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.

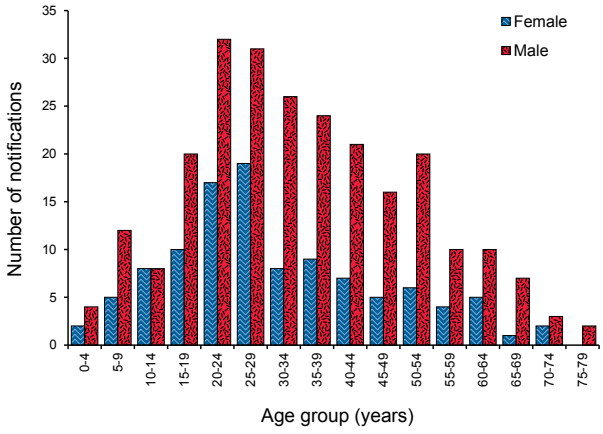
Malaria was most frequently reported amongst people aged 20–29 years, with 99 notified cases (Figure 9). Similar to previous years, the majority of cases were male (69.3%, n=246), and males predominated in every age group. Cases were from all jurisdictions.

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

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.

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