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Review of Rodent Monitoring and Control Methods as Alternatives to Glueboard Traps

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Executive Summary

In New Zealand the Animal Welfare (Glueboard Traps) Order 2009 restricts the use of glueboards and will ban all sale and use from 1 January 2015. Glueboard use is continuing for now in particular situations where it is considered that there are no suitable alternatives. The Ministry for Primary Industries is supporting the phasing out of glueboards by working with affected users, regulators, and rodent control experts, practitioners and manufacturers to identify and enable the implementation of alternative control techniques. This report provides a review of available methods that could replace glueboard traps for rodent detection and control and forms the basis for discussion with concerned users, to consider what further support is needed in response to the phasing out of glueboards. Specific objectives were to:

- Undertake a desktop review of available methods used to monitor and control rodents (including glueboards if they are used) in situations relevant to glueboard use in New Zealand.
- Provide commentary on whether any of the monitoring or control methods fulfil the cited advantages of glueboards being non-toxic; non-contaminating; holding carcass in one place; 100% capture rate for animals that encounter them; no licence required for use; and low cost.

Methods for monitoring rodents were identified by contacting New Zealand and international rodent experts, using web-based searches, and searching databases of science publications such as Science Direct and CAB Abstracts. Methods for controlling rodents were identified from searches of pest control product manufacturers and suppliers in New Zealand and internationally, and the Agricultural Chemicals and Veterinary Medicines database of vertebrate toxic agents. The previous discussion papers related to the proposed prohibition of the use of glueboards produced by MAF were also consulted, as were submissions relating to glueboards in the State of Victoria, Australia. Discussions were held with some of the currently-permitted users of glueboards to clarify the present situation regarding their use as monitoring and control tools, and practitioner views about possible alternatives.

Key findings were that:

- Large numbers of glueboards (c. 90 000 in 2012/13) have continued to be sold in New Zealand since the 2009 restrictions on their sale and use. Most of the glueboards sold are for mice infestations.
- Glueboards for rodents have two distinct advantages over all other currently available methods: they can be used in places where other devices cannot fit and they are not prone to false triggering.
- No commercially-available modifications to glueboards were found that are likely to reduce current welfare impacts of glueboards.
- From a technical perspective, enclosed single- and multi-catch live and kill traps are potentially suitable alternatives to glueboards for rodent monitoring and control in most situations. Toxins are also a suitable alternative to glueboards where toxin use is not restricted, particularly when combined with non-toxic control methods in an integrated control programme.
- The review revealed that comparing glueboards and alternative devices is complex for both technical and animal welfare reasons. Firm conclusions about the relative merits of glueboards and alternative devices and the feasibility of transition to other methods for

rodent monitoring and control are hampered by an absence of quantitative data on welfare impacts, efficacy and cost-effectiveness.

To address this there is a need for:

- Better data about numbers of glueboards used and rats and mice captured, including data on multiple captures on single traps, and the fate (alive/dead, injuries) of captured rodents. Obtaining this information would require close assistance from the pest control industry.
- Better data about the efficacy and cost-effectiveness of glueboards and alternative methods for rats and mice. This would require trials to assess trapping efficiency and to collect data on operational costs.
- Comparable welfare data on glueboards and other methods/devices for rats and mice. This would require observational assessments under controlled conditions for some devices and review of existing data.
- Information on the current economic costs of rodent impacts to sectors currently using glueboards. This could be obtained from the sectors concerned.
- Research into new alternatives to glueboards that are acceptable to industry. This would require assistance from industry with testing.

In the meantime, single and multi-catch live and kill traps (used with trap covers where applicable) would seem to be a potential practical alternative for rodent monitoring and control where the use of toxins is not acceptable.

1 Introduction

New Zealand has four species of introduced rodents pests – the Norway rat (*Rattus norvegicus*), the ship rat (*R. rattus*), the Polynesian rat or kiore (*R. exulans*) and the house mouse (*Mus musculus*). These pests impact on both native biodiversity and, to a lesser extent, agricultural production (Atkinson & Towns 2005; Innes 2005a,b; Ruscoe & Murphy 2005). They are also a significant problem in households and commercial businesses, particularly in premises manufacturing, storing or selling food and food products and in areas with high hygiene requirements, such as hospitals and care facilities. From a biosecurity perspective these rodents pose major risks of incursions to offshore pest-free islands and mainland pest-free sanctuaries, particularly through pathways that involve inadvertent transport via boats or planes or in luggage or materials transported to such places (MAF 2010).

