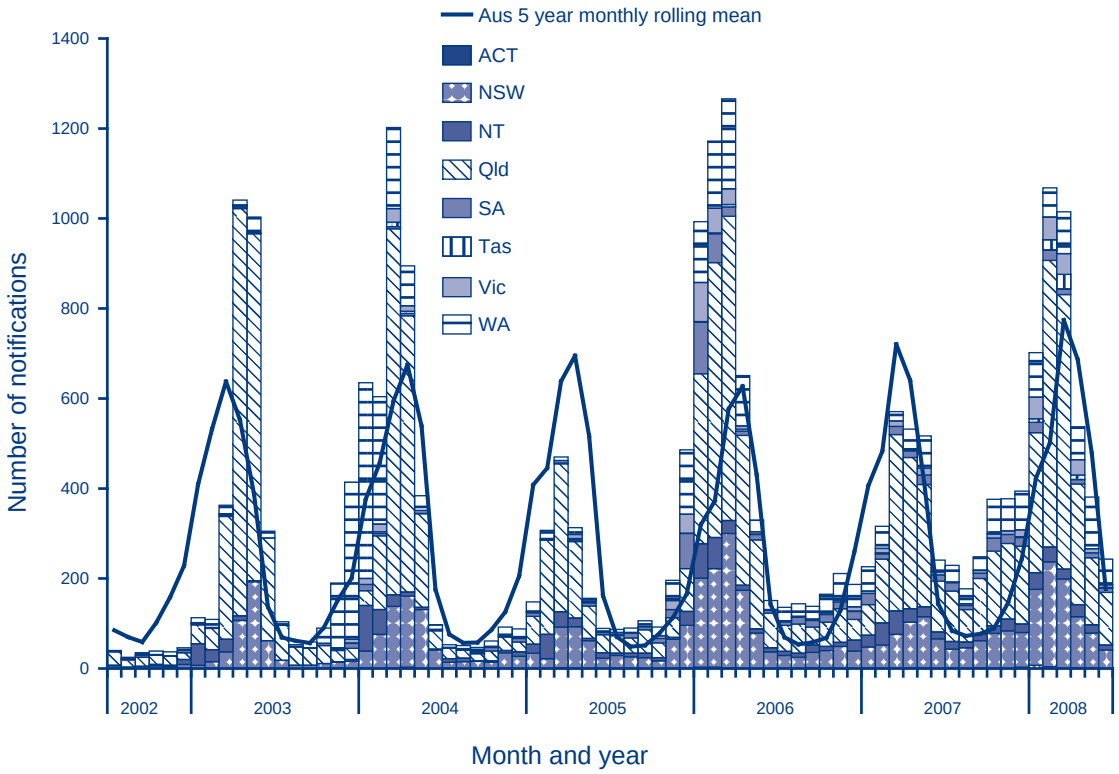
### *Overseas-acquired dengue virus infection*

During the 2007/08 season, there were 365 notifications of dengue virus infection acquired overseas compared with 203 notifications in the previous season (Table 2). On average, there were 164 overseas-acquired dengue cases per annum reported to NNDSS over the 5 seasons from 2002/03 to 2006/07.

Country of acquisition was available for 250 (68%) cases of overseas-acquired dengue reported to NNDSS (Table 3). Indonesia (including Bali) was reported as the place of acquisition for 104 (28%) cases and involved all 4 dengue serotypes. Cases identified travel to 25 other destinations, which reflect the worldwide distribution of dengue virus infection. Other countries most commonly recorded include Thailand (34), Tonga (18), India (12), Vietnam (11) and Papua New Guinea (9). The infecting DENV serotype was determined for 98 (27%) of the 365 overseas-acquired dengue cases. All 4 serotypes were reported including 35 cases of DENV serotype 1.

