Review of New Zealand Mosquito Surveillance:
Ports (Sea- and Air-) Mosquito Surveillance Review

Contracted to James Cook University

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conducted by

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Container devanning site at Napier seaport.

Highly receptive *Aedes albopictus* habitat is just across the road.

Background

New Zealand has been subject to the introduction and establishment of exotic mosquitoes capable of vectoring viruses causing disease in man. In 1998, Napier saltmarshes were found to harbour large numbers of the southern saltmarsh mosquito (SSM) *Aedes camptorhynchus* that was introduced from Australia. An eradication program was established and the SSM was declared successfully eradicated from New Zealand in July 2010 (for a comprehensive review see Kay and Russell 2013). The National Saltmarsh Mosquito Surveillance Program (NSP) continues to monitor at-risk sites for the presence of SSM; this is undertaken by the Ministry for Primary Industries (MPI) and is outside the scope of this review. Air- and seaports are also at risk of incursions of exotic mosquitoes, especially container-breeding *Aedes* such as the dengue vectors *Aedes aegypti* and *Aedes albopictus*. The Ministry of Health (MOH) administers vector surveillance programs at ports, with activities carried out by regional District Health Board (DHB) staff.

Several reviews of New Zealand (NZ) mosquito surveillance programs have been carried out in the past 15 years. We will not go into detail, but the reports of Kay (1997) and Ritchie and Russell (2002) highlighted the need to maintain and improve existing mosquito surveillance and control programs to minimise the establishment of exotic disease carrying mosquitoes. Our report here uses the 2002 review as a template to highlight changes associated with Port Surveillance since 2002, and new challenges that need to be addressed. At ports, the risk of importation of exotic mosquitoes appears to be increasing in some aspects, with *Ae. albopictus* occupying an ever-growing geographic area, but is decreasing where particular introduction pathways, such as imported used tyres, have been rectified.

To establish the current situation with port surveillance in NZ, we visited several key ports. Staff from the MOH, various DHBs and MPI were interviewed, with field "operational" staff observed doing their respective jobs in the field. As was the case in 2002, both reviewers were involved in tours and reviewing of programs, and contributed to discussions and editorial input. We would like to thank Lora Peacock of MPI for organising the project, and Sally Gilbert and JR Gardner of MOH for setting up port tours. We also thank them and the field staff of DHBs for their time and Kiwi hospitality.

This review was to be simply a review of port surveillance activities and not an audit of the procedures. The review team had discussions with MOH and MPI personnel, and visited the Mosquito Consulting Laboratory in Wellington, before visiting DHB and MPI personnel at Whangarei, Auckland, Tauranga, Napier, Christchurch and Nelson. The sea- and airports at these locations were visited, and the mosquito surveillance equipment and procedures were observed and discussed. This review comprises an executive summary, a basic introduction and description of the methodology, a review of the local and general findings, and a number of recommendations. Details of sites visited are provided in Annex A.

Executive Summary

- Since our previous review (Ritchie and Russell, 2002), the situation with respect to maintaining effective border surveillance for exotic mosquitoes has much improved: the current port surveillance program can be seen to be broadly meeting the needs of the Ministry of Health (MOH); mosquitoes are being collected by the methodologies employed within the various regional strategies, specimen despatch for laboratory identification has been found to be relatively efficient, and the laboratory has shown itself to be technically highly proficient. However, there is a relatively small number of particular issues where improvements are required and resolution of those mentioned below should be pursued.

- There should be more routine general larval ground surveys of ports and their potential / actual habitats. Fixed surveillance for immature stages of mosquitoes is undertaken well in general terms, but variously, with ovitraps targeting eggs of container mosquitoes and tyre traps that allow the collection of larvae. In our view, the use of ovitraps should cease and tyre traps deployed in their stead, and these should contain water infused with an attractant (e.g., rabbit/rat food pellet or similar) and have methoprene (pellets or granules) added for security against adult emergence.

