BUSSELTON MOSQUITO SURVEY
INTERIM REPORT AND PRELIMINARY MOSQUITO CONTROL RECOMMENDATIONS

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1. Introduction

Surveys of mosquito breeding areas within the Busselton Shire were undertaken by the author, with the assistance of Busselton Shire Health personnel, during winter and spring of 1996. However, delays in the commissioning of the Busselton Shire's Geographic Information System (GIS) have meant that it was not possible to analyse results of these mosquito breeding surveys until June 1998.

Analyses in this interim report also utilise relevant information from adult mosquito monitoring results obtained by the author as consultant to he Port Geographe development in 1988 and routine adult mosquito monitoring results provided by the University of Western Australia to the Shire of Busselton since 1992.

This Interim Report does not include detailed analysis of the above results or full discussion of the issues raised by them. These will be provided in a subsequent final report at a later date. The purpose of the Interim Report is to provide analysis and discussion of results sufficient to make recommendations for actions by the Busselton Shire which will enable reduction of both the health risks from Ross River (RR) virus and the associated nuisance mosquito problem.

2. Definition of the Mosquito/Ross River virus problem in the Busselton Shire

a) *Mosquito Breeding Areas (See Figs 1-3)*

Busselton is built on a broad, low coastal dune immediately adjacent to extensive freshwater wetlands which stretch in a long chain from just south of Bunbury to the eastern edge of Dunsborough. Tidal encroachment into these extensive sub-coastal wetlands is largely prevented by lock gates installed near the combined mouth of the Vasse/Wonnerup Estuaries. Consequently, only two relatively small areas of tidal salt-marsh remain in the Busselton Shire; the mouth of the Vasse/Wonnerup estuary and Toby's Inlet. In these two areas breeding of *Aedes camptohynchus* mosquitoes is generated by both heavy rainfall and high tides.

The majority of mosquito breeding areas within the Busselton Shire are within the sub-coastal chain of freshwater wetlands. *Aedes camptorhynchus* mosquitoes are responsible for the vast majority of the nuisance and associated health risk from Ross River (RR) virus within the Busselton Shire. They breed at varying densities following rises in water levels in these wetlands. These water level rises hatch the dormant eggs of this mosquito species laid both on

the substrate and the lower stems of *Sarcoconia* (samphire) plants in areas prone to flooding and water-logging. There is a very strong association between *Sarcoconia* and high density breeding of *Aedes camptorhynchus* in the Busselton Shire. ***Aedes camptorhynchus* breeding cycles are dependent on water level rises, both directly from heavy rain and indirectly from runoff elsewhere in the wetland catchments. This means that both the nuisance and health risks (RR virus) are restricted to the spring/early summer period each year.** This contrasts favourably with the Bunbury and Mandurah areas, where samphire marsh areas are subject to extensive tidal inundation intermittently throughout the whole year, resulting in year round populations of *Aedes camptorhynchus* and summer populations of *Aedes vigilax*, both of which are major vectors of Ross River virus. The latter species appears to be absent in the Busselton area.

However, despite the restriction of the mosquito nuisance and health threats posed by *Aedes camptorhynchus* to spring and early summer each year, the sheer extent of the mosquito breeding areas involved means that effective control of mosquitoes in the Busselton Shire will not be cheap or easy.

b) *Drainage System*

An extensive network of drains was installed throughout the coastal wetland areas of the Busselton Shire for flood mitigation purposes during the 1960's. Some of these drains are maintained and controlled by private landowners, whilst many are maintained and controlled by the Water Corporation. This drainage network was not installed for mosquito control purposes and maintenance of water levels within the drainage system is not conducted with mosquito control as a priority. Instead it would appear that water level maintenance schedules are carried out in a fairly *ad hoc* manner for the dual purpose of maximising usage by water birds and aesthetic appeal. In the case of the latter criterion, rather Euro-centric values appear to be in evidence, whereby the wetland areas are considered to be less aesthetically appealing if allowed to dry out seasonally as many would naturally in the mediterranean, summer drought climate which Busselton enjoys. Consequently, water levels appear to be maximised throughout much of the year to keep the wetlands wet as long as possible each year.

c) *Seasonal Variations*

The severity and duration of the nuisance and health threat posed by *Aedes camptorhynchus* mosquitoes breeding in freshwater wetlands within the Busselton Shire varies considerably from year to year depending upon the amount and pattern of seasonal rainfall. In seasons when spring rainfall is light or absent, *Aedes camptorhynchus* activity is reduced to the August/September period. However, in years when heavy late spring or early summer rainfall occurs, (eg: 1995), activity of these mosquitoes continues throughout spring into the summer school holidays in January. These are the years of greatest mosquito impact and are usually associated with epidemics of Ross River virus. Most years have rainfall patterns somewhere in between these two extremes,

and consequently the mosquito nuisance and Ross River virus risk lasts from about August until October or November in most years.

