Annual report

Arboviral diseases and malaria in Australia, 2011–12: Annual report of the National Arbovirus and Malaria Advisory Committee

Katrina E Knope, Stephen L Doggett, Nina Kurucz, Rebecca Feldman, Cheryl A Johansen, Jay Nicholson, Angus Sly, Michaela Hobby, Debra El Saadi, Mike Muller, Cassie C Jansen, Odwell M Muzari and the National Arbovirus and Malaria Advisory Committee

Abstract

The National Notifiable Diseases Surveillance System received notifications for 7,875 cases of disease transmitted by mosquitoes during the 2011–12 season (1 July 2011 to 30 June 2012). The alphaviruses Barmah Forest virus and Ross River virus accounted for 6,036 (77%) of these. There were 18 notifications of dengue virus infection acquired in Australia and 1,390 cases that were acquired overseas, while for 38 cases, the place of acquisition was unknown. Imported cases of dengue in Australia were most frequently acquired in Indonesia. There were 20 imported cases of chikungunya virus. There were no notifications of locally-acquired malaria in Australia during the 2011–12 season. There were 314 notifications of overseas-acquired malaria and 41 notifications where the place of acquisition was unknown. Sentinel chicken, mosquito surveillance, viral detection in mosquitoes and climate modelling are used to provide early warning of arboviral disease activity in Australia. In 2011–12, sentinel chicken programs for the detection of flavivirus activity were conducted in most states with the risk of arboviral transmission. Other surveillance activities to detect the presence of arboviruses in mosquitoes or mosquito saliva or for surveying mosquito abundance included honey-baited trap surveillance, surveys of household containers that may provide suitable habitat for the dengue vector, *Aedes aegypti*, and carbon dioxide baited traps. Surveillance for exotic mosquitoes at the border continues to be a vital part of preventing the spread of mosquito-borne diseases to new areas of Australia. *Commun Dis Intell* 2014;38(2):E122–E142.

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

Introduction

This report describes the epidemiology of mosquito-borne diseases of public health importance in Australia during the season 1 July 2011 to 30 June 2012. It includes notified cases of disease caused by the alphaviruses Barmah Forest virus (BFV), chikungunya virus (CHIKV) and Ross River virus (RRV); the flaviviruses dengue virus (DENV), Murray Valley encephalitis virus (MVEV), the Kunjin strain of West Nile virus (KUNV), Japanese encephalitis virus (JEV) and yellow fever virus (YFV); and malaria. Both locally acquired and overseas acquired cases are described. Vector, climate and sentinel animal surveillance measures for arboviruses (in particular for MVEV) conducted by states and territories, and also at the border are described.

The National Arbovirus and Malaria Advisory Committee (NAMAC) provides expert technical advice on arboviruses and malaria to the Australian Health Protection Principal Committee (AHPPC) through the Communicable Diseases Network of Australia (CDNA). Members of NAMAC have expertise in virus and disease surveillance, epidemiology, virology, vector ecology, vector control and quarantine, and represent agencies with a substantial interest in this area. NAMAC makes recommendations about surveillance and reporting systems, strategic approaches for disease and vector management and control, laboratory support, development of national guidelines and response plans and research priorities. NAMAC assists in the detection, management and control of real or potential outbreaks of arboviruses or malaria and provides advice on the risk of these diseases or exotic vectors being imported from overseas. NAMAC members participate in outbreak management teams as required.

Methods

Human cases of arbovirus infection and malaria are monitored using the National Notifiable Diseases Surveillance System (NNDSS). All Australian states and territories require doctors and/or pathology laboratories to notify cases of infectious diseases that are important to public health including several arboviruses and malaria. The *National Health Security Act 2007* (NHS Act 2007)

provides the legislative basis for the national notification of communicable diseases and authorises the exchange of health information between the Commonwealth and the states and territories. The NHS Act 2007 provides for the establishment of the National Notifiable Diseases List, which specifies the diseases about which personal information can be exchanged between the states and territories and the Commonwealth. State and territory health departments transfer these notifications regularly to the 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 during December 2013 and analysed by date of diagnosis. This derived field is the onset date, or where the date of onset was not known, the earliest of the specimen collection date, the notification date, or the notification received date. The data are from a 'snap-shot', thus numbers in this report may vary slightly from those reported elsewhere. Data in the snap-shot were confirmed with state and territory public health surveillance managers. Detailed notes on the interpretation of NNDSS are available in the 2011 NNDSS annual report.[1] Case definitions for the diseases included in this report are available on the Australian Government Department of Health web site (http://www.health.gov.au/casedefinitions). The report includes information on the following pathogens transmitted by mosquitoes, all which are nationally notifiable except CHIKV:

- alphaviruses (BFV, RRV, and CHIKV);
- flaviviruses (DENV, JEV, KUNV, MVEV and YFV);
- arboviruses not elsewhere classified (NEC); and
- malaria.

Whilst CHIKV infection is not currently nationally notifiable, a national case definition was implemented from 2010, and NNDSS allows the collection of notifications of CHIKV infection as a separate infection. Prior to this, CHIKV infections were notified under the disease category arbovirus NEC. All notifications of CHIKV infection under arbovirus NEC were counted under CHIKV infection instead of under arbovirus NEC.

Crude notification rates or counts for the 2011–12 season were compared with rates or counts for that disease over the previous 5 years. Notification rates were not calculated for diseases that are primarily acquired overseas, because resident populations are not an appropriate denominator for these diseases. Rates are not provided for rare diseases ($n<20$ in the 2011–12 season), because these rates tend to have very large standard errors and therefore cannot be meaningfully compared across time or geographical location.

Notification rates were calculated using the Australian Bureau of Statistics estimated resident populations for Australia and each state or territory at June 2012.[2] Population data are supplied as an estimate for calendar years; for this report, the population for the second half of the financial year was applied to that year (2012 population applied to the 2011–12 financial year).

Due to a limitation of surveillance systems, Queensland notifies mixed infections of malaria as a separate notification for each infecting organism. For the 2011–12 season, additional information was collected to enable these mixed infections to be reported as 1 case for the purpose of this report. In 2011–12, this resulted in 2 fewer notifications than if the adjustment was not made.

Additional information on the details of some notifications was obtained from state and territory public health surveillance managers. Data on sentinel animals and mosquito surveillance, control measures and detections of exotic mosquito vectors at the border were supplied by relevant agencies.

Vertebrate, vector and climate surveillance in states and territories

New South Wales

Surveillance mechanisms include mosquito monitoring, virus isolation from mosquitoes and sentinel chicken surveillance. The New South Wales Arbovirus Surveillance and Vector Monitoring Program is funded and coordinated by the NSW Ministry of Health (NSW Health), and laboratory services are contracted to the Institute of Clinical Pathology and Medical Research, Pathology West at Westmead Hospital. Mosquito trapping occurs from mid-spring to mid-autumn (November to April), and mosquitoes are collected weekly for species identification and quantification, and processed for isolation of arboviruses. Data on the Southern Oscillation Index (SOI), rainfall and temperature obtained from the Bureau of Meteorology (BOM) are used by members of the program to predict mosquito-breeding capabilities and potential arboviral activity, while climatic data are used to predict MVEV outbreaks. Sentinel animals are operated along with mosquito monitoring and isolation at inland locations of major population centres at risk of MVEV, while along the coast where MVEV does not occur, only mosquito monitoring and viral isolation are undertaken.

Northern Territory

Surveillance consists of routine year round sentinel chicken surveillance with monthly bleeds and *ad hoc* virus isolation from mosquitoes when MVEV or KUNV cases are reported. The program is com-

bined and coordinated by the Northern Territory Department of Primary Industries and Fisheries (DPIF) and the Northern Territory Department of Health, with support from volunteers. The Northern Territory Mosquito Borne Disease Control Program assists regional authorities with mosquito monitoring and provides some funding for direct mosquito control in some major towns. In 2011–12, routine adult mosquito trapping consisted of 21 trapping sites throughout the Darwin urban area. In other Northern Territory regions, adult mosquito trapping is carried out in liaison with Environmental Health and mining companies, with 6 traps located in Nhulunbuy, three in Tennant Creek, four in Katherine, three in Alyangula on Groote Eylandt, and six in Alice Springs. Climate information from the BOM is used in conjunction with animal and vector surveillance. Rainfall patterns, daily rainfall records and rain threshold models are used to assist in predicting mosquito and virus activity.

Queensland

Queensland does not currently conduct state-wide surveillance for MVEV in vertebrate hosts, and does not maintain sentinel chicken flocks. Queensland commenced an arbovirus surveillance trial using honey trap saliva technology in 2012, with the aim of evaluating its effectiveness as a sustainable method for arbovirus surveillance in Queensland. Mosquito monitoring is performed by some local councils, primarily for salt water and fresh water mosquitoes. Some councils implemented surveillance for container breeding mosquitoes in domestic and commercial premises as part of a joint Queensland Health and local government initiative. Opportunistic virus isolations from mosquitoes or animals have been carried out by the University of Queensland, the Tropical Public Health Unit network within Queensland Health and the Queensland Institute of Medical Research.

South Australia

Across South Australia, mosquito surveillance and control activities are conducted in partnership between South Australia Health, the University of South Australia, local government and Biosecurity South Australia. The program is coordinated by the South Australia Health and consists of mosquito trapping in the Riverland and areas in the mid-north of the state and virus isolation when required. Seasonal monitoring of mosquito population is undertaken along the Murray River; live collections for virus isolation are sampled in response to high vector numbers and samples are sent to Westmead Hospital for testing.

Tasmania

No state-wide systematic mosquito abundance, virus isolation or sentinel animal surveillance activities are undertaken due to the relatively low risk of arbovirus transmission in the state. However, mosquito collections are undertaken in Sorell Council region, (which includes mosquito breeding areas, is fairly populous, and is close to Hobart) during high risk periods over January to March, when tidal inundation floods salt marsh habitat, thereby leading to egg hatching and subsequent increased abundance of the main local vector, *Aedes camptorhynchus*. These are sent to Westmead Hospital for species identification and viral isolation.