- Surveillance of adult stages of mosquitoes is undertaken efficiently at most ports, but variously, with the number and range of trap types differing between ports. It is strongly recommended that those ports currently not using adult traps should do so and, although it is difficult to be prescriptive about the number that should be deployed, it would be useful to have at least 2 (if not 3) adult traps servicing each port wharf receiving high-risk vessels / cargo. Collection pots of Bland-type light traps should allow for efficient air through-flow to maximise insect capture (because currently some don't), and CO_2 lines should be attached above or to the side of the trap body (and not feed directly into the trap opening as we saw occasionally). A number of ports are using relatively novel traps: different versions of 'blacklight' (ultraviolet) traps. Such light traps will collect insects attracted to UV light (including diurnally active mosquitoes), but their relative effectiveness for the current principal target mosquitoes *Aedes aegypti* and *Aedes albopictus* is unknown and they need to be assessed as being 'fit-for-purpose'.

- Following on from the above, there needs to be a consideration of whether a uniform approach with particular equipment is desirable and practical, how this can be achieved, and whether this may require a central provider (such as MOH, Wellington). In our view, a national uniformity is desirable, providing the trapping equipment chosen has been shown to be 'fit-for-purpose', and practicality considerations of electricity supply (batteries or mains power) and

carbon dioxide provision (gas or dry ice) are taken into account. Further, these changes must be incorporated into the present training program which, while seemingly providing adequate instruction into surveillance methodology, could be enhanced with respect to developing competencies, and personnel could be required to take a refresher course after 3 years (in line with other statutory officer training requirements) to maintain their level of competence, and be updated on new threats, risk and equipment developments.

- Transitional Facilities (devanning sites) are becoming an increasing concern, and there appears to be a need for adequate surveillance. These facilities must somehow receive an increased level of expert surveillance, and must be maintained in a highly sanitary condition so as not to provide habitat for exotic mosquitoes; their neighbouring properties, likewise, should be inspected for receptivity. Given the very large number of transitional facilities that exist, a risk assessment is necessary to direct surveillance. MPI and MOH should explore options to ensure that the risk is effectively managed at transitional facilities. As an example, findings of exotic mosquitoes at these facilities (and at ports) should be reported with a view to those data being incorporated in their risk assessments for high risk site surveillance.

- The current Memorandum of Understanding (MOU) between MOH and Ministry for Primary Industries (MPI) needs to be reviewed, revised and widely agreed so that all parties involved fully understand their roles and requisite activities, and can work interoperably. This should lead to a mutually more productive relationship between MOH and MPI regarding effective exclusion, border surveillance for exotic pests and appropriate responses to interceptions and incursions of exotic mosquitoes.

- Finally, given the changes in scope and detail that came with the revised IHR, there may be a need for MOH to redefine their objectives with regard to the port surveillance program, so that appropriate technologies can be selected; e.g., is the strategy to continue to be directed towards the detection/interception of particular container species associated with transmission of dengue and yellow fever viruses, or should other exotic vector species of public health importance, and principally associated with wetlands and surface drainage systems, also be targeted? An extension of the list of target species may necessarily require an extension of surveillance practices and also of competency training.

Introduction

In 2002, the authors of this present report undertook a review of the '*New Zealand Mosquito Surveillance Programme*' (Ritchie and Russell 2002) for the NZ Ministry of Health (MOH), and this included a review of the surveillance strategies and procedures at NZ first ports (sea- and air-) of entry.

Subsequently, the *Mosquito Surveillance Review 2008* (McGinn 2008) also assessed the performance of the MOH Border Health Mosquito Surveillance programme.

Both of these reports provide background information on the rationale for, and the past and present procedures of, the commitment of the MOH to sustain a border protection capability to prevent introduction of exotic mosquitoes (particularly the 'disease vectors' *Aedes aegypti* and *Aedes albopictus*) to NZ through its international sea- and airports, in accordance with the current International Health Regulations of the World Health Organization (WHO, IHR 2005). Accordingly, such information is not repeated here.