The Western Australian Department of Health investigated 70 cases notified between 1 January 2007 and 1 February 2008. Of these, travel to Indonesia was reported by 41 (59%) cases with 31 people confirming travel to Bali. The public health response included alerting the Western Australian public

Figure 3: Number of notified cases of dengue virus infection, local and overseas acquired, Australia, 1 July 2002 to 30 June 2008, by date of diagnosis and state or territory



## Table 2: Number of notified cases of dengue virus infection, Australia, 1 July 2002 to 30 June 2008, by date of diagnosis, place of acquisition and state or territory

| Place of acquisition | Season | State or territory | | | | | | | | Australia |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ACT | NSW | NT | Qld | SA | Tas | Vic | WA | |
| Locally acquired | 2002/03 | 0 | 0 | 0 | 472 | 0 | 0 | 0 | 0 | 472 |
| | 2003/04 | 0 | 0 | 0 | 418 | 0 | 0 | 0 | 0 | 418 |
| | 2004/05 | 0 | 0 | 0 | 72 | 0 | 0 | 0 | 2* | 74 |
| | 2005/06 | 0 | 0 | 0 | 42 | 0 | 0 | 0 | 0 | 42 |
| | 2006/07 | 0 | 0 | 0 | 46 | 0 | 0 | 0 | 0 | 46 |
| | 2007/08 | 0 | 0 | 0 | 22 | 0 | 0 | 0 | 0 | 22 |
| Total | | 0 | 0 | 0 | 1,072 | 0 | 0 | 0 | 2 | 1,074 |
| Overseas acquired | 2002/03 | 6 | 82 | 18 | 71 | 8 | 0 | 12 | 21 | 218 |
| | 2003/04 | 8 | 33 | 23 | 42 | 7 | 2 | 13 | 6 | 134 |
| | 2004/05 | 1 | 33 | 16 | 41 | 3 | 0 | 8 | 11 | 113 |
| | 2005/06 | 7 | 54 | 16 | 33 | 10 | 0 | 13 | 20 | 153 |
| | 2006/07 | 2 | 72 | 15 | 66 | 12 | 0 | 9 | 27 | 203 |
| | 2007/08 | 4 | 104 | 26 | 83 | 35 | 4 | 14 | 95 | 365 |
| Total | | 28 | 378 | 114 | 336 | 75 | 6 | 69 | 180 | 1,186 |

* Cases acquired their infection while visiting Queensland.

## Table 3: Overseas-acquired dengue notifications, Australia, 1 July 2007 to 30 June 2008, by date of diagnosis, serotype and reported country of acquisition

| Country of acquisition | Total | Untyped | Dengue serotype | | | | |
|---|---|---|---|---|---|---|---|
| | | | Type 1 | Type 2 | Type 2 & 3 | Type 3 | Type 4 |
| Country unknown | 115 | 102 | 5 | 4 | 0 | 2 | 2 |
| Indonesia | 104 | 65 | 6 | 7 | 0 | 8 | 18 |
| Thailand | 34 | 24 | 6 | 2 | 0 | 2 | 0 |
| Tonga | 18 | 16 | 1 | 1 | 0 | 0 | 0 |
| India | 12 | 6 | 1 | 0 | 0 | 5 | 0 |
| Vietnam | 11 | 7 | 3 | 0 | 0 | 1 | 0 |
| Papua New Guinea | 9 | 4 | 4 | 0 | 0 | 0 | 1 |
| Malaysia | 9 | 5 | 3 | 1 | 0 | 0 | 0 |
| Philippines | 8 | 7 | 0 | 0 | 0 | 1 | 0 |
| French Polynesia | 5 | 3 | 2 | 0 | 0 | 0 | 0 |
| Singapore | 5 | 2 | 1 | 0 | 1 | 0 | 1 |
| Sri Lanka | 5 | 4 | 0 | 1 | 0 | 0 | 0 |
| Laos | 4 | 3 | 1 | 0 | 0 | 0 | 0 |
| New Caledonia | 3 | 3 | 0 | 0 | 0 | 0 | 0 |
| Fiji | 3 | 3 | 0 | 0 | 0 | 0 | 0 |
| Cambodia | 3 | 2 | 1 | 0 | 0 | 0 | 0 |
| East Timor | 3 | 2 | 0 | 0 | 0 | 0 | 1 |
| Bangladesh | 3 | 2 | 0 | 1 | 0 | 0 | 0 |
| Solomon Islands | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| Samoa, American | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| North Africa | 2 | 0 | 1 | 1 | 0 | 0 | 0 |
| Kiribati | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Nauru | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Cook Islands | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| China | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| Brazil | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| Total | 365 | 267 | 35 | 18 | 1 | 19 | 25 |