Reducing the risk of rodent incursions and spread requires methods to detect their presence. A wide range of techniques are used to monitor for rodent presence (Meehan 1984; Caughley et al. 1998; Singleton et al. 2003). These are generally of two types – passive ones that involve searching for sign left by rodents (e.g. droppings, urine, gnaw marks, smears, tracks) and active ones that use devices placed in the environment to detect current activity (e.g. tracking tunnels, remotely-triggered cameras, chew sticks or cards, bait piles). Equally, a wide range of methods are available for rodent control (Meehan 1984; Caughley et al. 1998; Singleton et al. 2003), with the primary methods used in New Zealand being live and kill trapping and poisoning.

Glueboards are both a monitoring device and a control method as, for example, are traps. They are basically sticky traps – pieces of card or similar material, coated with a non-drying adhesive material, that are laid in positions to catch principally insects or rodents that run across them (Fitzwater 1982; Frantz & Padula 1983; Corrigan 1998). Although glueboards are available for rats and mice, most use appears to be for mice. Despite their extensive use worldwide, there is little published information about their efficacy as control or monitoring devices for either rodent species. Concerns have been increasingly expressed about their humaneness, leading to recent bans (e.g. Ireland) and restrictions on their use to specified persons (e.g. licensed pest control operators) and situations (e.g. commercial food manufacturing premises) or requirements for Ministerial exemptions in the Australian States of Victoria and Tasmania, their ban in the ACT, and their phasing out in New Zealand by the end of 2014. Currently in New Zealand use of glueboards is restricted to:

- Commercial pest control operators
- Persons employed to conduct pest control on food production premises
- Department of Conservation contractors or employees
- Boat operators transporting persons or goods to, from, or in close proximity to mammalian-pest-free islands.

Internationally, there is increasing pressure to ban the use of glueboards because of their perceived unacceptable animal welfare impacts. For example, a range of US companies and government departments have voluntarily banned the use of glueboards (e.g. http://blog.selfstorage.com/self-storage-reits/uncle-bobs-glue-traps-2732, accessed 27 January 2014). The Animal Welfare Board of India, a statutory body of the central government, issued an advisory in 2011 to chief secretaries of all state governments and the Indian Pest Control Association to 'prohibit the use, sale and manufacture of glue traps to catch rodents, as they are harmful to the animals', although acknowledging the difficulty in

implementing a ban on sales and imports (http://mail.dailypioneer.com/todays-newspaper/banned-glue-used-to-trap-painfully-kill-rodents.html, accessed 28 January 2014). In 2009, a motion was raised in the UK Parliament suggesting the UK Government should follow the lead of many other parliaments worldwide and recognise the cruelty of such practices by introducing legislation to ban their use in the UK (www.npta.org.uk/assets/documents/Glue%20Board%20Code%20of%20Practice%20Information.pdf, accessed 28 January 2014). Numerous petitions about the banning of glueboards can also be found on the World Wide Web (e.g. http://www.peta.org/features/join-campaign-glue-traps/, accessed 28 January 2014).

2 Background

In New Zealand the Animal Welfare (Glueboard Traps) Order 2009 restricts the use of glueboard traps for rodents to particular users in particular situations. It bans all sale and use from 1 January 2015, on the grounds of pain and distress experienced by trapped rodents, and inhumane methods of killing. Glueboard use is continuing for now in particular situations where it is considered that there are no suitable alternatives. The Ministry for Primary Industries is supporting the phasing out of glueboards by working with affected users, regulators, and rodent control experts, practitioners and manufacturers to identify and enable the implementation of alternative control techniques.

This report is the first step in this process and provides a review of available methods that could replace the use of glueboard traps for rodent detection and control. The intention is that the review will form the basis for discussion with concerned users, to consider what further support is needed in response to the phasing out of glueboards by 2015.