Victoria

The Victorian Department of Health contracts the Victorian Department of Primary Industries to conduct sentinel chicken surveillance during the arbovirus season from November to April. The standard sentinel chicken monitoring program involves the weekly collection of blood samples from 20 chickens located at each of 9 sites in northern Victoria along the Murray River or in the surrounding region, usually from November to April. This program has been in place in Victoria since the 1974 outbreak and acts as an early warning system for possible human infections with flaviviruses. The samples are tested at the Department of Environment and Primary Industries. Flocks are replaced annually. Eight councils undertake mosquito surveillance as part of the standard mosquito monitoring program, with 4 traps placed in each area. Six councils are located along the Murray River, one is a coastal site and the other is within metropolitan Melbourne. The mosquitoes are collected weekly and sent on cold storage to the Department of Environment and Primary Industries for identification, enumeration and virus isolation. Additional mosquito surveillance and identification also occurs in the Geelong area. The Victorian Arbovirus Taskforce examines the risk of outbreaks of MVEV using meteorological surveillance data such as the SOI and rainfall deciles, and Indian Ocean Dipole using respectively the Forbes,[3] and Nicholls[4] and Bennett models.

Western Australia

The University of Western Australia Arbovirus Surveillance and Research Laboratory (ASRL) is funded by Western Australian Department of Health to coordinate the sentinel chicken program and mosquito surveillance and to provide confirmatory serological testing for other sentinel chicken programs in Australia as required. Twenty-eight sentinel chicken flocks of up to 12 chickens are located at major towns and communities in the

Kimberley, Pilbara, Gascoyne, Goldfields, Midwest and Central Coastal regions of Western Australia. Blood samples are collected from the chickens at fortnightly intervals during the peak MVEV risk season (December to June). At other times, monthly samples are collected unless prolonged flavivirus activity warrants continued fortnightly sampling. An annual program of mosquito trapping is undertaken towards the end of the wet season when MVEV activity is active over a 3–4 week period. This provides important information on size and species composition of mosquito populations, vector species and virus infection rates.

Results

During the 2011–12 season, there were 7,875 notifications of diseases transmitted by mosquitoes (Table 1). This represented a 2% decrease from the mean of 8,031 notifications for the previous 5 years.

Alphaviruses

In Australia, the most frequently notified viruses in the genus Alphavirus are RRV and BFV. Infection with RRV or BFV can cause illness characterised by fever, rash and polyarthritis. These viruses are transmitted by numerous species of mosquitoes that breed in diverse environments (freshwater habitats, coastal regions, salt marshes, floodwaters, established wetlands and urban areas).[5] RRV and BFV occur exclusively in the Australasian region.[6]

Local transmission of the alphavirus CHIKV does not occur in Australia, but the infection is regularly reported in travellers returning from overseas. Illness is characterised by an abrupt onset of fever, rash and severe joint pain. The acute disease lasts one to 10 days, but convalescence may include prolonged joint swelling and pain lasting months. Haemorrhagic manifestations may occur occasionally.[7] Humans are amplification hosts for CHIKV, and other vertebrates are not required for high levels of transmission to occur. Internationally, CHIKV is most commonly transmitted by *Ae. aegypti*, which occurs in northern Queensland and *Ae. albopictus,* which is found on Cocos Island, Christmas Island and in some areas of the Torres Strait Islands.[8] Other Australian mosquito species have been shown to be competent vectors of CHIKV in the laboratory.[9]

Ross River virus infections

There were 4,617 notifications of RRV infection during the 2011–12 season, representing a rate of 20.3 per 100,000 population, compared with a 5-year mean of 22.5 per 100,000 (Table 1). Queensland reported the largest number of cases (n=1,788), while the highest rate was in the Northern Territory.

Rates of RRV in the Northern Territory continued to decrease from previous years, and in South Australia and Victoria, where large increases were reported in 2010—11,[10] rates returned to previously reported levels (Figure 1). Rates in Western Australia increased to 63 per 100,000 (n=1,533) from 35.2 per 100,000 in 2010–11 (n=827) and were more than double the 5 year mean of 29.6 per 100,000 (n=661.6).

Figure 1: Notification rate for Ross River virus infection, Australia, July 2006 to June 2013, by year and state or territory

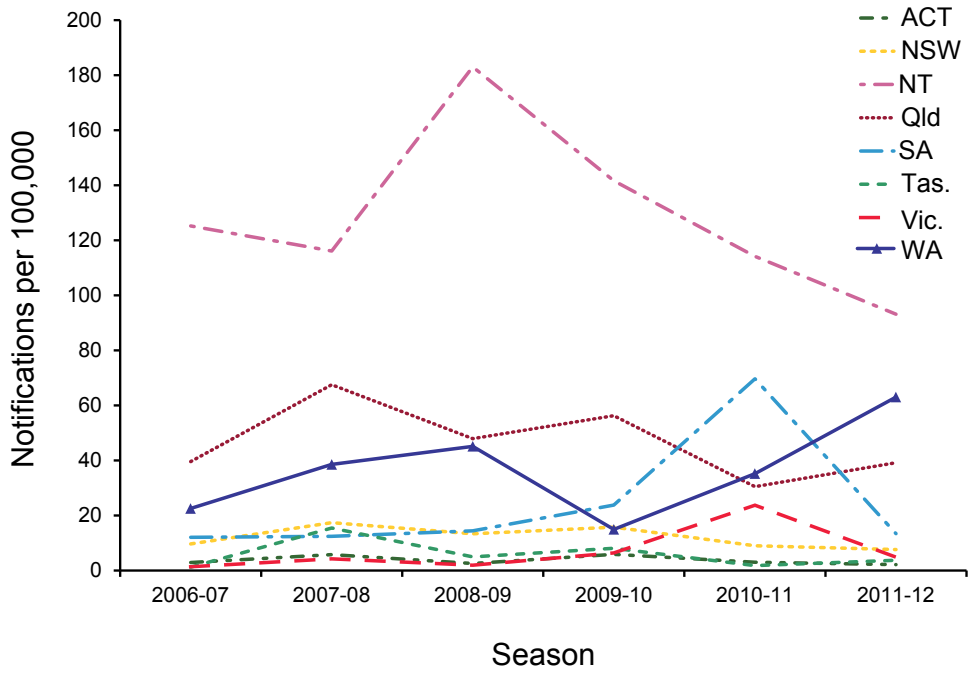


Table 1: Number of notified cases, notification rate* and 5 year mean for mosquito-borne disease, Australia, 2011–12, by disease and state or territory

		ACT	NSW	NT	Qld	SA	Tas.	Vic.	WA	Aust.
Arbovirus NEC†	Cases 2011–12	0	0	0	7	1	0	6	0	14
	5 year mean cases	0.0	0.6	0.0	6.6	0.0	0.0	5.8	0.0	13.0
	Rate 2011–12	–	–	–	–	–	–	–	–	–
	5 year mean rate	–	–	–	–	–	–	–	–	–
Barmah Forest virus infection	Cases 2011–12	1	318	52	806	50	0	39	153	1,419
	5 year mean cases	4.6	450.2	90.0	928.8	67.4	1.6	65.2	131.4	1,739.2
	Rate 2011–12	0.3	4.4	22.1	17.7	3.0	0.0	0.7	6.3	6.2
	5 year mean rate	1.3	6.3	40.2	21.1	4.2	0.3	1.2	5.9	8.0
Chikungunya virus infection	Cases 2011–12	0	4	1	0	2	0	13	0	20
	5 year mean cases	NN	6.8	2.6	2.8	1.0	0.4	7.4	5.4	26.4
	Rate 2011–12	–	–	–	–	–	–	–	–	–
	5 year mean rate	–	–	–	–	–	–	–	–	–
Dengue virus infection	Cases 2011–12	17	245	69	225	44	9	276	561	1,446
	5 year mean cases	10.2	140.2	26.8	361.8	22.4	3.8	48.6	199.0	812.8
	Rate 2011–12	–	–	–	–	–	–	–	–	–
	5 year mean rate	–	–	–	–	–	–	–	–	–
Japanese encephalitis virus infection	Cases 2011–12	0	0	0	1	0	0	0	0	1
	5 year mean cases	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2
	Rate 2011–12	–	–	–	–	–	–	–	–	–
	5 year mean rate	–	–	–	–	–	–	–	–	–
Kunjin virus infection	Cases 2011–12	0	1	0	0	0	0	0	0	1
	5 year mean cases	0.0	0.0	0.6	0.6	0.0	0.0	0.2	0.0	1.4
	Rate 2011–12	–	–	–	–	–	–	–	–	–
	5 year mean rate	–	–	–	–	–	–	–	–	–
Malaria	Cases 2011–12	9	71	15	120	5	10	82	43	355
	5 year mean cases	11.6	107.4	24.6	160.6	20.0	9.4	100.4	80.0	514.0
	Rate 2011–12	–	–	–	–	–	–	–	–	–
	5 year mean rate	–	–	–	–	–	–	–	–	–
Murray Valley encephalitis virus infection	Cases 2011–12	0	1	0	1	0	0	0	0	2
	5 year mean cases	0.0	0.6	0.6	0.2	0.4	0.0	0.0	2.4	4.2
	Rate 2011–12	–	–	–	–	–	–	–	–	–
	5 year mean rate	–	–	–	–	–	–	–	–	–
Ross River virus infection	Cases 2011–12	8	556	219	1,788	222	19	272	1,533	4,617
	5 year mean cases	14.2	931.2	305.4	2,124.0	433.8	31.8	418.2	661.6	4,920.2
	Rate 2011–12	2.1	7.6	93.1	39.2	13.4	3.7	4.8	63.0	20.3
	5 year mean rate	4.0	13.1	136.4	48.3	26.7	6.3	7.7	29.6	22.5
Yellow fever	Cases 2011–12	0	0	0	0	0	0	0	0	0
	5 year mean cases	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.4
	Rate 2011–12	–	–	–	–	–	–	–	–	–
	5 year mean rate	–	–	–	–	–	–	–	–	–
Total 2011–12		35	1,197	356	2,948	324	38	688	2,290	7,875

* Rates are not provided for diseases with less than 20 cases, or for diseases predominantly acquired overseas.

† Flavivirus (NEC) replaced Arbovirus (NEC) from 1 January 2004. Arbovirus (NEC) replaced Flavivirus (NEC) from 2008.