via print and radio media, of the need for preventive measures in dengue endemic areas. Western Australian doctors (general practitioners, emergency departments, infectious disease physicians, and travel doctors) and laboratories were alerted via a communicable disease bulletin.[17]

### Malaria

Malaria is a serious acute febrile illness which can be transmitted from person to person through the bite of an infected mosquito. It is caused by a parasite called *Plasmodium* that includes 4 species – *vivax*, *falciparum*, *malariae* and *ovale*.[18] There were 505 cases of overseas-acquired malaria notified in Australia during the season 2007/08 and no reports of locally-acquired malaria. The annual notification rate for the 2007/08 season was 2.4 per 100,000 population, which was a decrease when compared with the mean rate of the previous 5 years of 3.2 per 100,000 population (Table 1).

Figure 4 shows that as in previous years, there was no seasonal trend. The highest number of notifications occurred in October (58) and February (54). The number of notifications per month exceeded the 5-year rolling mean in October and November 2007.

Notification rates ranged from 1.8 per 100,000 population in Victoria to 10.7 per 100,000 population in the Northern Territory (Figure 5). All jurisdictions reported a decrease in notifications when compared with the previous 5 years other than for Western Australia (3.6 to 3.7 per 100,000 population). Queensland reported 165 notifications compared with a 5 year average of 247 cases. The male to female ratio during 2007/08 was 1:0.5 (68%

Figure 5: Notification rates of malaria infections, 2007/08, compared with the mean of the past 5 financial years, by date of diagnosis and state or territory