3 Objectives

- Undertake a desktop review of available methods used to monitor and control rodents (including glueboards if they are used) in the following situations and other relevant examples in New Zealand and around the world
  - Food production premises, including manufacturing, preparing, packaging and storage.
  - Aircraft
  - Hospitals and areas of high hygiene (e.g. laboratories, hospitals, childcare centres)
  - Boats providing transport to or around ‘pest-free’ sanctuaries
  - Transitional or quarantine facilities used to manage biosecurity and conservation risks (e.g. airports, ports, quarantine stations, luggage treatment facilities and the like at borders, transitional areas to pest-free offshore or mainland islands)
  - Emergency shelters/centres (e.g. centres of operation in overseas peace-keeping missions)
- Provide commentary on whether any of the monitoring or control methods fulfil the cited advantages of glueboards, namely
  - Non-toxic
  - Non-contaminating
  - Carcass held in one place
  - 100% capture rate for animals that encounter them
  - No licence required for use
  - Low cost

4 Methods

Methods for monitoring rodents were identified by contacting New Zealand and international rodent experts, using web-based searches, and searching databases of science publications such as Science Direct and CAB Abstracts. Methods for controlling rodents were identified from searches of websites of pest control product manufacturers and suppliers in New Zealand and internationally, and the Agricultural Chemicals and Veterinary Medicines database of vertebrate toxic agents authorised under the Agricultural Compounds and Veterinary Medicines (ACVM) Act 1997 and Regulations (www.foodsafety.govt.nz/industry/acvm/vertebrate-toxic-agents/index.htm). The previous discussion papers related to the proposed prohibition of the use of glueboards produced by MAF were also consulted (MAF 2002, 2008, 2009), as were a submission to the inquiry into Victoria's Regulatory Framework arising out of changes to regulations governing the use glueboards in the State of Victoria, Australia (Garrards 2010). In addition discussions were held with the currently permitted users of glueboards (see Section 1) to clarify the present situation regarding the use of glueboards as monitoring and control tools, and their views about possible alternatives.

5 Results

5.1 Glueboards

Glueboards have been used in New Zealand for many years. Different sizes of glueboards are available; for mice these range from 11 × 8 cm to 22 × 14 cm, and for rats from 25 × 12 cm to 34 × 22 cm. Large numbers of glueboards have continued to be sold in New Zealand since the 2009 restrictions on their sale and use. In 2012/13 about 90 000 glueboards were sold by the major suppliers. Most glueboards are used for mice infestations; for example, 84% of c. 64 000 glueboards sold by three companies in the last year were for mice. The main purchasers of glueboards are pest control operators and companies, and companies involved in all aspects of food production and storage, including feed mills. They are also sold to marine farms, zoos, shipping ports, and museums. Most deployment of glueboards is by registered pest control companies. There are few data on the numbers of rodents caught in the types of premises where glueboards are mostly used, but 1950 devices set across 26 premises caught 34 mice (E VanEssen, pers. comm.). If those figures are typical, they suggest the total catch of rodents may be a few thousand per year.

5.2 Current methods used to monitor and control rodents in specific situations

5.2.1 Food production premises

The Australian Environmental Pest Managers Association and the Pest Management Association of New Zealand have produced a code of practice (COP) for pest management in the food industry (www.aepma.com.au/Consumer-Resource-Centre/Publications, accessed 16 January 2014). Within an integrated pest management framework the COP recommends exclusion and deterrent methods as the primary approach, complemented by snap traps, confined capture, glueboards and baiting. It suggests glueboards are effective for sites where there is no access for baiting or where a non-toxic approach is required. It also suggests

glueboards should be moved after a few captures to prevent the development of trap shyness in mice (but see Section 5.4.2). One of the key uses of glueboards in food production premises is for barrier trapping, both to prevent incursions and to isolate infested materials or equipment.

The Approved Maintenance Compounds (Non-Dairy) Manual 2007 of the New Zealand Food Safety Authority allows the use of non-toxic rodent monitoring baits and lures provided the use of the compounds is (i) detailed in a vermin control programme that is compliant with relevant NZFSA legislation; (ii) limited to the initial detection of vermin activity prior to the use of rodenticide; (iii) limited to food areas provided there is no exposed product or food ingredient present in the room; and (iv) removed again from areas for edible foods before processing operations commence.