However, what remains relevant for consideration in the present context is the Memorandum of Understanding (MOU) on biosecurity activities between Ministry of Agriculture and Forestry (MAF) now Ministry for Primary Industries (MPI), and Department of Conservation, Ministry of Fisheries (now part of MPI), and Ministry of Health (31 October 2006), with the associated Biosecurity Handover Certificate (23 April 2008). Through these documents, MoH, at Paragraphs 43, 44 and 45 of Section 5.2.2, is responsible for *"….surveillance for and exclusion of rats and mosquitoes, which pose human health risks.*" MOH is also to be responsible for "*port sanitation; surveillance for and exclusion of rats and mosquitoes that pose health risks to meet international health regulations,….*". And, notwithstanding the changes in government departmental structures, the MOU specifies at Para 37 of Section 5.2.1, that MAF (now MPI) is responsible for "*managing national-scale programmes for post-border surveillance, investigation, initial and on-going responses*". Further, in Appendix 7 of the MOU, at point 4, it is specified that the MOH and MAF (MPI) will work together to maintain a capacity for identifying mosquitoes of public health significance, and that any mosquito specimens found at the ports or received by MPI (then MAF) or MOH will be forwarded as soon as possible to the Mosquito Consulting Services (MCS) reference laboratory for identification.

Methodology

The review team met with MOH, MPI and MCS personnel in Wellington, visited the MCS laboratory, and then travelled to the following regional centres to meet with MOH Public Health Unit (PHU) staff and MPI quarantine staff associated with the local port surveillance activities: Whangarei, Auckland, Tauranga, Napier, Christchurch and Nelson (see the itinerary in Annex A). Although MPI staff may detect mosquito larvae or adults on a vessel, or on cargo or sundry receptacles within the confines of a port, advise the local PHU and collect the specimens for handing on to PHU staff, it is the MOH PHUs that are responsible for auditing the port companies' performance on medical vector surveillance at the border in larger regions or by undertaking the surveillance themselves in smaller regions.

It was emphasised to us and the local PHU staff that this review was to be simply a review of port surveillance activities and not an audit of the procedures. At each centre, a meeting was first held at the Public Health Unit where documentation relating to import vessels and cargo, and previous surveillance results, was provided and discussion ensued that together provided an overview of the local strategies and technologies that constituted the local border health protection for medical vector surveillance. The local surveillance equipment and procedures were discussed and inspected, tours of the ports (both sea- and air-, where applicable) were undertaken, and local MPI personnel were met and engaged in similar discussion.

Overall findings

Fixed surveillance for immature stages of mosquitoes is typically undertaken efficiently at most ports, but variously with ovitraps targeting eggs of container mosquitoes and tyre traps that allow the collection of larvae. However, general ground surveys for larval habitats are not undertaken routinely in all ports.

Fixed surveillance of adult stages of mosquitoes is typically undertaken efficiently at most ports but variously, with the number and range of trap types differing between ports, although the so-called 'Bland' trap is most commonly used.

Although the overall surveillance appears to be undertaken in an effective manner, the lack of a uniform consistent approach is worrying. There should be a national stocktake (inventory) of surveillance equipment with a view to standardising surveillance with known effective technologies. This applies particularly to the use of different adult traps in different ports and their likely different efficacies (and may involve having some of the new-type adult traps tested internationally for practicality and effectiveness against the current main target mosquitoes *Aedes aegypti* and *Aedes albopictus*, and perhaps other exotic species if any become of particular concern). The standard use of tyres as larval traps (and the removal of ovitraps as an option) with infused water and the addition of methoprene, and the cessation of internal brush scrubbing before re-filling as part of the protocol, would improve the surveillance.

At the introductory meetings with MPI and MOH separately in Wellington, and in later discussions with MOH and MPI regional operatives, it became apparent there was a lack of clarity and mutual understanding regarding the MOU: details of 'detection' definitions (such as 'interception' and 'incursion') and the responsibilities for initial and follow-up actions/responses subsequent to the finding of a mosquito specimen in a vessel or cargo or receptacle within a port, in a surveillance trap at the port, or in some place near to but beyond the boundary of the port. As we progressed through the itinerary, this lack of clarity around the detail of the MOU (and even, in some cases, of its existence) by personnel who could be involved with detections of mosquitoes at the ports was reinforced.