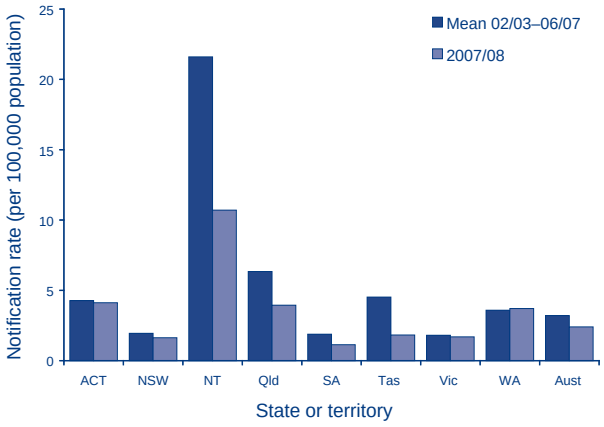
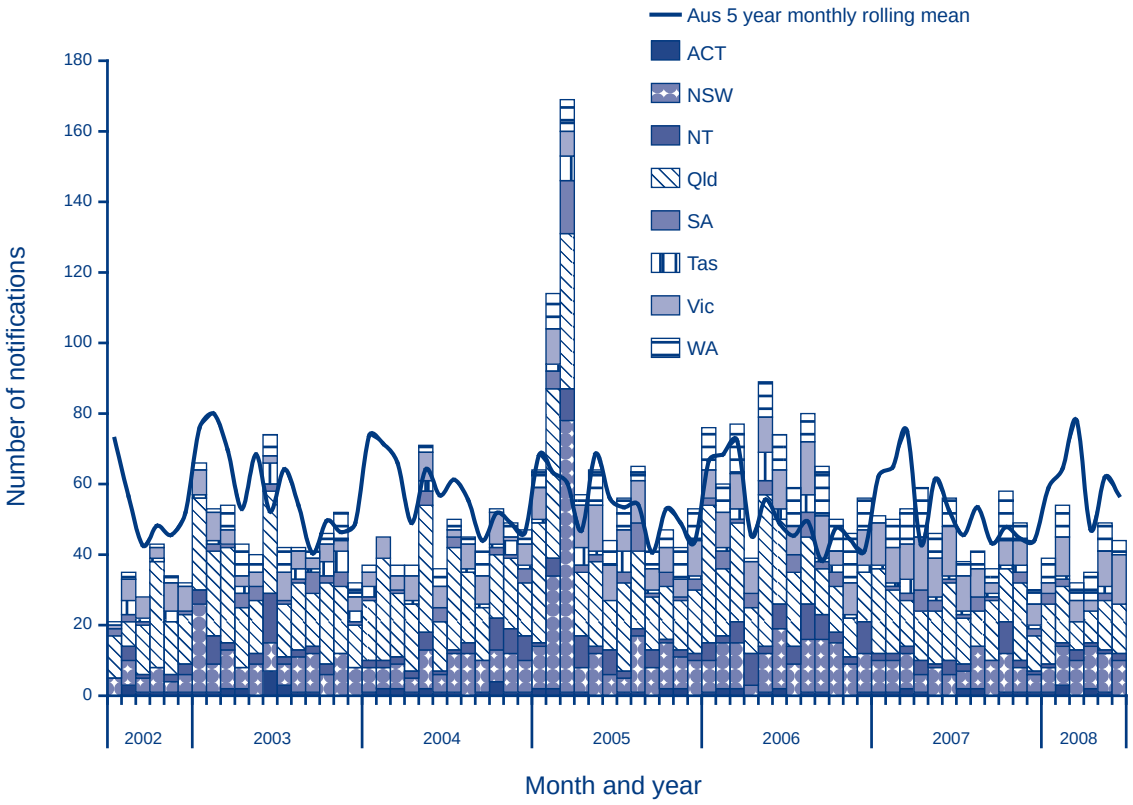



Figure 4: Number of notified cases of malaria infection, Australia, 1 July 2002 to 30 June 2008, by date of diagnosis and state or territory



of notifications were male, which was consistent with the past 5 years). The highest age specific rate for males was 6.4 per 100,000 population; reported in the 20–24 year age group and the highest rate for females was 3.6 per 100,000 population; reported the in 25–29 year age group.

The infecting *Plasmodium* species was reported for 98% of malaria notifications in 2007/08 (Table 4). Of these 505 notifications, *P. falciparum* (46%) and *P. vivax* (48%) were the predominant species.

The country of acquisition was available for 112 (22%) cases of malaria reported to NNDSS (Table 5). Papua New Guinea was reported as the country of acquisition for 80 (28%) cases and included both *falciparum* and *vivax* species. Cases identified travel to 14 other destinations. They included the Solomon Islands (8), Tanzania (5), and Indonesia (4).

### Exotic Vector Eradication Program on Groote Eylandt

The exotic dengue vector *Ae. aegypti* was first detected on Groote Eylandt, Northern Territory on 20 October 2006. The Australian Government Department of Health and Ageing (DoHA) agreed in March 2007 to assist with funding for a 2 year *Ae. aegypti* eradication project.

In 2007/08, the *Ae. aegypti* survey and control operations on Groote Eylandt continued to the end of field operations in March 2008. The activities included: adult mosquito control by receptacle and harbourage site spraying, receptacle (breeding site) treatment and larval and adult mosquito surveys. *Ae. aegypti* is a domestic breeder and breeds in water filled receptacles such as tyres, pot plant drip trays, buckets, drums and tins around houses.[16,19] All potential breeding sites were sampled for larvae, which were identified by Northern Territory medical entomology staff.

Increased surveillance and control activities were similar to those used in a previous eradication program at Tennant Creek[20] with the exception that receptacles were primarily treated with alpha cypermethrin instead of bifenthrin. The Groote Eylandt Mining Company (GEMCO) assisted with the survey and control activities.