Approved products for rodent control in such premises fall into two categories. Type C products are rodenticides that (i) may only be used in premises according to the requirements of a pest control programme that has been documented to relevant NZFSA legislation; (ii) may be used in food areas provided there is no exposed product or food ingredient present in the room; and (iii) must be removed from areas for edible foods before processing operations commence. Any Type C liquid baits, and dry baits in which the inert ingredients consist mainly of meal or flour, must be coloured a definite blue or green. Where inert ingredients consist mainly of whole or cracked grain, pressed into cakes or pellets, and clearly have the characteristics of bait, no addition of colour is necessary. This is to minimise the possibility of undetected contamination of food products.

Type D products are miscellaneous pesticides/pest control products such as glue/sticky boards. Where the Type D compound contains a pesticide, the directions for use must not give any indication that it is acceptable to use it in areas for edible foods when exposed product or food ingredients are present. Where the compound does not contain a pesticide, use may be permitted in areas for edible foods provided that it does not create a nuisance.

5.2.2 Rodents and aircraft

Rats and mice are regarded as a safety hazard on aircraft. They may gnaw at cables, packaging material, insulating material and more. Rodents on aircraft also pose biosecurity and health risks. Rodents may carry exotic zoonoses, and rodent faeces have been found in aircraft where food is prepared. The rodent species itself and the diseases it carries may be exotic to the port and country of arrival.

Most monitoring for rodents on aircraft is passive (i.e. rodents are seen and reported by air crew or passengers or their droppings are found). Sometimes, nests are found when panels or covers are removed from aircraft equipment or fixtures. In the worst case, gnawed wires or cables are discovered during maintenance (http://ftp.rta.nato.int/public/PubFullText/AGARD/AG/AGARD-AG-340/AGARDAG340.pdf, accessed 9 January 2014). Trained dogs are sometimes used to search aircraft for invasive vertebrate stowaways including rodents (M. Hall, USDA, pers. comm.) and such searching is available as a commercial service in some countries.

Methyl bromide fumigation has traditionally been used to control pests in aircraft, including rodents (e.g. www.stopest.com.my/Aircraft-Fumigation-Pest-Control-Services-Pest-Control-Malaysia, accessed 9 January 2014), but its use is being phased out under the Montreal Protocol, which prohibits the use of ozone-depleting substances. Atmospheric modification is

a technique specifically developed to control rats, mice and other pests in aircraft. It involves creating a sealed low-oxygen environment, making it impossible for rats and mice to escape before death by suffocation (www.eco2.nl/en/techniques/modified-atmosphere-technique, accessed 9 January 2014). The technique has the stated advantage of a short treatment period of 6–10 hours. However, rodents killed by fumigation may die in inaccessible places, causing contamination problems.

Most rodent control at airports in New Zealand and elsewhere is focused on keeping airport buildings and hangers rodent-free through regular inspection and control (e.g. baits in bait stations), which, in turn, reduces the risk of rodent incursions on aircraft (Witmer & Fantinato 2003). Rodent incursions on commercial aircraft in New Zealand or as hitchhikers on incoming flights are uncommon and have usually involved mice (G. Curran, pers. comm.). When a rodent incursion is detected and reported to MPI, an agreed response is implemented, and the airline is directed to use an MPI-approved Residual Disinfection Treatment Applicator to carry out a baiting programme as directed by the National Disinfection Manager (www.biosecurity.govt.nz/files/regs/stds/bnz-std-abtrt.pdf, accessed 22 January 2014).

The response is usually rapid, and may include intensive coverage using snap traps and glueboards to maximise chances of rodent capture and to minimise the risk and expense of aircraft grounding. Once glueboards are installed, aircraft may be allowed to continue flying, and the glueboards are checked at next landing or journey's end, depending on whether the flight is domestic or international (S. Gay, pers. comm.). Glueboards are considered to have advantages over snap traps in that they do not necessarily depend on attracting rodents to them, as rodents are trapped when they run over them during their normal activity (G. Curran, pers. comm.), and traps may be triggered by aircraft movement.