Similarly, with the regional PHUs, there was an apparent lack of full awareness and need for full compliance with the MOH guidelines for port surveillance as set out in the *Environmental Health Protection Manual*, and its *Section 5 (Biosecurity)*, where standard operating procedures (derived from the Ritchie and Russell 2002 report) are described in detail. Not all ports were deficient in this regard but the principle

issues of concern related to (i) the continued use of ovitraps rather than the more practical tyre traps, (ii) the non-use of an organic additive to the tyre trap water to increase its attractiveness and the non-use of methoprene in tyre traps to prevent adult emergence, and the brushing out of tyres prior to refilling (which would remove recently laid eggs that have not yet had the opportunity to hatch, and provide for false negative results), (iii) the non-use of carbon dioxide (CO_2) as a bait for the adult traps, and the diversity of adult traps used (including some that may have great practical value but for which there is no evidence of relative effectiveness in attracting and collecting the principal target species), (iv) regular ground surveys within (and adjacent to) port boundaries for larval habitats (container and surface water). Unfortunately, in this regard, MOH doesn't have direct control over PHU activities and cannot directly control the regional / local surveillance strategies and methodologies.

Overall, however, finding that the various PHUs were collecting mosquitoes, albeit almost always local species, from their egg/larval surveillance efforts at the ports was a welcome indication that their traps could be expected to intercept the target exotic species leaving arriving vessels or emerging from arrived cargo. With regard to the adult mosquito collections that have been made, again mostly local not exotic species, assessing the capacity of the various traps being used is somewhat coloured by the fact that some of the traps have not been shown to be 'fit-for-purpose' for the principal target species. A number of ports are using a version of 'blacklight' (ultraviolet) traps, which purport to attract mosquitoes with their UV light source and production of CO_2 from a photocatalytic action of the UV light on a titanium dioxide plate within the trap. Such UV light traps will collect insects (including diurnally active mosquitoes) attracted to the light, but their effectiveness for the target species *Aedes aegypti* and *Aedes albopictus,* relative to alternative traps being used in NZ is not known to us. One of these traps (V-MART) has been tested in two versions by one of us (SAR) in Australia and been shown to be significantly less effective for *Aedes aegypti* than the BG Sentinel trap that was used as a comparison. These traps do present as being logistically attractive and practical devices for use in port surveillance strategies, particularly as they appear to not need carbon dioxide gas; however, they do require mains (240v) power, which does limit the deployment options, and they have not been tested as being 'fit-for-purpose', even as compared with the CO_2-baited 'Bland' trap that is more widely used.

While the MOH is responsible for mosquito surveillance at first ports of entry under the International Health Regulations (IHR) of the World Health Organization (WHO), beyond the port border there is an increasingly very large number of Transitional Facilities (TFs) where devanning of cargo containers is undertaken. While many of the TFs have a 6 monthly audit and habitat checks by the auditors, these places are becoming increasingly problematic with increase in cargo from high risk areas. Surveillance should be done to ensure receptive habitat for mosquitoes is managed. Currently, MPI are more directly involved with the TFs and perhaps should be responsible for their surveillance for mosquitoes (given it could be argued the TFs are outside the MOH's particular IHR interest with respect to keeping air- and seaports sanitary), and perhaps the National Surveillance Program (NSP) activities could be expanded to cover the TFs, by at least undertaking local site container surveys and checking nearby surface habitats.

There is some concern within MOH and their PHUs that MPI appears to have changed its *modus operandi* at the ports, and has moved from a hands-on border inspection model to a more remote ITOC risk-assessment driven approach. With the 'proliferation' of TFs, there is a perceived concomitant increase in the risk of exotic mosquito importations not being detected.

Finally, the MCS mosquito reference laboratory, which provides identification and training services, was found to be a highly professional unit with technically proficient personnel and appropriate professional resources and practices.

Recommendations

1. Overall, with regard to advice on surveillance strategies and procedures, the Appendix 1 of our previous report (Ritchie and Russell 2002), '*Standardised Guidelines and Best Practice Procedures for Vector Monitoring at Ports*' is still relevant, as is the related *Section 5 (Biosecurity)* of the *Environmental Health Protection Manual*, which provides the MOH guidelines for port surveillance and standard operating procedures. Although the overall port surveillance activities appear to be undertaken in an effective manner, some deficiencies remain and these should be addressed as follows:

2. There should be more general ground surveys of ports for larval habitat (in container and surface waters) undertaken regularly (e.g., 3 times per year), and drainage pits/sumps/catch-basins at ports should be treated regularly with methoprene (pellets or granules). Where methoprene is not locally available for use, this situation should be remedied.