The last interception of *Ae. aegypti* was in the Alyangula residential area, Northern Territory on 4 June 2007. This was the single property found to have *Ae. aegypti* during the 4th round of survey and treatment. The following 3 rounds of survey and treatment and the Targeted Potential Breeding Site Survey this year, along with broad scale surveys and trapping over a wet season, indicated that the *Ae. aegypti* mosquito population had been eradicated.

## Discussion

This report summarises the surveillance of nationally notifiable mosquito-borne disease in Australia for the season 1 July 2007 to 30 June 2008. Of particular concern were overseas-acquired dengue infections and the unusual MVEV activity in surveillance programs in south-east Australia.

Australia experienced an increased number of overseas-acquired dengue virus infections during the season 1 July 2007 to 30 June 2008. Cases of dengue acquired from overseas are of particular importance in north Queensland because of the presence the *Ae. aegypti* mosquito species that can transmit dengue infection to humans.[21] Much of the rise in overseas-acquired dengue virus infections over the past few years can be attributed to disease activity in the Asia Pacific region. Other possible explanations include increased numbers of Australians travelling to dengue-affected areas or changes to diagnostic methods. Regardless, travellers require a doctors' advice prior to travel, outlining the risk of mosquito-borne disease and the required precautions. The World Health Organization has warned of a spreading threat of dengue outbreaks in the Asia Pacific region and urged for a more compre-

Table 4: Overseas-acquired malaria cases, Australia, 1 July 2007 to 30 June 2008, by date of diagnosis, Plasmodium species and state or territory

| *Plasmodium* species | Type (%) | State or territory | | | | | | | | Aust |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ACT | NSW | NT | Qld | SA | Tas | Vic | WA | |
| *Plasmodium falciparum* | 46 | 2 | 39 | 20 | 70 | 12 | 5 | 30 | 53 | 231 |
| *Plasmodium vivax* | 48 | 10 | 64 | 3 | 88 | 5 | 3 | 54 | 17 | 244 |
| Other *Plasmodium* species | 3 | 0 | 6 | 0 | 5 | 0 | 0 | 2 | 3 | 16 |
| Mixed *Plasmodium* species | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 4 |
| *Plasmodium* species unspecified | 2 | 2 | 2 | 0 | 2 | 1 | 0 | 0 | 3 | 10 |
| Total | | 14 | 111 | 23 | 165 | 18 | 9 | 88 | 77 | 505 |

Table 5: Overseas-acquired malaria cases, Australia, 1 July 2007 to 30 June 2008, by date of diagnosis, country of acquisition and Plasmodium species

| Country of acquisition | Total | *Plasmodium* species | | | | |
|---|---|---|---|---|---|---|
| | | Not specified | *Falciparum* | *Vivax* | Other *Plasmodium* species | Mixed *Plasmodium* species |
| Country unknown | 393 | 10 | 185 | 180 | 15 | 3 |
| Papua New Guinea | 80 | 0 | 29 | 50 | 1 | 0 |
| Solomon Islands | 8 | 0 | 0 | 8 | 0 | 0 |
| Tanzania | 5 | 0 | 5 | 0 | 0 | 0 |
| Indonesia | 4 | 0 | 2 | 2 | 0 | 0 |
| Kenya | 3 | 0 | 3 | 0 | 0 | 0 |
| Sudan | 2 | 0 | 2 | 0 | 0 | 0 |
| Sierra Leone | 2 | 0 | 1 | 0 | 0 | 1 |
| Vanuatu | 1 | 0 | 0 | 1 | 0 | 0 |
| East Timor | 1 | 0 | 0 | 1 | 0 | 0 |
| India | 1 | 0 | 0 | 1 | 0 | 0 |
| Congo | 1 | 0 | 1 | 0 | 0 | 0 |
| Nigeria | 1 | 0 | 1 | 0 | 0 | 0 |
| Burundi | 1 | 0 | 1 | 0 | 0 | 0 |
| Madagascar | 1 | 0 | 0 | 1 | 0 | 0 |
| Uganda | 1 | 0 | 1 | 0 | 0 | 0 |
| Total | 505 | 10 | 231 | 244 | 16 | 4 |

hensive approach to mosquito control and disease prevention. The control of dengue and its vectors are important to Australia's health security.[22]