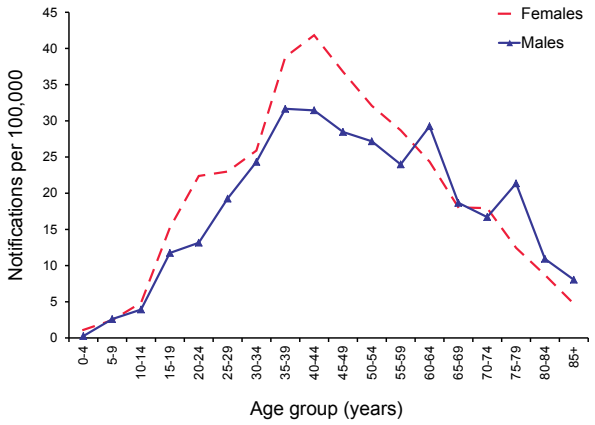
NEC Not elsewhere classified.

NN Not notifiable.

RRV was most commonly reported amongst middle-aged adults, with notification rates peaking in the 35–54 year age groups (Figure 2). As in previous years, a little more than half of all cases (54%) were female. The overall rate of RRV in females was 21.9 per 100,000, while in males the rate was 18.7 per 100,000.

As in previous years, there was a marked seasonal trend in RRV notifications, with the largest number notified between January and April (Figure 3). It is important to note that seasonal trends vary between and within states and territories according to differences in mosquito vectors, hosts and climate.

Figure 2: Notification rate for Ross River virus infection, Australia, 2011–12, by age group and sex*



* Age for 1 notification was not available.

Barmah Forest virus infections

There were 1,419 notifications of BFV infections during the 2011–12 season, representing a rate of 6.2 per 100,000 population, a decrease from the mean of 8.0 per 100,000 for the previous 5 years (Table 1). Queensland reported the largest number of notifications of BFV infection (n=806) while the highest rate was reported in the Northern Territory (22.1 per 100,000 population). Rates in 2011–12 were similar to or below the 5-year mean for all states and territories (Figure 4).

BFV notifications were most commonly reported amongst middle aged adults, with notification rates peaking in the 40–64 year age range (Figure 5). Similar to previous years, 52% of cases were male.

Figure 3: Notifications of Ross River virus infection, July 2007 to June 2012, by month

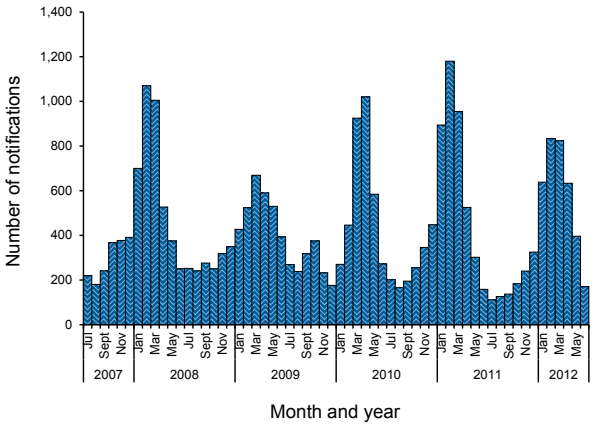


Figure 4: Notification rate for Barmah Forest virus infection, Australia, July 2006 to June 2012, by year and state or territory

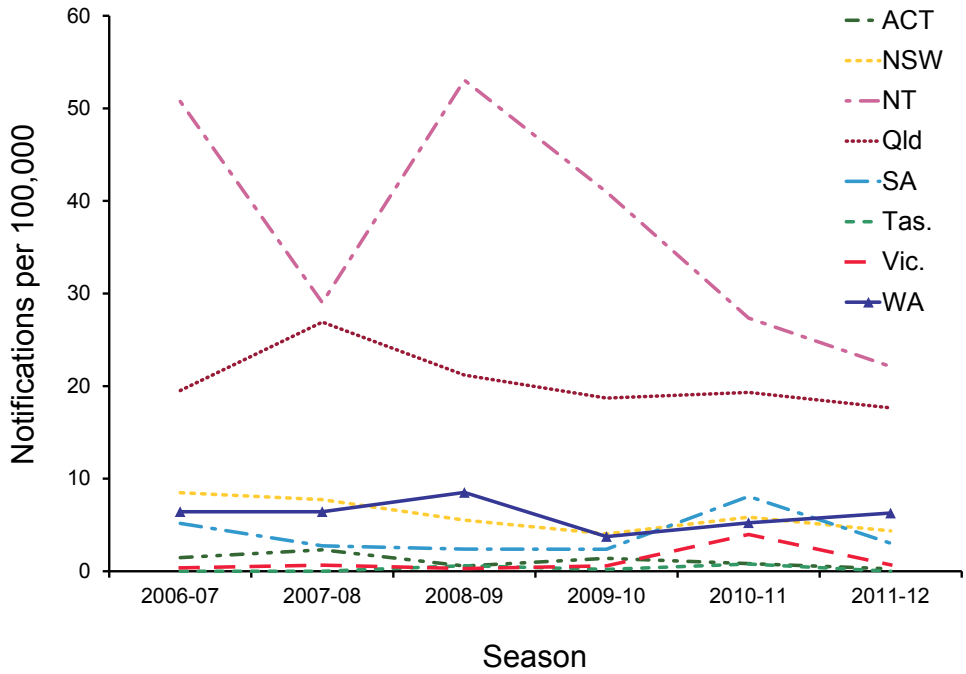
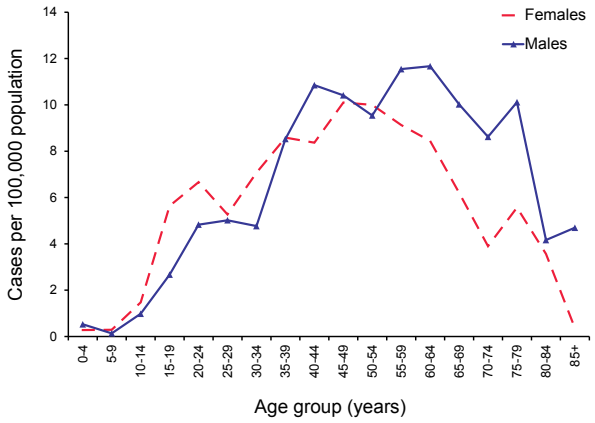
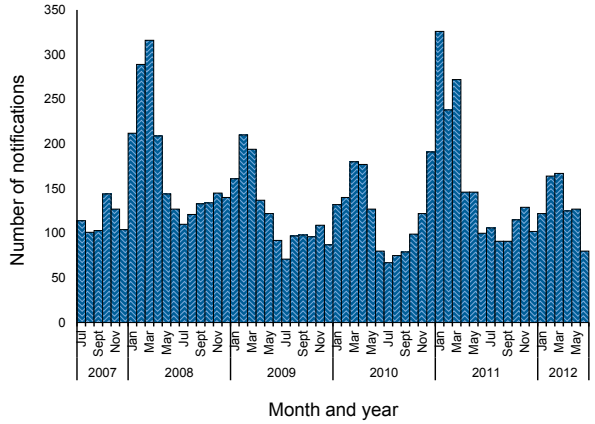


Figure 5: Notification rate for Barmah Forest virus infection, Australia, 2011–12, by age group and sex



In 2011–12, infections were most frequently notified between February and March (Figure 6), and while BFV notifications showed a seasonal trend, this trend was less marked than for RRV infections. The higher than expected numbers of BFV notifications in the cooler months is possibly an artefact, reflecting the possibility of false positive IgM diagnoses. Subsequent to the 2011–12 season, in October 2012, the number of BFV notifications began to increase dramatically, and marked the start of an epidemic of notifications due to false positive IgM diagnoses.

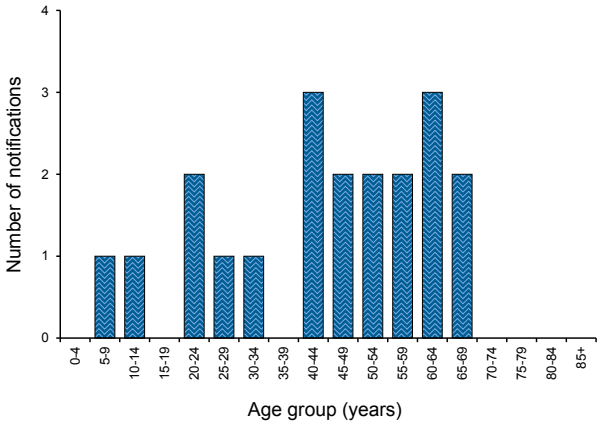
Figure 6: Notifications of Barmah Forest virus infection, Australia, July 2007 to June 2012, by month and year



Chikungunya virus infection

CHIKV infection is a notifiable disease in all jurisdictions other than the Australian Capital Territory, where there are plans to make the infection notifiable in the future (Ranil Appuhamy, ACT Health personal communication). There were 20 notifications of CHIKV infection during the 2011–12 season compared with a 5–year mean of 26.4 cases. All cases were acquired overseas, with complete information supplied on the country of acquisition for 15 of these cases. The most frequently reported countries of acquisition were India (6 cases), Thailand (2 cases) and Indonesia (2 cases). For 4 notifications, the specific country of acquisition could not be determined (for example, due to visiting multiple countries within their incubation period), and 1 case was lost to follow-up so the place of acquisition could not be determined. CHIKV infection was most frequently notified amongst young and middle aged adults (Figure 7).

Figure 7: Notifications of chikungunya virus infection, Australia, 2011–12, by age group



Flaviviruses

This section provides information on several flaviviruses notified to NNDSS including DENV, MVEV, KUNV and JEV. Other flaviviruses may be notified under the Arbovirus (NEC) category.

Dengue virus has 4 serotypes, all of which are notified in imported cases to varying degrees each year, and may be involved in local outbreaks. The clinical illness is characterised by mild to severe febrile illness with fever, headache, muscle/joint pain and sometimes a rash. A minority of cases progress to severe dengue with haemorrhage and shock, more commonly on subsequent infection with a different DENV serotype.

