SOUTHERN SALTMARSH MOSQUITO

1. Description of the problem

(a) Location of the case study

East coast of the North Island of New Zealand, from Hawke’s Bay north to East Cape.

(b) History (origin, pathway and dates, including time-period between initial entry/first detection of alien species and development of impacts) of introduction(s)

Southern saltmarsh mosquitoes were first discovered in New Zealand in December 1998. It is not known how they arrived but possible pathways include by sea via the Port of Napier, possibly in soft-top containers, tyre imports or live-sheep ships returning from Australia. Mosquitoes were most likely present for more than one breeding season before discovery in 1998.

From the initial site near Napier, three other populations have now been discovered, the most recent in November 2000.

The mosquitoes were thought to be spreading by hitch-hiking on planes and ship containers, but the most recent find is near a town with no international airport or port, although fishing vessels, pleasure craft and top-dressing or other small aircraft will be present.

Almost immediately after the mosquito was identified (on 25 December 1998) a response centre was set up. Spraying of Bacillus thuringiensis israeliensis (Bti) to contain the mosquito began one month later (21 January 1999). (Bti is a biological spray specific to mosquito, blackfly and gnat larvae). A health risk assessment was finalised in February and an eradication plan begun in August of that year.

(c) Description of the alien species concerned: biology of the alien species (the scientific name of species should be indicated if possible) and ecology of the invasion(s) (type of and potential or actual impacts on biological diversity and ecosystem(s) invaded or threatened, and stakeholders involved)

The southern saltmarsh mosquito, Aedes camptorhynchus, is believed to have come to New Zealand from Australia. The mosquito is recognised as being of public health significance. In Australia, Aedes camptorhynchus is known to be a vicious biter and is a vector for a number of arboviruses, the most serious of which is the Ross River Virus, which may lead to epidemic polyarthritis. In some patients this can cause chronic fatigue and lethargy for up to a year. More than 35,000 cases have been reported in Australia in the last seven years. The southern saltmarsh mosquito is also a potential vector of Barmah Forest virus.
Ross River virus is not yet in New Zealand, but the concern is that if the mosquitoes became established they could pick it up from an overseas visitor or returning tourist infected with the disease. It is likely the virus would then be transmitted to animal "reservoirs" such as feral possums or farm livestock. If this happened it would become almost impossible to limit the spread of disease.

Because of the risk the southern saltmarsh mosquito has been declared an unwanted organism in New Zealand under the Biosecurity Act 1993.

Immediate stakeholders are the agencies involved in the eradication attempt (the public health services in Hawke’s Bay and Tairawhiti), local government (regional councils and territorial authorities), and people living on the east coast of the North Island who are at risk from the mosquito.

(d) Vector(s) of invasion(s) (e.g. of deliberate importation, contamination of imported goods, ballast water, hull-fouling and spread from adjacent area. It should be specified, if known, whether entry was deliberate and legal, deliberate and illegal, accidental, or natural.)

Entry of the southern saltmarsh is considered accidental, possibly through vessels from Australia, containers or imported tyres. Under New Zealand’s import health standards (Ministry of Agriculture and Forestry), every tyre imported into New Zealand is fumigated using methyl bromide. However, this is to prevent the entry of freshwater container-breeding mosquitoes, not saltmarsh mosquitoes. It is unlikely any saltmarsh mosquitoes would actually be imported in used tyres, vehicles or machinery.

(e) Assessment and monitoring activities conducted and methods applied, including difficulties encountered (e.g. uncertainties due to missing taxonomic knowledge)

Identification of the mosquito was not problematic. Aedes camptorhyncus was identified within five days of an adult specimen being handed in to a local city council. However, at the time of this first finding, surveillance for saltmarsh mosquitoes was not undertaken in New Zealand as previous expert advice had suggested the risk from these mosquitoes was negligible. The mosquito was discovered through public complaints of nuisance biting.

Immediately after the identification, a biosecurity response centre was set up in Napier to co-ordinate field activity. This included a delimiting survey, habitat survey and mapping, mosquito and larval trapping, treatment and source reduction.

A potential problem is that the mosquito’s ability to spread may have been underestimated. That is, it was believed that the insect had a five-to-eight kilometre flight range and would therefore only be found close to ports and airports. However, the latest discovery is near a town with neither facility, raising questions about how it arrived there.