The successful eradication of *Ae. aegypti* from Groote Eylandt was officially announced on 8 May 2008.[23] A number of factors contributed to the successful eradication. A monitoring program enabled early detection of the exotic mosquito incursion and allowed a very quick field response. Assistance from government staff and volunteers aided the initial field response. Rapid access to funding allowed a quick response for program activation, while waiting for approval of funds from DoHA. The success of the program was due to the selection of appropriate chemicals that were successful in treating mosquito adults, larvae and egg infested receptacles. The program incorporated a thorough and repeated larval search of every possible place, treatment of every possible water receptacle and a good evaluation of potential *Ae. aegypti* presence with the aid of ovitraps, carbon dioxide baited encephalitis vector surveillance traps and larval searching of high risk locations. The assistance given by GEMCO and other enterprises on Groote Eylandt and the residents of the various communities also contributed to the successful eradication of *Ae. aegypti*. Increased monitoring for *Ae. aegypti* at Alyangula residential and Alyangula port/industrial areas, and in other areas of the Northern Territory have been implemented and will continue.

Whilst MVEV activity is regularly reported in mosquitoes and sentinel chicken flocks in northern Western Australia and the Northern Territory, it is unusual for activity in mosquitoes and sentinel chicken flocks to occur in south-east Australia. During the season, seroconversions in sentinel chickens in Victoria and New South Wales first indicated the presence of MVEV in February 2008. MVEV was also detected in a chicken in South Australia in May and in horses in Victoria. A human case (fully recovered) of MVEV was also reported from Macquarie Marshes in New South Wales in March 2008. NAMAC considered the level of MVEV activity reported in 2007/08 and in particular its wide geographical distribution to be unusual. The virus detections in mosquito and animals in south-east Australia is also perplexing as the recent drought in south-east Australia caused lower than usual numbers of mosquitoes in the region. NAMAC members note that the reason for last year's MVEV activity is not known, which highlights the gap in knowledge about the epidemiology of MVEV in Australia. Given this recent MVEV activity, NAMAC is reviewing the current guidelines for responding to an outbreak of MVE. Issues in the guidelines currently being reviewed include the nature of MVEV disease, surveillance and detection of an outbreak, investigation of an outbreak source, actions for containment of an outbreak, and actions arising from the initial detection of an outbreak.

The limitations of surveillance data used in this report are referred to in detailed notes on the interpretation of NNDSS, which is available in the 2006 annual report.[1] A limitation of the data used in this report relates to the virological testing, which is required to distinguish alphavirus disease from other causes of arthritis. The alphavirus infections notified to NNDSS each season are based on laboratory definitive evidence only and assume a clinically compatible arthritic infection. A case may still be notified when clinical illness may not be consistent with the diagnosis of alphavirus infection. Furthermore, false positive reactions are an issue in the serological diagnosis of some arboviral infections and cross-reacting IgM can occur, particularly with flavivirus infections. Following some infections, particularly alphaviruses and flaviviruses, IgM antibodies can persist for long periods and should be interpreted as presumptive evidence of recent infection.[24] Human surveillance of alphavirus infection enables local authorities to implement public health action and manage local disease outbreaks, but does not necessarily provide a reliable indication of the true incidence of a disease.

Arboviral and malaria disease surveillance provides information that assists in the assessment of the effect of mosquito-borne disease in Australia. The monitoring of these diseases has many benefits, including identifying the source of infection and risk factors for illness. Ongoing efforts to strengthen the quality of these data will ensure better use by agencies to prevent and control illness.

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