Infection with MVEV, KUNV or JEV is usually asymptomatic or produces a non-specific illness, but a small percentage of cases progress to encephalomyelitis of variable severity. *Culex annulirostris* is the major vector of MVEV, KUNV and JEV. No specific treatment is available for these diseases and care is largely supportive. A vaccine is available

to prevent JEV infection (available for children in affected areas of Queensland and for long term travellers to endemic areas)[11] but there are no vaccines currently available for DENV, MVEV or KUNV infection.

Dengue virus infection

There were 1,446 notifications of DENV infection during the 2011–12 season. Of these, 18 cases were acquired in Australia, and 1,390 cases acquired the infection while overseas (Table 2). For the remaining 38 cases, no information on place of acquisition was supplied. In 2011–12, the median age of cases was 38 years (range 0–86 years), and 48% (n=704) of cases were male.

Locally-acquired dengue virus infection

The 18 notified cases of DENV infection acquired in Australia during 2011–12 (9 DENV-1, 2 DENV-2 and 7 untyped) was an 87% decrease compared with the 134 locally-acquired cases in 2010–11, and was the lowest number reported since the 2000–01 season when there were 10 cases.

Local transmission of dengue in Australia is normally restricted to areas of northern Queensland where the key mosquito vector, *Ae. aegypti* is present.[12] Dengue is not endemic in North Queensland, but local transmission can occur upon introduction of the virus to the mosquito vector by a viraemic tourist or a resident returning from a dengue-affected area overseas.[13]

In 2011–12, 16 cases of locally-acquired DENV were notified by Queensland and one each by New South Wales and Victoria. All but one of these cases resided or travelled in north Queensland and those reported by Queensland were linked with one of the 3 known outbreaks (2 in Townsville and 1 in Cairns) during the reporting period. One of

Table 2: Notifications of dengue virus infection, Australia, 1 July 2006 to 30 June 2012, by year, state or territory and place of acquisition

Place of acquisition	Year	ACT	NSW	NT	Qld	SA	Tas.	Vic.	WA	Aust.
Locally-acquired*	2006–07	0	6	1	48	0	0	0	0	55
	2007–08	0	5	0	26	3	0	0	0	34
	2008–09	0	5	0	1,003	1	0	4	1	1,014
	2009–10	0	3	0	33	0	0	1	0	37
	2010–11	0	2	1	126	0	0	3	2	134
	2011–12	0	1	0	16	0	0	1	0	18
Overseas-acquired	2006–07	2	65	14	58	12	0	9	27	187
	2007–08	4	100	25	78	30	4	15	94	350
	2008–09	14	169	27	115	25	6	18	120	494
	2009–10	19	121	36	125	11	4	51	226	593
	2010–11	4	221	29	180	27	5	139	524	1,129
	2011–12	11	240	69	209	44	9	247	561	1,390
Unknown	2006–07	0	0	0	5	0	0	1	0	6
	2007–08	0	0	0	4	2	0	0	0	6
	2008–09	0	0	0	5	0	0	1	0	6
	2009–10	0	2	0	1	0	0	1	0	4
	2010–11	8	2	1	2	1	0	0	1	15
	2011–12	6	4	0	0	0	0	28	0	38
Total	2006–07	2	71	15	111	12	0	10	27	248
	2007–08	4	105	25	108	35	4	15	94	390
	2008–09	14	174	27	1,123	26	6	23	121	1,514
	2009–10	19	126	36	159	11	4	53	226	634
	2010–11	12	225	31	308	28	5	142	527	1,278
	2011–12	17	245	69	225	44	9	276	561	1,446

* Locally-acquired cases are acquired in Australia and not necessarily in the state or territory from which they are reported. Under the cross-border notification protocol, cases are notified by their state or territory of residence where this differs from the diagnosing state or territory.

the outbreaks continued post 30 June 2012, and data on cases after 2011–12 are not included in this report. The prevention of incursion of dengue vectors into densely populated areas of South-East Queensland where imported dengue cases are regularly notified, is a continuing priority in Queensland. Despite frequent outbreaks relating to transmission from imported cases, mosquito and infection control measures undertaken by public health authorities and by residents have ensured that dengue has not become endemic in north Queensland.

Overseas-acquired dengue virus infection

There were 1,390 notifications of dengue virus infection acquired overseas during the 2011–12 season (Table 2), 2.5 times the 5-year mean of overseas-acquired infections (550.6). All states and territories reported increased numbers of notified cases of overseas-acquired DENV infection compared with 2006–07, and the ratio compared with the 5-year mean ranged between 1.3 in the Australian Capital Territory, to 5.3 in Victoria.

The country of acquisition was available for all but two of the overseas-acquired cases (n=1,388) (Figure 8). Indonesia was the country of acquisition for more than half of all overseas acquired cases (64.2%, n=893). The infecting DENV serotype was determined for 23.1% (n=330) of overseas-acquired dengue cases (down from 50% in 2010–11 and 64% in 2009–10). DENV 2 (n=205) was the most frequently reported serotype in 2011–12 (Figure 8, Table 3).

Japanese encephalitis virus infections

There was 1 notification of JEV infection in Australia during 2011–12. The case was a 16-year-old girl who acquired the infection in the Philippines and was diagnosed in February 2012. The last locally-acquired case was in 1998.[14]

Kunjin virus infection

There was 1 human case of KUNV infection notified in Australia during 2011–12. The case was a 44-year-old woman from the South Coast of New South Wales, who was diagnosed in December 2011. This is thought to have been the 1st case ever to have been acquired in a coastal area of the state.

Murray Valley encephalitis

In 2011–12, two cases of MVEV infection in Australia were notified, compared with an average of 4.2 cases for the previous 5 years.

Figure 8: Notifications of dengue virus infection, Australia, July 2006 to June 2012, by month, year and place of acquisition

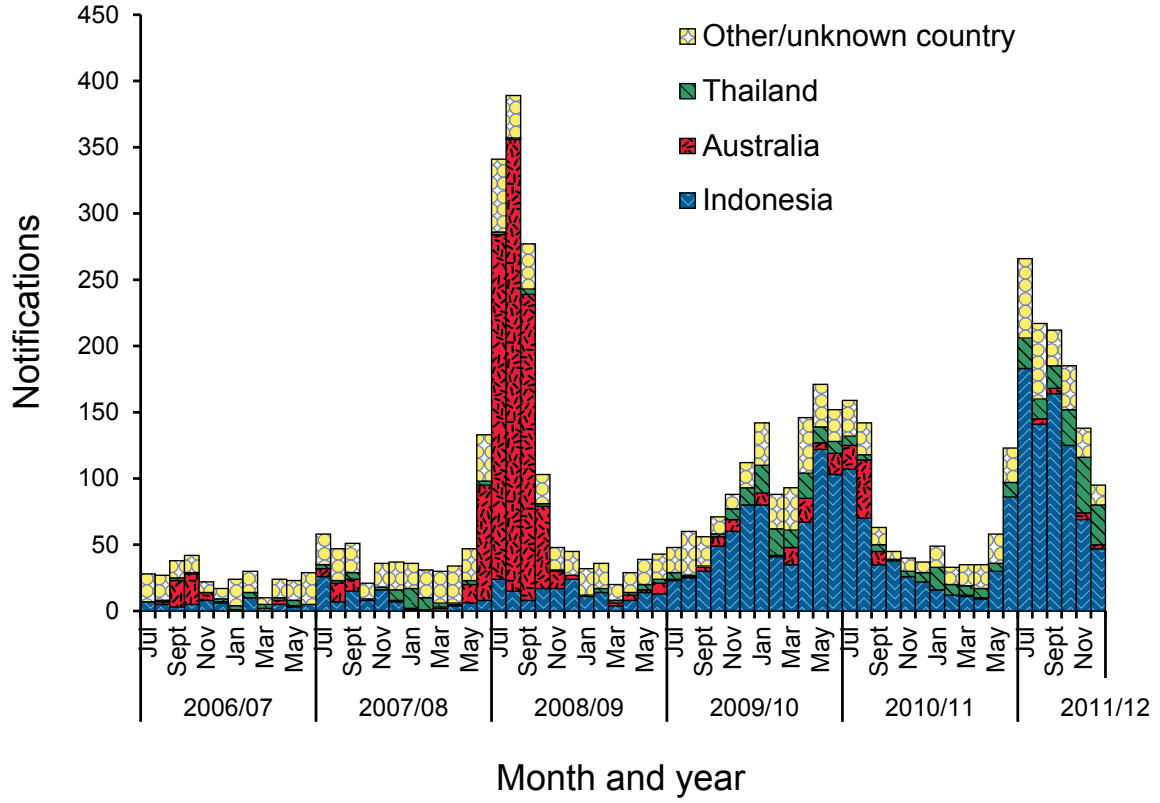


Table 3: Overseas acquired cases of dengue virus infection, Australia, 2011–12, by serotype and country of acquisition

Country	Total number of cases	Percentage of cases*	Dengue virus serotype				
			DENV 1	DENV 2	DENV 3	DENV 4	Untyped
Indonesia	893	64.3	30	168	11	8	676
Thailand	210	15.1	15	16	17	3	159
East Timor	55	4.0	1	1	13	0	40
The Philippines	45	3.2	3	0	1	1	40
India	35	2.5	1	2	1	0	31
Fiji	25	1.8	5	0	0	0	20
Malaysia	23	1.7	3	4	1	0	15
Vietnam	16	1.2	0	3	1	0	12
Sri Lanka	14	1.0	2	1	0	0	11
Papua New Guinea	10	0.7	1	2	2	0	5
Bangladesh	9	0.6	1	2	0	0	6
Cambodia	7	0.5	0	1	0	0	6
Kiribati	7	0.5	2	0	0	0	5
South East Asia	4	0.3	0	0	0	0	4
Pakistan	3	0.2	0	1	0	0	2
Other countries†	32	2.3	0	2	0	1	29
Unknown country	2	0.0	0	2	0	0	0
Total	1,390	100.0	65	205	47	13	1,061

* Excludes cases where the specific country was unknown. Percentages do not add up due to rounding.

† Each country with less than 2 cases.

The 1st case was a 25-year-old woman who was diagnosed in New South Wales in December 2011. The 2nd case was a 14-year-old boy who acquired the infection in Papua New Guinea and was diagnosed in Queensland in February 2012.