2. Options considered to address the problem
The process for decision-making and consultation by the Ministry of Health (MoH) were a mix of briefings, e-mails, circular letters, meetings, press releases and formal papers. The main points are described below:

1998
27/29 December – Meetings between national and local health officials to provide initial planning and direction to the mosquito response

1999
6 January:
- Notified the Minister for Biosecurity
- Briefed Cabinet Ministers of the Government
5 – 8 January – notified other agencies - Ministry of Agriculture and Forestry (MAF), Department of Conservation (DOC) and Ministry of Research, Science and Technology (MoRST)
7 January - notified local general practitioners
8 January
- First media statement
- Public Health Service managers in other regions around New Zealand notified

18 January:
- Hawkes Bay mosquito event upgraded to a national biosecurity issue
- MoH staff met in Wellington to clarify actions and responsibilities

19 January:
- Technical advisory group met for first time and provided significant policy and strategy advice, including to immediately putting in place a containment strategy. This advice was based on a draft health impact assessment that indicated the potential health risks from mosquito-borne disease warranted a spray programme to try and contain the insect. The group’s members are selected as individual experts, rather than representatives of their organizations, and include entomologists, ecologists, epidemiologists, public health specialists, and biosecurity experts. Health officials are present as observers.
- First interagency briefing (MoRST, DOC, MfE, HFA, MAF and Treasury) held
- Began setting up a Napier-based community liaison and information group.

10 February - Cabinet Strategic Committee committed NZ$2.087 million to phase one (containment)

Late March, early April – Discussions with Treasury about a cost benefit analysis for an eradication plan

12 April – Cabinet agreed to an increase in appropriation in Vote: Biosecurity (Health) of NZ$1.042 million to help fund the response

26 April – Cabinet agreed to proceed with phase two (eradication) with a 13-month treatment programme, a 24-month local surveillance programme and ongoing national surveillance
29 April – Biosecurity Minister announces Government funding of up to NZ$6.4 million for eradication.

23 July – Eradication plan revised by the technical advisory group, mainly to increase the dosage rate of s-methoprene.

2000

13 March – Eradication plan revised by the technical advisory group to provide for application of control agents until April 2001, to ensure two summer periods were included in the active eradication phase of the programme.

(b) Type of measures (research and monitoring; training of specialists; prevention, early detection, eradication, control/containment measures, habitat and/or natural community restoration; legal provisions; public education and awareness)

In developing the eradication plan, a number of options were considered and adopted to varying extents depending on the situation:

- habitat modification – of limited value but included clearing drains, filling in some areas of ponding, some vegetation removal
- use of larvacades – Bti was used initially as a larvicide to reduce population numbers and contain the mosquito within known habitats while longer term responses were considered. It was recognized that eradication using Bti alone was unlikely to be successful
- use of adulticides – was not considered feasible although it was discussed by the technical advisory group on a number of occasions
- use of growth regulators – S-methoprene was used as the eradication agent because of its sensitivity, specificity and residual properties.
- increased and improved surveillance – implemented in the Hawkes Bay as part of the eradication programme but also nationally to ensure the mosquito was limited to known habitats and also to ensure any future incursions were detected quickly to improve the probability of successful eradication if that was the response agreed to
- aircraft disinsection – to reduce the probability of mosquitoes spreading from Napier to other areas.

(c) Options selected, time-frame and reasons for selecting the options

From 28 December 1998 to 5 January 1999 environmental surveys were made to identify potential breeding sites and other areas that need to be included in the delimiting survey. No direct control treatments were carried out during this initial period, primarily due to dry weather which meant no new eggs were hatching. Eggs, which had hatched prior to Christmas, were too developed (ie had pupated or become adults) for treatment by the time they had been discovered.

Initially a ‘sure and steady’ approach of containment was followed, while a health risk assessment was completed with help of the Wellington Medical School. This assessment was used to make decisions about appropriate responses. That is, whether the potential risk of human arboviral disease (in particular Ross River Virus Disease) required active control or eradication of the mosquito.

Origin Natural History Media
Marieke Hilhorst
Environmental surveys of the terrain suggested it was favourable for control or eradication. The salt marsh areas where the mosquito was first found were readily accessible and control would be relatively straightforward. Alternative controls could also include habitat modification (such as clearing or filling drains), plus careful monitoring and spraying of aircraft.