d) *Vertebrate Hosts of Ross River Virus*

RR virus survives in natural zoonotic cycles between mosquito vectors and wildlife hosts, largely independent of humans. In the south-west of Western Australia the major wildlife host of RR virus is thought to be western grey kangaroos due to the steadily accumulating weight of evidence implicating them in virus transmission. Large numbers of western grey kangaroos occur throughout the Busselton area, their numbers apparently boosted by the widespread availability of pasture, and artificial feeding by one particular local property owner. Arguably, these practices appear likely to result in an elevated health risk from RR virus due to the increased availability of virus infected bloodmeals for *Aedes camptorhynchus* mosquitoes.

e) *Adult Mosquito Harbourage*

Once they have emerged as flying adults, mosquitoes are very subject to dissication and their mortality rate is high; studies in the USA suggest daily mortality rates of 10-25%. Although such studies have not yet been undertaken in Western Australia, similar results would appear likely here. In order to transmit RR virus, *Aedes camptorhynchus* mosquitoes must feed on a viraemic host, incubate the virus for 1-2 weeks until it has multiplied to an infective dose, and then pass it on at a subsequent bloodmeal. Therefore mosquito populations that live longer are a far greater health threat as vectors of disease than those which die off quickly.

Numerous observations suggest that *Aedes camptorhynchus* mosquitoes in the Capel/Busselton region are attracted to, and survive longer in heavily wooded areas, especially areas where Tuart (*Eucalyptus gomphocephala*) and Peppermint (*Agonis flexuosa*) trees are prevalent.

Strong circumstantial evidence suggests that adult *Aedes camptorhynchus* can disperse 3-5 kms away from breeding areas in search of bloodmeals. Thus adult mosquitoes emerging from the extensive sub-coastal freshwater wetland and tidal saltmarsh breeding areas spread over most of the coastal 5 km corridor. This has important implications for control as discussed briefly in the latter section on adult mosquito control.

f) *Health Threats; Ross River Virus and Barmah Forest Virus*

These two viruses cause debilitating and painful arthritic diseases lasting for an and average of 6-12 months. The arthritic pain and associated fatigue syndrome usually result in severe disruption to lifestyle, extensive time off work and deleterious stress effects on marriages and families. Accordingly, these diseases adversely impact upon productivity, and almost certainly tourism and house and land values, in areas where they are prevalent.

Ross River virus is very active in the Busselton area, with over 300 human cases notified from the Shire since 1988. The majority of these cases were notified during the wet spring epidemic years of 1988, 1991 and 1995 with a further 88 cases in 1997/98 following localised flooding of the Radio Tower swamp west of Busselton. Case attack rates in the Busselton Shire are even higher than those in the Peel Region.

3. Mosquito Control Recommendations

a) *Enhancement of the Existing Drainage System*

In order to minimise the breeding of *Aedes camptorhynchus* mosquitoes in seasonal freshwater wetlands the existing drainage system should be renovated, including the following specific initiatives:

i) Remove sandbars preventing effective emptying of major channels where they drain into Geographe Bay. This should be done at least once per year in early August and repeated as often as necessary to ensure effective drainage following each significant water level rise created by rainfall and catchment runoff;

ii) Ensure all gates and flap valves are maintained in good working order to prevent any encroachment of sea water back up the drains into the freshwater wetlands. This is necessary for both mosquito control and wetland conservation reasons;

iii) Where environmentally permissible the existing drainage system should be enhanced by the installation of small drains or runnels feeding into the existing drainage system.

b) *Drainage of Saltmarsh Areas*

Runnels should be installed in tidal saltmarsh areas around the mouth of Vasse/Wannerup Estuary and at Toby's Inlet to largely prevent the breeding of *Aedes camptorhynchus* mosquitoes following high tides.

c) *Tidal Exclusion*

The existing exclusion of tides from the Vasse/Wonnerup Estuary should be maintained to the extent necessary to prevent tidal inundation of fringing samphire marshes.

d) *Monitoring of Breeding Areas*

The three high priority areas (Figs 1-3) should be intensively monitored weekly from early August each year until three weeks following the last seasonal rainfall during spring/early summer. Low priority and suspected mosquito breeding areas should likewise be monitored and evaluated as time permits.

e) *Adult Mosquito Monitoring*

Adult mosquito levels should be monitored weekly at the sites indicated on Fig 4 in order to both evaluate the success of control measures and to assist in the direction of future monitoring and control efforts. These are the minimum trap-sites necessary for this purpose. Over time it will probably be necessary to regularly monitor additional sites. Opportunistic monitoring of residential area sites should be carried out following complaints by ratepayers to help determine the likely source(s) of mosquito problems.

f) *Mosquito Control Using Larvicides.*

This technique is the key to obtaining effective mosquito control in the short to medium term until maximum levels of mosquito control via renovation and enhancement of the drainage system can be achieved. Even when the drainage system has been thus upgraded, some reliance on the use of larvicides will remain.