Yellow fever

There were no notifications of yellow fever in 2011–12.

Vertebrate, vector and climate surveillance programs for flaviviruses in 2011–12

The sentinel chicken program is designed to detect flavivirus activity. In 2011–12, sentinel chicken flocks were located in the Northern Territory, New South Wales, South Australia, Victoria and Western Australia. The programs aim to provide early warning of the endemic arboviruses MVEV and KUNV, as well as exotic arboviruses such as JEV.[15] Public health messaging or other response measures can be implemented when chickens from a flock seroconvert to a flavivirus of interest. Public health messaging may advise residents or target groups such as campers or fishermen of the need to take added precautions to avoid mosquito bites.

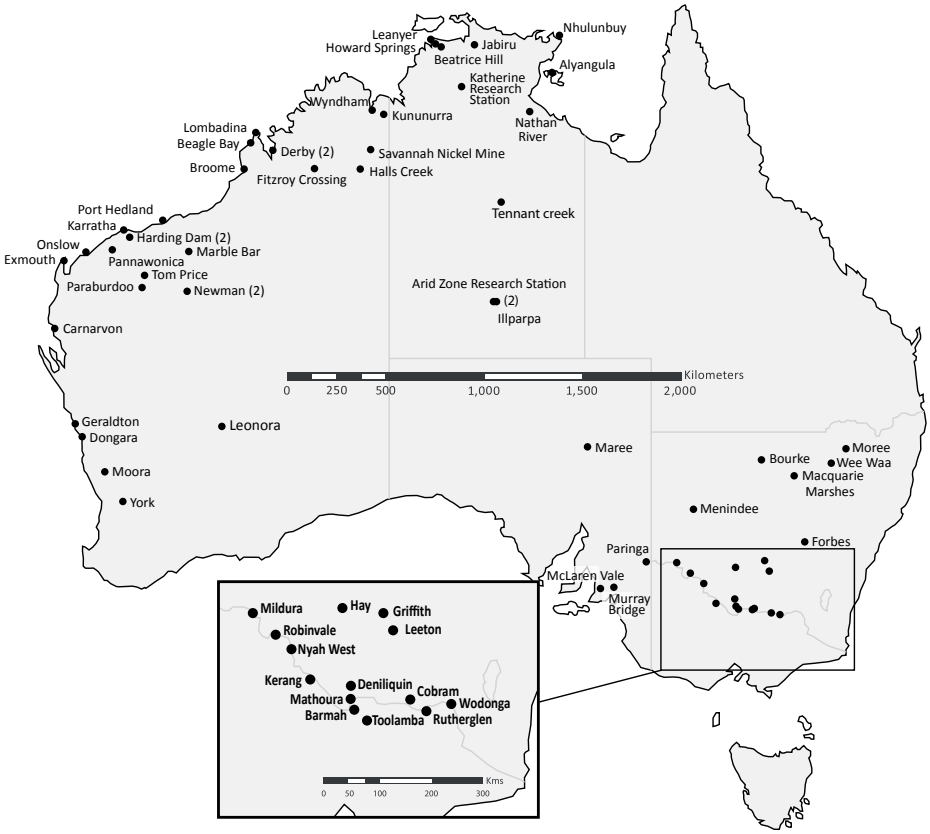
Sentinel chickens are replaced at least annually and more frequently if birds die or large proportions seroconvert. Flocks are well located geographically to detect flavivirus activity and to provide a timely and accurate indication of risk to people (Map).[16]

New South Wales

The 2011–12 sentinel chicken program began on 27 October 2011 with the first bleed and ended on 30 April 2012. A total of 11 flocks each containing up to 15 Isa Brown pullets were deployed, with 1 flock each at Bourke, Deniliquin, Forbes, Griffith, Hay, Leeton, Macquarie Marshes, Menindee, Moama (near Mathoura), Moree and Wee Waa (Map).

The NSW Chicken Sentinel Program was approved by the Western Sydney Local Health Network Animal Ethics Committee. This approval requires that the chicken handlers undergo training to ensure the chickens are cared for appropriately and that blood sampling is conducted in a manner that minimises trauma to the chickens. The chickens are cared for and bled by local council staff and members of the public. Laboratory staff are responsible for training the chicken handlers. A veterinar-

Map: Location of sentinel chicken sites, Australia, 2011–12



ian (usually the Director of Animal Care at Westmead) must inspect all new flock locations prior to deployment to ensure animal housing is adequate. Existing flocks are inspected approximately every 2 years. The health of each flock is reported weekly, and is independently monitored by the Animal Ethics Committee via the Director of Animal Care. Full details of the bleeding method and laboratory testing regimen were detailed in the 2003–04 NSW Arbovirus Surveillance Program annual report.[17]

The results of chicken serology are disseminated via email to the relevant government groups as determined by NSW Health and are placed on the NSW Arbovirus Surveillance website. Confirmed positives are notified by telephone to NSW Health and CDNA.

The season began with 164 pullets and 6 deaths were recorded during the program. A total of 2,660 samples were received from the 11 flocks in New South Wales over the 6-month period in 2011–12. This represented 5,320 enzyme-linked immunosorbent assay (ELISA) tests (excluding controls and quality assurance samples), with each specimen being tested for MVEV and KUNV antibodies.

During the 2011–12 season, MVEV and KUNV were first detected on 4 December 2011 at Hay and Forbes respectively (Table 4). There were a number of other seroconversions to MVEV, but no further KUNV detections.

Northern Territory

The current Northern Territory sentinel chicken program commenced in January 1992 and replaced an earlier program run by the Australian Quarantine Inspection Service. Sentinel chicken flocks in the Northern Territory are maintained, bled and analysed for flaviviruses in a combined program between the Department of Health, the virology laboratories of DPIF and volunteers.

Sentinel chicken flocks are located at Leanyer (Darwin), Howard Springs, Coastal Plains Research Station (CPRS), Jabiru, Alyangula, Katherine, Nhulunbuy, Nathan River, Tennant Creek, Jabiru,and Alice Springs (2 flocks), Nathan River and Alyangula. DPIF officers or volunteers usually bleed flocks once a month and the samples are tested for MVEV and KUNV. When chickens from a flock show antibodies to MVEV during a prime risk period, a media warning is issued for the general area or the region for

Table 4: Seroconversions to Murray Valley encephalitis virus and Kunjin virus in sentinel chicken flocks, New South Wales, 2011–12

Site	Seroconversions			First positive date	Last positive date
	MVEV	KUNV	Total		
Forbes	0	1	1	30 April 2012	30 April 2012
Hay	2	0	2	4 December 2011	11 December 2011
Leeton	8	0	8	12 December 2011	12 December 2011
Macquarie Marshes	3	0	3	13 December 2011	13 December 2011
Moama	1	0	1	7 December 2011	7 December 2011
Total	14	1	15	4 December 2011	30 April 2012

the risk period. These warnings advise residents and visitors of the need to take added precautions to avoid mosquito bites.

In February 2012, the Northern Territory sentinel chicken program was revised, and the Jabiru, the Ilparpa Swamp and the Alyangula flocks were terminated. The Jabiru flock was terminated due to difficulty in regular bleeding. The Alyangula flock was terminated, as no seroconversions to MVEV have occurred, most likely due to the ecology in the area not being favourable for MVEV activity. The Ilparpa Swamp flock was terminated due to sufficient data being available from the flock. In addition, it was decided to only bleed the chickens during the highest MVEV risk period between December and June inclusive.

In the 2011–12 season, MVEV activity was only detected in the Katherine region, with seroconversions in Katherine in January and in Nathan River in January and February 2012. KUNV activity was detected in Nathan River in January 2012 and in the Nhulunbuy flock in the East Arnhem region in April 2012 and in Nathan River in January 2012.

Preliminary results from the new experimental mosquito honey-baited card arbovirus surveillance system trial carried out between February and June 2012 in the Darwin area, in collaboration with Queensland Health, James Cook University and the Berrimah Veterinary Laboratory, showed there was additional KUNV activity in the Darwin region in February and March. This new system is thus more sensitive than sentinel chickens and is envisaged to replace the current Northern Territory sentinel chicken program in at least some locations in the future.

Queensland

Queensland does not have a single system for mosquito surveillance due to its large geography and mix of tropical and sub-tropical climate. The prevalence of mosquito-borne diseases such as DENV, RRV, BFV and malaria, along with the presence of vectors such as *Ae. aegypti* and *Ae. albopictus* in specific areas of Queensland pose a particular challenge for surveillance activities.

During 2011–12, a range of mosquito and arbovirus surveillance and/or control activities were carried out in Queensland. This included targeting mosquitoes inhabiting domestic containers in southern and central Queensland; *Ae. albopictus* elimination activities on Horn and Thursday Islands; surveillance and control of *Ae. aegypti* in north Queensland; mosquito surveillance activities on Saibai and Dauan Islands following a malaria outbreak in early 2011;[18] salt water and fresh water mosquito surveillance and control activities across Queensland; and targeted arbovirus monitoring using honey-baited surveillance technology in Mt Isa and Emerald.

During 2011–12, a large survey of Brisbane houses (n=2,381) was led by the Queensland Institute of Medical Research, in collaboration with Queensland Health and the Brisbane City Council to identify mosquito species inhabiting domestic containers. No *Ae. aegypti* were detected at any Brisbane premise. *Ae. notoscriptus,* a likely vector of RRV and BFV, was found in 949 premises.

Household surveys for container inhabiting mosquitoes were also undertaken at approximately 2,300 premises in 13 towns in regional central and southern Queensland during the reporting period, with *Ae. aegypti* found in six of the 13 towns. *Ae. aegypti* had been detected in all of these towns in previous years. Of note, an extensive 473 house survey for *Ae. aegypti* was undertaken in the town of Gin Gin following confirmation of an imported dengue case. Mosquito larvae were found at approximately 40% of premises and *Ae. aegypti* was detected at 11 properties across approximately 6 neighbourhood blocks. No local transmission of dengue occurred. Similarly, in May 2012, *Ae. aegypti* was detected at several residences nearby to a notified overseas acquired dengue case and again no local transmission occurred.