Livestock were surveyed with animals selected on the basis of likely exposure to Aedes camptorhynchus. Animals were bled that were closest to the estuary, had been in the area for the longest time, or had a history of being bitten. A sample size of 353 sera was determined by financial as well as epidemiological considerations. Horses, cattle and brushtail possums (Trichosurus vulpecula) within 5km of the mosquito habitat were sampled by MAF in February 1999. All sera were sent to the Victorian Institute of Animal Sciences (VIAS) for testing using a group-specific epitope-blocking enzyme linked immunosorbent assay (ELISA). Control samples from 20 horses and 20 possums from another region of New Zealand were tested at the same time. None showed any indication of the virus which meant eradication of the mosquito could proceed without a concurrent need to manage infected reservoir hosts.

Initially the response was to contain the mosquito with Bti, which had undergone a full health impact assessment and was deemed to leave no long-term residue or have any other impact on the environment or people. Sprays were applied by helicopter except near residential areas where backpacks were used.

The decision was made in April 1999 to fund an eradication plan using s-methoprene. In March the local public health service of Healthcare Hawkes Bay, received an experimental use permit from the regulatory Pesticides Board to use three (s)-methoprene formulations: pellets, granules and briquettes.

In August, tonnes of the slow-release granules of s-methoprene were dropped into wetlands around Napier to eradicate the mosquitoes. It was believed that the adult insects’ flying range of only 5-10 kilometres meant its containment would be relatively easy.

A national surveillance programme was put in place through public health service managers to monitor the extent of mosquito incursion and the effectiveness of the eradication programme. It has been during these intensive inspections of the east coast of the North Island that the further three populations of larvae and adults have been found.

Surveillance and monitoring along the east coast of the North Island has subsequently picked up three further sites and these have each had ground-spraying of Bti to contain and attempt to eradicate the mosquito. Disinsection of aircraft near infected sites continues.

(d) Institutions responsible for decisions and actions

The lead agency in dealing with the invasion is the Ministry of Health, with funding from Vote Health as well as a new appropriation to Vote Biosecurity.
As part of the response, the Ministry of Health has established a technical advisory group to provide expert advice. It includes an Australian mosquito expert from the Queensland Institute of Medical Research.

The Ministry of Health has also sought advice from with Hawke's Bay local authorities, the Ministry for the Environment (MfE), Department of Conservation (DOC), Ministry of Agriculture and Forestry (MAF), Ministry of Fisheries (MFish), Ministry of Research, Science and Technology (MoRST), the Health Funding Authority (HFA), and the Treasury. Healthcare Hawkes Bay is also talking with a community liaison/information group that includes conservation interests and iwi representatives.

Government Ministers involved cover the portfolios of Biosecurity, Health and Finance.

Overseas expert advice on cost benefit analyses, pesticides, mosquitoes and arboviral diseases and information management was received from Australia (Queensland, New South Wales, Western Australia and the Northern Territories) and the United Kingdom.

New Zealand technical advice came from organisations such as the Institute of Environmental Science and Research (ESR) Ltd, AgriQualty, an independent taxonomist contracted to the Ministry of Health, and primarily from the members of the technical advisory group.

3. Implementation of measures, including assessment of effectiveness

(a) Ways and means set in place for implementation

Initial funding of the response came from the Ministry of Health, which then sought reimbursement from the Government. In February the Cabinet agreed to fund the first phase, containing the mosquito, with NZ$2.087 million. A further NZ$1.117 million required for phase one was funded in part from a transfer of funding from Vote Health to Vote Biosecurity, but mainly through an increase in appropriation for Vote Biosecurity.

Invitations from the Ministry of Health to 12 relevant local and national government agencies to help fund the response were all declined.

In April 1999, four months after the mosquito was identified and the response begun, Government funding of up to NZ$6.4 million over four years was confirmed. About half of this came from Vote Health, from the Health Funding Authority's risk reserves (NZ$2.5m), and the rest through new appropriations to Vote Biosecurity - Health. Treasury recommended against eradication on the basis of marginal benefit: cost ratios.
Licensed contractors were hired to conduct the application of control agents – aerial (by helicopter) and using backpack. Local public health service staff carried out weekly monitoring of potential habitat, especially after rain.

A mosquito consultant, contracted by the Ministry of Health, provides regional public health services with advice on the design of surveillance programmes.