5.2.3 Hospitals and areas of high hygiene

Internationally, standards or technical guidelines for rodent control at such sites place very strong emphasis on prevention of incursions of rodents through good facility design and operation, and generally only discuss broad principles in relation to rodent control (e.g. US Department of Defense 2005). Actual control techniques are mentioned infrequently. For example, the Newcastle upon Tyne (UK) Hospitals NHS Trust Pest Control Policy 2013 identifies a number of anticoagulants approved for use on their premises but does not mention glueboards or traps (www.newcastle-hospitals.org.uk/PestControlPolicy201102.pdf, accessed 16 January 2014). Glueboards are, however, mentioned as part of an integrated pest management (IPM) programme in a US report on controlling pests in hospitals without pesticides (www.beyondpesticides.org/hospitals/Healthy_Hospitals_Report.pdf, accessed 16 January 2014) and in a US Armed Forces Pest Management Board Technical Guide (www.afpmb.org/sites/default/files/pubs/techguides/tg20.pdf accessed 24 April 2014). The latter recommends "Use snap traps, live traps or glue boards within laboratories, administrative, food handling, or maintenance areas only. They work quickly, eliminate the possibility of secondary poisoning, and prevent the problem of rodents dying in wall voids, where odors may occur and blowflies or dermestids may develop." Similar use of glueboards as part of an IPM programme is advocated in some countries for childcare centres and schools (e.g. http://midwestpesticideaction.org/wp-content/uploads/2013/10/MPAC-Resource-Guide-for-IPM-in-Schools-and-Childcares.pdf, accessed 16 January 2014).

In New Zealand, rodent control as part of more general pest control in hospitals, care facilities, schools and similar institutions is usually contracted out to professional pest control

companies. Relevant policy, where it exists, on the use of chemicals, including rodenticides, often only states that chemicals used shall be applied and used by the contractor according to the manufacturer's recommended method and rate and only products approved for hospital use are to be used (e.g. www.westcoastdhb.org.nz/publications/policies_n_procedures/policies_n_procedures_docs/infection_control/PestControlProcedure.pdf, accessed 24 January 2014).

5.2.4 Boats providing transport to or around pest free sanctuaries

The Department of Conservation (DOC) has responsibility for many high-conservation-value offshore islands that are pest free. It maintains that status for those islands through its biosecurity and surveillance programmes for both the boats that service those islands and the staff and equipment and supplies that are transported to and from them (Broome 2007; E. Kennedy, pers. comm.).This involves the use of enclosed quarantine facilities at points of departure and arrival that are used to search equipment and supplies. Glueboards are the principal tool used to detect and catch invasive rodents on the boats and in and around island quarantine facilities, particularly targeting mice. Management and prevention of rodents on jetties and wharfs associated with boat transport is usually undertaken using bait boxes and anticoagulant toxins. Dogs trained to detect rodents are also being used increasingly by DOC for detection of rodents after incursions and for ongoing surveillance of pest-free islands. DOC's use of glueboards is projected to increase as it intensifies efforts to protect pest-free islands (E. Kennedy, pers. comm.).

DOC's concerns about incursions of invasive species on pest-free islands extend beyond rodents. Reptiles (see Section 5.4) and invertebrates (e.g. invasive ants) are major concerns and glueboards are also used for monitoring and capture of such species as part of routine biosecurity and surveillance.

5.2.5 Transitional and quarantine facilities

Transitional facilities and containment facilities in New Zealand are approved to hold and manage imported risk goods that are brought into New Zealand and that may pose a biosecurity risk. Transitional facilities are generally for imported goods such as food products, objects made from wood or plant material, sea containers, used machinery or vehicles, and other products that might have some associated biosecurity risk. These facilities operate under MPI-specified facility standards. With regard to rodent management, the General Transitional Facility Standard (www.biosecurity.govt.nz/files/regs/stds/bnz-std-tfgen.pdf, accessed 22 January 2014) requires each facility to have an Operating Manual to address 'prevention of possible refuge areas for pests' [section 5.7] and 'Facility operators must ensure that pests, vermin and weeds are effectively controlled' [section 5.8]. Those requirements mainly address prevention and control of incursions of rodents existing in New Zealand. Where rodents are detected in association with risk goods MPI also specifies additional approved biosecurity treatments which, for live rodents that evade capture, includes fumigation with methyl bromide or hydrogen cyanide (www.biosecurity.govt.nz/files/regs/stds/bnz-std-abtrt.pdf, accessed 22 January 2014).