An unusually low level of activity by saltmarsh mosquitoes in the south-east corner of the State continued throughout the 2011–12 season. In general, the number of aerial programs required targeting *Ae. vigilax* was well below expectations, and started later in the season and finished early. This may have been attributable to higher than average rainfall over the preceding 18 months, keeping larval habitat continuously wet, rather than subject to the usual cycles of wetting and drying, which favours saltmarsh mosquito production.

For similar reasons, an interesting spectrum of freshwater species was more abundant than usual in the south-east. In addition to *Culex annulirostris*, some less common species, which were also abundant, included *Ae. aculeatus, Ae. burpengaryensis* and *Ae. lineatopennis*, suggesting the persistence of the eggs of these species over long periods.

In coastal Central Queensland, there were also relatively low numbers of *Ae. vigilax*. But in the Central Highlands, there was medium to high rainfall and consequently very high mosquito numbers. Abundant species included *Cx. annulirostris, Ae. lineatopennis, Ae. vittiger, Ae. alternans* and *Coquillettidia xanthogaster*. One spectacular overnight collection at the sewage treatment plant at Emerald in March collected approximately 30,000 mosquitoes. *Austrosimulium pestilens* was also active across Central Queensland, following good summer rains. A number of coastal local governments sent staff and equipment to assist inland mosquito control after floods in March.

A new honey-baited arbovirus surveillance tool based on the collection and testing of mosquito saliva was trialled in 2 sites, Mt Isa and Emerald, in Queensland between February and May 2012 to compare the sensitivity of this novel system with sentinel chicken surveillance.[19] In Emerald, KUNV was detected in 8 traps between February and March and RRV was detected once each in February and April. In March, BFV, KUNV and RRV were detected in Mt Isa, with an additional detection of RRV in April. The honey-baited surveillance tool will be used more broadly in 2012–13 to survey areas where MVEV viral activity could be present.

Following a falciparum malaria outbreak in the Torres Strait islands of Saibai and Dauan in early 2011, surveillance of overnight landing rate counts and hourly indoor and outdoor mosquito collections were conducted on Saibai Island. Carbon-dioxide-baited United States Centers for Disease Control and Prevention (CDC) light traps were also used to compare vector activity across the island. More than 2,000 samples of the potential malaria vectors *Anopheles farauti* and *Anopheles hilli* were collected and host-seeking behaviours were observed.

South Australia

The Mosquitoes and Public Health Research Group at the University of South Australia (UniSA) provided contracted mosquito surveillance and spot control services approximately monthly (11 trips in total) to 7 local governments along the Murray River in South Australia from September 2011 to April 2012. UniSA also provided mosquito surveillance and control services for 2 northern metropolitan councils, the City of Salisbury and the City of Port Adelaide Enfield for the 2011–12 season. South Australia Health funds half of all local government costs for mosquito surveillance and control on public land through the South Australian Mosquito Management Subsidy.

In the north of metropolitan Adelaide, *Ae. camptorhynchus* and *Ae. vigilax* numbers were low compared with the previous 2 seasons. The mosquito populations along the Murray River during the season exhibited 2 distinct patterns associated with geographic location. Traps north of Mannum in the Mid Murray Council were typified by low numbers through most of the season with a sudden increase around the end of March into April of primarily *Cx. annulirostris*. These areas also lacked any significant number of the spring mosquito *Ae. camptorhynchus* at any time in the season. In the northern river Murray councils, increased numbers of *Ae. eidsvoldensis* adults were recorded and an increased number of *Ae. alternans* larvae were observed. The mosquito populations at Mannum and to the south of this town, retained distinct spring peaks of *Ae. camptorhynchus* through to December.

Throughout the 2011–12 season, sentinel chicken surveillance was conducted opportunistically in South Australia with 2 seroconversions to KUNV at Marree in a remote area of the State in December 2011. One of these had previously been seronegative in May 2011, while the other was a new introduction to the flock, had not been previously bled, and was of unknown origin.

Victoria

A winter sentinel surveillance program was in place between April and October 2011 in response to increased arboviral activity during 2010–11. Sentinel chicken flocks in Barmah, Kerang and Mildura were bled and tested fortnightly for flaviviruses. Fortnightly mosquito trapping was also conducted at these 3 winter sentinel chicken flock locations. Across the winter sentinel monitoring program, 384 serum samples were tested for general flavivirus antibodies during the period of July to October 2011. There was no evidence of seroconversion. In addition, no arboviruses were detected in the trapped mosquitoes.

The 9 standard seasonal sites were located at Mildura, Robinvale, Nyah West, Kerang, Barmah, Toolamba, Cobram, Rutherglen and Wodonga. The standard 2011–12 monitoring period was brought forward to mid-October in eight of the 9 flock sites.

The standard sentinel chicken monitoring program tested 4,249 serum samples for antibodies to flaviviruses using a defined epitope blocking ELISA. KUNV activity was detected in 2 chickens; one from the Barmah flock during week 14 (beginning 2 April) and one from a chicken in the Nyah West flock during week 17 (beginning 23 April 2012). The Barmah flock seroconversion was confirmed by The Elizabeth Macarthur Agricultural Institute, NSW Department of Primary Industries. The Nyah West flock site chicken died before sufficient blood could be collected for additional testing.

No flaviviruses were isolated in trapped mosquitoes (70,290 sent for testing) during the 2011–12 season.

Western Australia

The flavivirus sentinel chicken program in Western Australia is undertaken by the ASRL at The University of Western Australia, on behalf of the Western Australian Department of Health. The sentinel chicken surveillance program is approved by The University of Western Australia Animal Ethics Committee. Many state and local government authorities and community volunteers also take part in the program. Twenty-eight sentinel chicken flocks (of up to 12 chickens) are located at major towns and communities in the Kimberley, Pilbara, Gascoyne, Goldfields, Midwest and Wheatbelt regions of Western Australia (Map). Blood samples are collected from the chickens by environmental health officers or trained volunteers at fortnightly intervals. Samples are transported to ASRL where they are tested for antibodies to flaviviruses using an epitope blocking ELISA.[20]

Central parts of Western Australia experienced wetter than normal conditions prior to the commencement of the 2011–12 wet season. November 2011 was the second wettest on record in Western Australia with thunderstorm activity creating heavy rainfall through the Pilbara, Gascoyne and northern Goldfields. The combination of an active monsoonal trough, Tropical Cyclone Heidi crossing the Pilbara coast and ex-Tropical Cyclone Iggy resulted in parts of the west Kimberley, Pilbara and north Gascoyne recording their wettest January on record. Monsoonal activity during the middle of March and Tropical Cyclone Lua crossing the Pilbara coast resulted in much of the Kimberley and Pilbara experiencing above average rainfall during the month.

A total of 4,185 serum samples from 28 flocks were tested for antibodies to flaviviruses during 2011–12.[21, 22] Seroconversions to flaviviruses were detected in 225 (5.3%) samples. Seroconversions to MVEV detected at Paraburdoo (3 samples), Fitzroy Crossing (1 sample) and Karratha (1 sample) in July, Roebuck Plains (1 sample) and Ophthalmia Dam (1 sample) in August and Roebuck Plains (2 samples), Port Hedland (4 samples) and Marble Bar (7 samples) in September were associated with activity continuing from the 2010–11 season.

The 1st activity associated with the 2011–12 wet season occurred in November 2011, when MVEV (1 sample) and KUNV (1 sample) infections were detected in sentinel chickens at Kununurra in the north-east Kimberley region and 2 KUNV infections were detected at Moora, in the Wheatbelt. This was the earliest start to the flavivirus season in more than 10 years. High levels of flavivirus activity were subsequently detected throughout the Kimberley, Pilbara and Midwest regions in December. The activity continued in January (Kimberley, Pilbara and Midwest/Wheatbelt), February and March (Kimberley, Pilbara and Midwest), April (Kimberley, Pilbara and Gascoyne), May (Kimberley, Pilbara and Midwest), and June (Kimberley). Overall, there were 195 seroconversions to MVEV (including 3 dual MVEV/KUNV infections) and 31 KUNV infections (including the dual MVEV/KUNV infections). The overall level of flavivirus activity was slightly lower than the very high levels seen in 2000 and 2011.[10, 23] The majority of sentinel chicken flocks required replacement with new chickens during the course of the season, some on multiple occasions. No human cases of MVE were diagnosed in Western Australia during the 2011–12 season (Dr David Smith, PathWest Laboratory Medicine Western Australia, personal communication).

The Western Australia Department of Health issued 3 media statements. The 1st was issued on 24 August 2011 following continued detections of MVEV antibodies in sentinel chickens in the Kimberley and Pilbara regions associated with the 2010–11 wet season. The 2nd was issued on 16 December 2011 after MVEV and KUNV infections were detected in sentinel chickens in the Kimberley and Wheatbelt regions for the 1st time in the 2011–12 wet season. The 3rd media release was issued on 26 March 2012 after widespread detections of MVEV and KUNV infections in sentinel chickens in the Kimberley, Pilbara, Gascoyne, Midwest and Wheatbelt regions.

Tasmania

No viruses were isolated in 2011–12 from mosquitoes trapped during ad hoc collections undertaken in the Sorrell Council region.

Arbovirus infection (NEC)

This disease category enables the capture and epidemiological analysis of emerging infections within this very broad disease group. Emerging diseases are then made nationally notifiable. An unspecified category is particularly important for the flaviviruses, because it is recognised that some infections cannot be attributed to a single flavivirus.

There were 14 notifications of arbovirus NEC in 2011–12, similar to the 5-year average of 13 cases (range 4–22 cases). Half of these notifications relate to infections that were known to have been acquired overseas (n=7). In 2011–12, 5 notifications were for an unspecified arbovirus, 6 notifications were for an unspecified flavivirus, with the remainder due to the flaviviruses Kokobera (n=2) and Alfuy (n=1).

The largest number of notifications were from Queensland (n=7) and Victoria (n=6). In Queensland, an extensive panel of flaviviruses is used for testing, and flaviviruses may be more prevalent particularly in the north of the state, so patients may be more likely to be exposed to more than 1 flavivirus, and these 2 factors could increase the probability of cross-reacting antibodies (Dr Sonya Bennett, Queensland Health, personal communication) resulting in more notifications of arbovirus NEC.