(b) Achievements (specify whether the action was fully successful, partially successful, or unsuccessful), including any adverse effects of the actions taken on the conservation and sustainable use of biodiversity

The effectiveness of the Hawkes Bay mosquito response from a public health perspective is deemed to be shown by the absence of arborviral disease, its cost effectiveness and measures of eradication which include:

- A steady reduction of adult female *Aedes camptorhynus* found in light traps during 1999 and up to February 2000;
- Of adult female mosquitoes collected, only one of nine egg-bearing females displayed normal ovarian development;
- Larval detections are only occurring in about 20% of the habitat zone and no larvae have been detected in the southern zone since November 1999;
- As at February 2000 no mosquitoes were found outside the known infestation area;
- No cases of Ross River virus nor Barmah Forest virus disease have been reported on the New Zealand communicable disease database since the date of identification of *Aedes camptorhynus* in Hawkes Bay; and
- The costs for the eradication programme appear to be within the projections on which the cost benefit analysis was based and therefore indicate that the programme is cost effective.

However, despite the success at the first site, three subsequent populations of the mosquito have been found on the east coast.

(c) Costs of action

Phase one, containment, was allocated NZ$3.204 million.
Phase two, eradication, was allocated NZ$6.4 million over four years.

4. Lessons learned from the operation and other conclusions

(a) Further measures needed, including transboundary, regional and multilateral co-operation

The Hawkes Bay mosquito invasion, plus two recent border interceptions of exotic mosquitoes of public health significance in Auckland and Wellington have reminded public health services of the importance of an effective risk-based mosquito surveillance system. Up till the Napier discovery of *Aedes camptorhynus*, planning had focused on the risk from fresh water species (in particular container breeding mosquitoes like *Aedes albopictus*). However, the...
Napier discovery showed routine surveillance needs to include saline or brackish water habitats.

This needs to be combined with continued effective border control targeting high risk imports, such as used tyres.

Funding was a critical and ongoing issue throughout the response period. Agencies with biosecurity responsibilities hold votes for this work, but these are typically too small to effect any serious response to a biosecurity emergency. As well, each of these agencies were already responding to other biosecurity responses, such as undaria seaweed, Dutch Elm disease, varroa bee mite and painted apple moth. One suggestion is for the Government to provide an incursion fund, which agencies can draw on for initial responses to incursions (ie for containment and delimiting until information is available for decisions on the long-term response to the incursion).

There is a need to determine why adult Aedes camptorhyncus are still being detected and amend either the eradication or operational plan accordingly.

An audit of the process used for the Hawkes Bay incursion suggested that any future exotic mosquito response would benefit from:

- Adequate funding to enable timely and appropriate responses to be mounted so that public, political and professional confidence in the Government and the bureaucracy can be maintained;
- Greater clarity in the chain of responsibility from a national to local level;
- Greater information about and experience with the chosen control agents, in this case Bti and s-methoprene; and
- Maintaining expertise, capacity and physical resources in all Public Health Units throughout New Zealand.

Use of the ozone depleting gas methyl bromide to fumigate imported tyres is being banned throughout the world, except for quarantine use. However, restrictions are being put in place to apply pressure to also reduce its use in quarantine operations. A ceiling has been set at the 1995 tonnage. This is an issue for the Ministry of Agriculture and Fisheries because its use of methyl bromide has increased eight-fold since 1992. In the lead-up to the next global climate conference in 2003, MAF is looking for alternatives to the gas and has applied for funding for research into the efficacy of heat treatment for cargo and containers. Other countries are carrying out heat treatment research but most of these focus on soil sterilisation. MAF is likely to be at the forefront of research on cargo and containers.

(b) Replicability for other regions, ecosystems or groups of organisms

The biosecurity response initiated in Hawkes Bay at the end of 1998 was done without the benefit of a national procedure for handling such incursions. Since then the Ministry of Health has produced a biosecurity section for the Environmental Health Protection Manual to outline public health protection and
regulatory service guidelines relevant to biosecurity, and specifically relating to exotic mosquitoes.

An audit was conducted on the response process for Hawkes Bay compared to the timeframes for action given in the new manual. The *Aedes camptorhynchus* process was found to be sound. Although the manual has now superseded it, the audit result suggests it would have been a replicable process.

(c) Information compilation and dissemination needed

One thing identified as missing during the audit of the response to the *Aedes camptorhynchus* incursion is complete records of the health education material and media statements. These would have been useful as a future resource.

As well, the audit recommends that separate files be kept for reports from the mosquito response centre to the Ministry of Health. And that a communication/media strategy be set up, documented and carried through.

The web site operated by the Ministries of Health continues to present information about the incursion, the threat and the response.

Media coverage of the event has been high, helped in part by the initial discovery being made during the summer ‘silly season’ when news is scarce.

Efforts were made to keep key players (such as public health managers in other regions, relevant other agencies, local communities) informed through briefings, circular letters and the media.