Transitional and containment facilities must be constructed to minimise the risk of vermin entry. They must have a control/monitoring programme in place, but this is often part of a larger site-wide programme and is generally contracted out to pest control companies (M. Aitkenhead, pers. comm.). To the best of MPI's knowledge glueboards have not been

used for a number of years in any of the containment facilities they monitor and have been replaced with bait boxes.

5.2.6 Emergency centres and shelters

The issue of rodent control is mentioned in the environmental guidelines of major agencies dealing with refugees and other situations where it is necessary to establish medium- and long-term emergency shelters and centres. For example, the United Nations High Commission for Refugees (UNHCR) Environmental Guidelines (www.unhcr.org/cgi-bin/texis/vtx/home/opendocPDFViewer.html?docid=3b03b2a04&query=rodent control, accessed 23 January 2014) note, '..insect and rodent control measures should be implemented, taking into account the toxicity of many pesticides and insecticides. Over the longer term, non-chemical pest-control methods should be instituted, to the extent possible.' The UNHCR Handbook for Emergencies (www.unhcr.org/cgi bin/texis/vtx/home/opendocPDFViewer.html?docid=471db1092&query=rodent control, accessed 23 January 2014) expresses a similar view. Its 1997 publication on Vector and Pest Control in Refugee Situations in Africa (www.unhcr.org/49d082fe2.html, accessed 23 January 2014) mentions use of traps but makes no specific reference to glueboards or other trap types amongst the applicable rodent control methods. Generally, the information provided by agencies that deal with emergency shelters and centres does not provide specifics about particular pest control methods but rather flags the issues of rodent control as an essential component of management systems for sanitation and disease prevention.

5.3 Detecting and monitoring rodents

The probability of detecting a rodent through using a device depends on the probability that the rodent will encounter the device and the probability that an encounter will result in an interaction with the device that leaves evidence of rodent presence (where the evidence may be a carcass or some other sign such as footprints). Probability of an encounter depends principally on how many devices are put out within an animal's normal home range, how those devices are distributed (e.g. uniformly or at predicted preferred sites and routes for rodent activity), and how long they are left in the animal's environment. Probability of interaction depends largely on the animal's behavioural response when it encounters a device, which might be influenced by the physical design of the device, added lures or bait, or behavioural states such as curiosity or fear. Unfortunately there are almost no measures of encounter and interaction probabilities for most of the devices used to monitor rodents, including glueboards, which makes it impossible to compare relative cost-effectiveness.

5.3.1 Methods of detection and monitoring for rodent presence

In most of the situations where glueboards are currently used rodent density is likely to be low, so passive detection methods, such as searching for droppings or other rodent sign, may have low probability of detection unless rodents have been present for some time. An exception to this is the use of dogs specially trained to find rodents and rodent sign. Such dogs are now used routinely in New Zealand to search for animal survivors of rodent eradication programmes or assist with surveillance of offshore islands (www.doc.govt.nz/parks-and-recreation/plan-and-prepare/dog-access/conservation-dog-programme, accessed 22 December 2013; Smith et al. 2001; Gsell et al. 2010). Trained dogs are also used overseas to search aircraft for invasive vertebrate stowaways including rodents (M. Hall, USDA, pers. comm.) and such searching is available as a commercial service in

some countries. The use of such trained dogs would obviously not be practicable in food production premises.