Malaria

Malaria is a serious acute febrile illness that is normally transmitted from person to person through the bite of an infected mosquito of the genus *Anopheles*. It is caused by a protozoan parasite in the genus *Plasmodium* that includes 5 species that infect humans – *Plasmodium vivax*, *Plasmodium falciparum*, *Plasmodium malariae*, *Plasmodium ovale* and *Plasmodium knowlesi*.[24,25]

There were 355 notifications of malaria during the season 2011–12 (Table 1), a 30.9% decrease compared with the mean of 514 notifications during the past 5 years and, consistent with the steady decline in the number of notifications since the 2004–05 season. Most infections were known to have been acquired overseas (88%, n=314), while the place of acquisition for the remainder was reported as unknown or not stated, but none were known to have been locally-acquired.

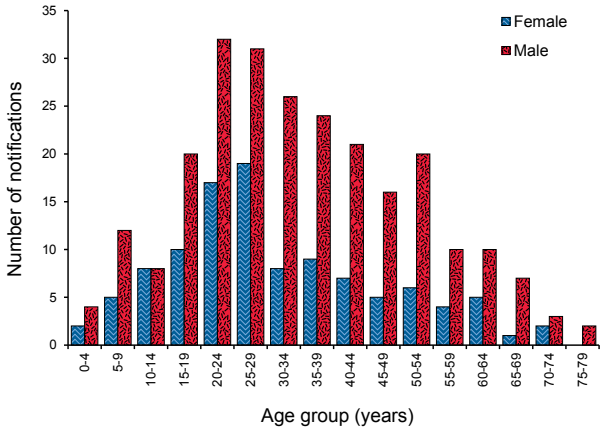
Malaria was most frequently reported amongst people aged 20–29 years, with 99 notified cases (Figure 9). Similar to previous years, the majority of cases were male (69.3%, n=246), and males predominated in every age group. Cases were from all jurisdictions.

The infecting species was reported for 97.7% of notifications during the season 2011–12. *P. falciparum* and *P. vivax* were the predominant infecting species (Table 5). In 2011–12, no cases were infected with *P. knowlesi*.

Complete information about the country of acquisition was available for 87.0% (n=309) of malaria cases. Papua New Guinea was the most frequently reported place of acquisition for cases with a country of acquisition specified (21.7%, 67/309), followed by India (11.7%, 36/309) (Figure 10).

P. vivax infections were commonly associated with travel to Asia or Pacific nations (96%, 106/110). *P. falciparum* infections were frequently associ-

Figure 9: Notifications of malaria infection, Australia, 2011–12, by age group and sex*



* Sex was not available for 1 case, and this case is not included here.

Table 5: Cases of malaria, Australia, 2011–12, by *Plasmodium* species

Malaria species	Number of cases	% of all cases
Plasmodium falciparum	206	58.0
Plasmodium vivax	123	34.6
Plasmodium ovale	9	2.5
Plasmodium malariae	6	1.7
Plasmodium falciparum and *P. malariae*	3	0.8
Plasmodium spp.	8	2.3
Total	355	100.0

ated with travel to the Middle East and Africa (79%, 139/176), and only 3 *P. vivax* infections (2.7%) were associated with travel to African and Middle East regions.

Other surveillance and research activities

Exotic mosquito detections at the border

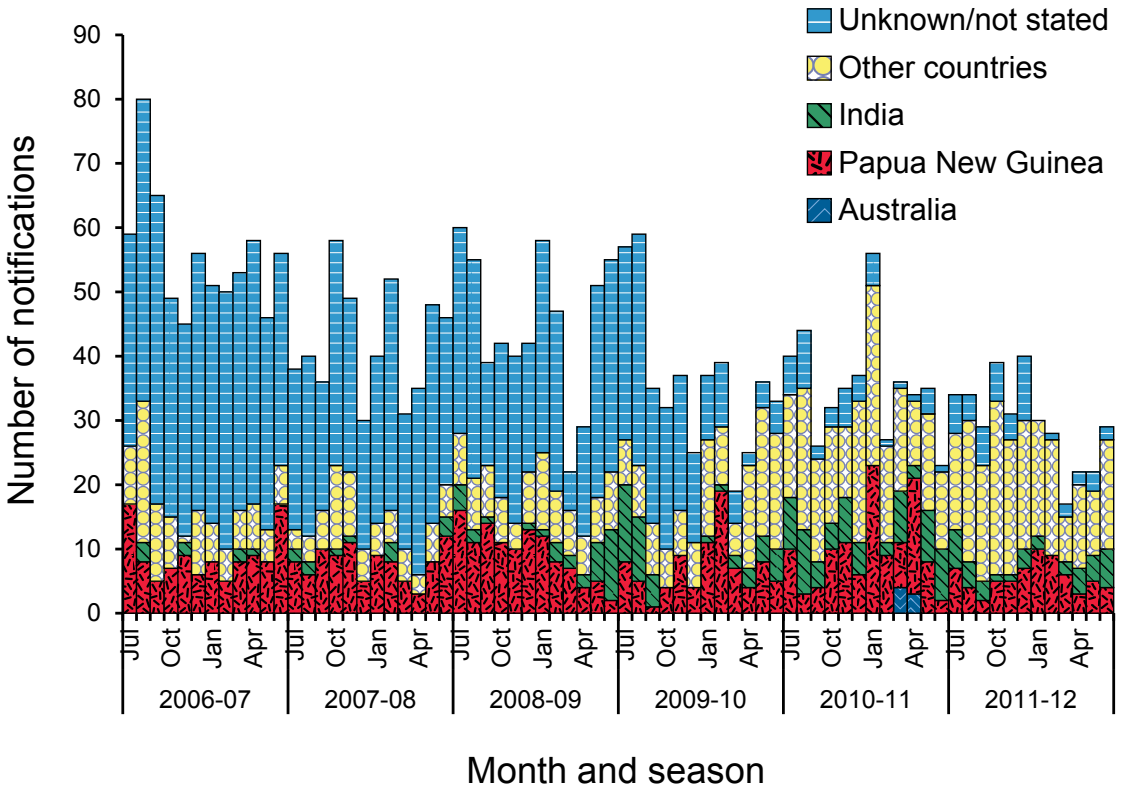
Between July 2011 and June 2012 there were 5 exotic mosquito detections made by the Department of Agriculture (formally the Department of Agriculture, Forestry and Fisheries) at the Australian border (Table 6). This is similar to the 2010–11 period where there were also 5 exotic mosquito detections. Two detections were made via inspection of international vessels and a single detection was made via routine inspection of imported cargo. The remaining 2 detections were made through vector monitoring activities performed at international ports. No further exotic mosquitoes were collected following the initial detection.

Torres Strait Aedes albopictus *Elimination and Control Program*

The Asian tiger mosquito, *Ae. albopictus*, which was previously exotic to Australia, was found on the outer islands of Torres Strait in April 2005.[26] This mosquito is capable of transmitting dengue and chikungunya, as well as becoming a new serious pest mosquito. Since 2005, the Australian Government has provided funding to Queensland Health towards a mosquito elimination program in the Torres Strait. The initial aim of the program was to eliminate *Ae. albopictus* from the Torres Strait islands. However, as elimination was subsequently not considered to be possible, the development and implementation of a program based on the *cordon sanitaire* approach (a barrier designed to prevent a disease or other undesirable condition from spreading) around Thursday and Horn islands was initiated in May 2008 in an attempt to prevent the spread of *Ae. albopictus* further south.

The main focus of the program in 2011–12 was to suppress *Ae. albopictus* populations and possibly eliminate the species from Horn Island and Thursday Island, both regarded as the gateway to the mainland of Australia due to their strategic

Figure 10: Notifications of malaria, Australia, July 2006 to June 2012, by month, year and place of acquisition*



* Thirty-four cases between 2006–07 and 2008–09 were listed as being acquired in Australia, however this was due to a default value for place of acquisition. The country of acquisition was set to unknown for this report.

Table 6: Exotic mosquito detections at the border, Australia, 2011–12

Date	Species	Location	Method of detection	Source / origin	Action/ mitigation	Surveillance results
July 2011	*Ae. albopictus* (larvae)	Cairns	Inspection	Larvae found in water within storage recesses inside vessel hold. Vessel from Irian Jaya.	Water in the hold treated. Mosquito harbourage treatments performed in the surrounding port area and additional trapping. Storage recess modified to exclude water pooling.	No further exotic mosquitoes detected.
Aug 2011	*Ae. albopictus* (adult)	Cairns	Inspection	Adult mosquitoes observed flying inside vessel hold. Vessel from Irian Jaya. No mosquito breeding observed in the vessel hold.	Targeted trapping performed on board the vessel and in the hold. Increased surveillance and trapping.	No further exotic mosquitoes detected.
Jan 2012	*Ae. aegypti* (1 adult)	Darwin	CO_2 baited BG trap.	Unknown/unable to identify source.	Ultra low volume fogging, receptacle treatment surveys, increased trapping.	No further exotic mosquitoes detected.
Feb 2012	*Ae. albopictus* (larvae and adults)	Townsville	Inspection	New oversize tyres from Papua New Guinea.	Tyres treated. Ultra low volume fogging, mosquito harbourage treatments, receptacle treatment surveys and increased trapping.	No further exotic mosquitoes detected.
June 2012	*Ae. Albopictus* (1 adult)	Townsville	CO_2 baited BG trap.	Detection coincided with the importation of new oversize tyres from Papua New Guinea but no mosquitoes found associated with the imported tyres.	Ultra low volume fogging, mosquito harbourage treatments, receptacle treatment surveys and increased trapping.	No further exotic mosquitoes detected.

location and transport networks. Consistent monitoring of mosquito densities and distribution on the 2 islands showed up to a 60-fold decline in numbers of adult *Ae. albopictus* after intensive intervention that included residual pyrethroid treatment of vegetated peri-domestic harbourage sites. The control operation also included repeated house-to-house yard inspections on at least 800 properties for removal or treatment of water-holding receptacles. At least 3,000 receptacles were inspected and treated on each field visit. The yard inspections also constituted part of the mosquito surveys and *Aedes* larval samples were collected from all positive receptacles for identification. A decline in the Breteau Index of up to 10-fold was recorded for *Ae. albopictus* on the 2 islands during the wet seasons of the reporting period, demonstrating a dramatic impact of the control program.