Larvicides should be applied to *Aedes camptorhynchus* mosquito breeding areas whenever weekly monitoring [d) above] indicates the need to do so. This will usually be 4-20 days following rainfall and water level rises, depending on temperature; in winter life cycles (egg hatch until adult emergence) can be as long as a month or so, whereas in mid-summer they can be as little as one week.

Many of the seasonal and permanent wetlands in the Busselton Shire have fairly extensive areas of mosquito breeding. In these larger areas it is recommended that larviciding should be carried out by helicopter to allow effective disposal at a consistent minimum dose. The best larvicide for this purpose is Altosand^{R}, consisting of a 4g/kg coating of S-methoprene on sand granules suitable for aerial application. S-methoprene is a synthetic insect growth regulator which mimics the mosquito juvenile hormone, preventing metamorphosis into adult mosquitoes and retaining the immature mosquitoes as larvae and pupae for several days before their eventual death. This means that these immature mosquitoes remain in the aquatic environment as food for birds and other forms of life. S-methoprene is highly specific in its effects to mosquitoes and midges and is extremely safe for other forms of life.

To date the other extremely safe larvicide, *Bacillus thuringiensis* var. *israelensis* (Bti), is not available in a sand granule formulation suitable for aerial application. However, this larvicide is available in liquid and coarse

granule formulations suitable for ground based application and should be thus used to treat smaller *Aedes camptorhynchus* breeding areas.

Use of two larvicides with completely different modes of action (*Bti* is a mosquito specific endotoxin derived from bacteria) will help delay the onset of resistance in the target mosquitoes. Funding assistance for health driven mosquito control programs is available from the Health Department of Western Australia in the form of fifty percent of the cost of larvicides (based on an annual budget) and the full cost of helicopter hire for aerial application of larvicides. A draft application for Health Department of Western Australia funding assistance to enable larvicide treatment of the three highest priority areas is attached (Appendix 1). All three of these areas are under the control of the Department of Conservation and Land Management, whose permission will be necessary before larvicide applications can commence.

g) ***Personnel Required to Effectively Control Busselton Mosquitoes***

Mosquito control using larvicides is dependent upon the ability of people to effectively find and kill the mosquito larvae. If only half of the mosquito breeding is thus located and all mosquitoes found are killed, half of the problem will remain. Needless to say people are not usually very appreciative of getting say fifty bites in an evening instead of a hundred. However, they might appreciate ten bites instead of a hundred.

The point is mosquito control simply will not work if inadequate personnel are deployed to deal with the problem. Based upon experience of mosquito control in the Peel Region (the benchmark for Western Australia), and knowledge of similar programs in the Brisbane and Gold Coast municipalities in Queensland, I believe the following represents minimum staff necessary to carry out an effective control program as outlined above.

i) Monitoring of mosquito breeding sites/ground larviciding. Four to six well trained and interested staff would be required to carry out this function effectively, however all but one would only be required from about July to December each year (depending upon seasonal rainfall), and would be available for other duties for the other six months of the year.

ii) Adult monitoring and identification. One well-trained person would be required full-time, year round, and a second person would be required from July to December each year.

iii) Renovation and enhancement of drainage systems. This is more difficult to assess as some of the work is likely to be the responsibility of other agencies. However, a team of two to four personnel would probably be required for maintenance purposes, and for the excavation of runnels.

4. Adult Mosquito Control

To date, mosquito control in the Busselton Shire has been restricted to fogging to kill adult mosquitoes. Whilst adulticide fogging can have some temporary impact when used in residential areas, it is largely ineffective because of the ability of adult *Aedes camptorhynchus* to disperse 3-5 km away from breeding sites. **It is therefore simply not possible to apply adulticides to a large enough area to obtain effective control.** Furthermore, the widespread use of adulticides is environmentally undesirable because the insecticides concerned (synthetic pyrethroids) kill all other insects and spiders they contact. This issue will be discussed more fully in the final report.

5. Public Education Measures

These will be dealt with in the final report. However, in the interim public awareness of the health risks posed by Ross River virus should be maximised during the risk season of spring/early summer. The Health Department of Western Australia can provide pamphlets, posters and a video to assist with this process.

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