3. Consideration should be given to providing for a national uniform approach to larval and adult surveillance collection methodology at ports; this may require MOH to consider supplying particular adult traps to the PHUs to ensure their use and enhancing their continuing training program. In our view it is desirable to have a uniform approach, providing the trapping equipment chosen has been shown to be 'fit-for-purpose' at the particular port. This includes ensuring that any Bland-type traps used have trap collection pots with good airflow, and any blacklight-type traps used have been shown to effectively collect the principal target species; further, practicality considerations of electricity supply (batteries or mains power) and carbon dioxide provision (gas or dry ice) must be taken into account relative to the particular port. Moreover, these changes must be incorporated into the present training program which, while seemingly providing adequate instruction in surveillance methodology, could be enhanced with respect to developing competencies, and personnel could be required to take a refresher course after 3 years to maintain their level of competence, and be updated on new threats, risk and equipment developments.

4. In our view, the use of ovitraps should cease and tyre traps used routinely in their stead; the tyres should contain water infused with an attractant (e.g., rabbit / rat food pellet or similar) and have methoprene (pellet or granules) added for security against adult emergence (where methoprene is not locally available for use, this situation should be remedied).

5. Adult traps should be deployed at all ports (in suitable protected situations) and the various traps available should be assessed to determine which is best 'fit-for-purpose'. If it is considered that one type of trap is not to be required for standard use across all ports, the most suitable trap for the local environment should be employed. It is strongly recommended that those ports currently not using adult traps should do so as soon as possible and, although it is difficult to be prescriptive about the number to be deployed, it would be useful to have at least 2 (if not 3) adult traps servicing each port wharf receiving high-risk vessels/cargo.

6. Transitional Facilities (devanning sites) are becoming an increasing concern, and there is a lack of human resources within the local PHUs to cope with this concern. Given the increasing international pressure, the risk of importing exotic mosquitoes (mostly *Aedes* species) through ports into Transitional Facilities, and then beyond, will surely increase. They have become an increasing source of mosquitoes submitted for examination (generally these have been local species but they should be seen as indicators of locally receptive conditions). These facilities must somehow receive an increased level of expert surveillance, and must be maintained in a highly sanitary condition so as not to provide habitat for exotic mosquitoes. Findings of exotic mosquito species at these facilities (and at the ports themselves) should be reported with a view to those data being incorporated in risk assessment systems.

7. The interface between MOH and MPI is problematic. The existing MOU must be revisited, reviewed and revised to ensure cross-ministry joint understanding of terminology, and areas of responsibility and accountability, and to provide for interoperable strategies and procedures, and ground-level inter-departmental communication of relevant survey data.

8. Finally, given the changes in scope and detail that came with the revised IHR, there may be a need for MOH to redefine their objectives with regard to the port surveillance program, so that appropriate technologies can be selected; e.g., is the strategy to continue being directed towards the detection/interception of particular container species associated with transmission of dengue and yellow fever viruses, or should other exotic vector species of public health importance and principally associated with wetlands and surface drainage systems also be targeted? An extension of the list of target species may necessarily require an extension of surveillance practices.

References

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Ritchie, SA. 2008. Assessment of current Southern Saltmarsh Mosquito adult trapping programme, 2008. Report to Ministry of Agriculture and Forestry, New Zealand.

Ritchie, SA and Russell, RC. 2002. *A Review of the New Zealand Mosquito Surveillance Programme*. A report prepared for the New Zealand Ministry of Health, 47pp.

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ANNEX A. SITES VISITED DURING THE REVIEW

Itinerary

Date	Site
Monday 25th	Mosquito Consulting Services, 2-4 Bell Road South, Lower Hutt
Tuesday 26th	MoH Meeting
	Ministry for Primary Industries, Pastoral House 25 The Terrace
Wednesday 27th	Whangarei- DHB
Thursday 28th	Auckland - DHB
Friday 29th	Mosquito Consulting- Field work- Auckland
Saturday 30th	Tauranga - DHB
Monday 2nd	Napier - DHB
Tuesday 3rd	Mosquito Consulting- Field work- Napier; Neocom Business Solutions (Database developers)
Wednesday 4th	Christchurch- DHB
Thursday 5th	Mosquito Consulting – Field work- Christchurch
Friday 6th	Nelson- DHB
	Mosquito Consulting- Visit to Wairau