Surveillance activities for early detection of *Ae. albopictus* incursions in the high-risk zones of Cairns and the Northern Peninsula Area (Bamaga, Seisia, New Mapoon, Injinoo and Umajico) throughout the 2011–12 wet season did not find any *Ae. albopictus*.

Discussion

NAMAC contributes to a One-Health approach to the control of arboviral disease and malaria, by uniting experts from a range of fields to provide strategic advice on the epidemiology, surveillance and management of these diseases. This report describes the epidemiology of arboviral diseases and malaria for the season 1 July 2011 to 30 June 2012, activities undertaken by health authorities in response to human cases, and evidence of virus activity. Sentinel animal and

vector monitoring continue to be an important part of the early warning system for arboviruses in Australia.

The number of dengue notifications was notably increased compared with historical totals; there were 1.7 times as many dengue cases during the 2011–12 season as during the previous 5 years, due to an increase in the number of overseas-acquired cases. For all other diseases, notification counts and rates were similar to or below the 5-year means.

The number and proportion of dengue cases that were overseas acquired has increased in recent years, and for cases acquired in Indonesia, (which comprises most of the increase), the increase in the frequency of travel by Australians to Indonesia does not completely explain this increase.[27] Viraemic returning travellers (or visitors from overseas) present a risk of starting a local outbreak in North Queensland, and travellers should minimise the risk of infection by avoiding being bitten by mosquitoes through the use of personal prevention measures. Travellers are encouraged to consider the information available on the Smartraveller travel health website and to seek a doctor's advice prior to travel.[28]

The risk of dengue becoming endemic in North Queensland following an imported case remains a major concern. Public health authorities conduct extensive control efforts in partnership with residents in order to control the outbreaks that occur every season. The most recent large outbreak of dengue in Australia was in the 2008–09 season, when there was an outbreak of DENV3 in Cairns that lasted for 31 weeks, with 915 cases.[29] Subsequent to this reporting period (in 2012–13 and 2013–14) there have been significant outbreaks, but each comprised less than 150 notified cases. The Queensland Dengue Management Plan 2010–15[13] outlines current best practice in dengue management for the 4 levels of dengue activity; ongoing prevention, response to sporadic cases, outbreak response, and multiple outbreaks.

During the 2011–12 season, there were a small number of imported cases of CHIKV in Australia, but no local transmission. Health authorities are alert to any changes in the number of notified cases in Australia and in the region, and to the possibility of local transmission, particularly in North Queensland where competent mosquito vectors occur in suitable environments near susceptible populations.[30] While *Ae. aegypti* and *Ae. albopictus* are the principal vectors for CHIKV, laboratory studies suggest the possibility of spread by some Australian mosquito species.[31] CHIKV transmission in Australia would have significant population health implications.

The national surveillance case definitions for RRV, BFV and CHIKV require laboratory definitive evidence. One option for laboratory definitive evidence is virus-specific IgM alone, in the absence of IgM to other alphaviruses. These case definitions may introduce the possibility of false positive diagnoses, where the pre-test probability of infection is low (i.e. where the infection is rare, such as RRV or BFV in metropolitan areas). This has been particularly recognised as a problem for BFV notifications in recent years, and the laboratory case definition (on which the surveillance case definition is based) is currently under review by the Public Health Laboratory Network (PHLN). In Victoria, BFV diagnoses by IgM alone, but without a compatible exposure history (such as metropolitan Melbourne cases who have not travelled to rural areas) are followed up, and a 2nd blood sample is requested from patients to demonstrate seroconversion (Rebecca Feldman, Victorian Department of Health, personal communication). Consequently, an epidemic of false positive BFV from October 2012 in a number of Australian states was not observed in Victoria.

Since 2005, *Ae. albopictus* has become established on the majority of islands in the Torres Strait. The risk of dengue transmission in central and southern Queensland and other jurisdictions would be substantially increased if this vector became established on the mainland, and control efforts through the Torres Strait *Ae. albopictus* Elimination and Control Program are vital to prevent incursions to the mainland. In mid-2011, small populations of *Ae. albopictus* continued to persist on Horn Island despite control efforts, however since that time, the program has been demonstrably successful at reducing *Ae. albopictus* numbers in the *cordon sanitaire* to levels where eradication is now a real possibility. The 60-fold decline in the number of adult *Ae. albopictus* on the 2 islands following intensive intervention, and a 10-fold decline in the Breteaux index demonstrates this impact.

In response to the MVEV outbreak between March and May 2011, the AHPPC requested that NAMAC prepare a framework for the surveillance, prevention and control of MVEV in Australia, emphasising a One-Health approach, along with guidance for public health units as part of CDNA Series of National Guidelines (SoNGs). The SoNGs document and the Framework were endorsed by AHPPC on 14 November 2013.

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 2011 NNDSS annual report.[1] A specific 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 assumes a clinically compatible illness. A case can still be notified when clinical illness may not be consistent with the diagnosis of alphavirus infection. From 1 January 2013, revised case definitions for RRV and BFV were implemented, whereby an IgM-only diagnosis for one of these was required to be in the absence of IgM to the other. However, there remains the issue of whether IgM only is an appropriate diagnostic method for these viruses. At the time of writing, the laboratory case definition for BFV was under review by the PHLN. Another limitation on the findings of this report relates to place of acquisition of infection for infections that are commonly acquired overseas, in terms of completeness and consistency of coding. Information on place of acquisition is particularly important for the arboviruses that do not commonly occur in Australia, because it facilitates the monitoring of increased importations from particular areas, and allows the detection of any local transmission. The National Surveillance Committee is currently undertaking a project to standardise coding of place of acquisition between jurisdictions.

Continued vigilance and the involvement of all relevant sectors enable the rapid detection of and early response to the threat of arboviral disease and malaria in Australia. The expert advice provided by NAMAC to AHPPC, CDNA and health departments has a vital role in mitigating mosquito-borne disease threats. Into the future, NAMAC strives for a reduction in the number of arbovirus cases in Australia, a strengthened disease prediction capacity to allow planning for response, and to retain, build and disseminate expertise and knowledge pertaining to mosquito-borne diseases.

Arbovirus research laboratories in Australia

Commonwealth Scientific and Industrial Research Organisation

CSIRO Australian Animal Health Laboratory
Private Bag 24 (5 Portarlington Road)
GEELONG VIC 3220
Telephone: +61 3 5227 5000

New South Wales

Institute of Clinical Pathology and Medical Research, Pathology West
Westmead Hospital
Locked Bag 9001
WESTMEAD NSW 2145
Telephone: +61 2 9845 6255

Northern Territory

Northern Territory Department of Primary Industries and Fisheries
Makagon Road
BERIMAH NT 0828
Telephone: +61 8 8999 9251

Queensland

Queensland Health Forensic and Scientific Services
39 Kessells Road
Coopers Plains
PO Box 594
ARCHERFIELD QLD 4108
Telephone: +61 7 3274 9151

Victoria

Victorian Infectious Diseases Reference Laboratory (Human)
792 Elizabeth Street
MELBOURNE VIC 3000
Telephone: (03) 9342 9600

Victorian Department of Primary Industries
Attwood Centre
475 Mickleham Road
ATWOOD VIC 3049
Telephone: +61 3 9217 4200

Western Australia

PathWest Laboratory Medicine WA
Division of Microbiology and Infectious Diseases (Human)
Hospital Avenue
NEDLANDS WA 6009
Telephone: +61 8 9346 3122

Arbovirus Surveillance and Research Laboratory
Discipline of Microbiology and Immunology (animal/vector)
School of Pathology and Laboratory Medicine
The University of Western Australia
35 Stirling Highway
CRAWLEY WA 6009
Telephone: +61 8 9346 2212

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Author details

Katrina E Knope[1]
Stephen L Doggett[2]
Nina Kurucz[3]
Cheryl A Johansen[4]
Jay Nicholson[4]
Rebecca Feldman[5]
Angus Sly[7]
Michaela Hobby[8]
Debra El Saadi[9]
Mike Muller[10]
Cassie C Jansen[11]
Odwell M Muzari[12]

The National Arbovirus and Malaria Advisory Committee (see acknowledgement).

1. Zoonoses, Foodborne and Emerging Infectious Diseases Section, Health Emergency Management Branch, Office of Health Protection, Department of Health, Canberra, Australian Capital Territory
2. Department of Medical Entomology, Pathology West, Institute for Clinical Pathology and Medical Research, Westmead Hospital, Westmead, New South Wales
3. Medical Entomology, Centre for Disease Control, Health Protection Division, Northern Territory Department of Health, Royal Darwin Hospital, Casuarina, Northern Territory
4. Division of Microbiology and Infectious Diseases, PathWest QEII Medical Centre, School of Pathology and Laboratory Medicine, Faculty of Medicine, Dentistry and Health Sciences, University of Western Australia, Nedlands, Western Australia
5. Arbovirus Surveillance and Research Laboratory, School of Pathology and Laboratory Medicine, Faculty of Medicine, Dentistry and Health Sciences, University of Western Australia, Nedlands, Western Australia
6. Communicable Disease Prevention and Control, Department of Health, Melbourne, Victoria
7. Operational Science Program, Department of Agriculture, Border Compliance Division, Eagle Farm, Queensland
8. Health Protection, Public Health, South Australian Department of Health, Adelaide, South Australia
9. Communicable Diseases Unit, Queensland Health, Herston, Queensland
10. Medical Entomologist, Brisbane City Council, Fortitude Valley, Queensland
11. Medical Entomologist, Metro North Hospital and Health Service, Windsor, Queensland
12. Medical Entomologist, Cairns Hospital and Health Service, Cairns, Queensland

Corresponding author: Ms Katrina Knope, Zoonoses, Foodborne and Emerging Infectious Diseases Section, Health Emergency Management Branch, Office of Health Protection, Australian Government Department of Health, MDP 14, GPO Box 9848, CANBERRA ACT 2601. Telephone: +61 2 6289 2751. Email: Katrina.Knope@health.gov.au

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