Rodents make ultrasonic vocalisations, which are outside the range of human hearing. Devices are available to detect these sounds (www.metris.nl/print/en/products/sonotrack/sonotrack_information, accessed 22 December 2013) and could be used to monitor for the presence of rodents. Rodent urine fluoresces under UV light (www.maxmax.com/auvproducts.htm, accessed 14 January 2014) and the use of such a device might facilitate detection searches. Tracking powder that fluoresces under UV light is also available to help detect rodents (www.arrowscientific.com.au/index.php?option=com_content&view=category&layout=blog&id=35&Itemid=43, accessed 14 January 2014). Several pest control companies market electronic mouse detection units (e.g. www.rentokil.com.au/technical-support/our-products-and-services/rodent-control/mouse-monitor-unit-mmu/index.html, accessed 14 January 2014). These are simple plastic tunnels that activate a warning light when a mouse runs through the tunnel and breaks two consecutive infrared beams. The devices are usually battery operated and some can provide information about the time in days or weeks since the unit was last activated.

Glueboards are detection devices that depend on rodents running over them and making sufficient contact with the adhesive that they remain fixed to the device. Glueboards may or may not be lured to attract rodents. Tracking tunnels (e.g. www.gotchatraps.co.nz, accessed 22 December 2013) and patches of inert tracking dust or similar material similarly depend on rodents moving across them to record their footprints. Hair collection tubes are similar in function to tracking tunnels – rodents passing through them leave a sample of hair, which can be identified to species from its cuticle pattern (Teerink 2004) or extracted DNA (e.g. www.ecogene.co.nz, accessed 9 January 2014). Wax tags and chewcards (e.g. www.connovation.co.nz, accessed 22 December 2013) detect rodents via impressions of the tooth marks left as rodents chew the devices. Similar devices designed to detect rats from their gnawing include wooden sticks soaked in oil and candle wax (Russell et al. 2008). Bell Laboratories has combined two approaches in its product 'DETEX with Lumitrack', a non-toxic bait block that can provide evidence of gnawing, with a dye additive that makes rodent droppings glow bright green under UV light (www.belllabs.com/product_details/new-zealand-pest-control-detex-with-lumitrack, accessed 22 December 2013).

Traps, like glueboards, can be used as both detection and control devices. Traps may either catch and hold rodents alive or kill them. Generally different-sized traps are used for rats and mice because of their different physical size and the need for stronger killing mechanisms on kill traps for rats. There are many varieties of live trap for rodents, mostly made of mesh or with solid metal or plastic walls. Many types of kill trap are also available, differing both in their construction material and in the method of killing (e.g. nopests.co.nz; www.connovation.co.nz; www.traps.co.nz, accessed 22 December 2013). Multi-catch live and kill traps are also available for both rats and mice. Traps are usually baited with attractive food-based bait or with a lure soaked into an attachment to or behind the trigger device. Current New Zealand animal welfare legislation requires live traps (which include glueboards) to be checked daily within 12 hours of sunrise.

5.3.2 Comparison of glueboards and other monitoring methods

Product websites often suggest that glueboards are effective because rodents simply run over them and get stuck, implying that encounter and interaction are effectively simultaneous, and

that no additional action (e.g. take bait, enter a tunnel) is required on the part of the rodent. However, glueboards often incorporate a lure (presumably to attract rodents), and the observations of Frantz and Padula (1983), Corrigan (1998) and Gupta et al. (2004) suggest that inadvertent interaction is not always the case as different glueboards had different catch rates, mice were observed attempting to jump over glueboards, and laying glueboards in one part of their environment resulted in mice shifting activity to another area. Mice make extensive use of their vibrissae and sense of smell to investigate and move about their environment. New objects (such as a glueboard) in a mouse's environment tend to be actively investigated, although initial approaches may be cautious and may even prompt avoidance and/or defensive burying. However, in general, mice seem to investigate rather than avoid new objects and accept their presence rapidly (reviewed in Latham & Mason 2004).

Devices like tracking tunnels and chewcards/tags where an animal leaves an identifiable mark (such as a tooth mark or foot print) are the nearest alternatives to glueboards for monitoring. Glueboards cost $1–$3 each, which is roughly comparable with the cost of tracking tunnels ($13 for tunnel and $1.40 per tracking card) and wax tags ($2–$3 each). Chewcards are significantly cheaper (c. $0.05 unbaited, $0.40 baited). However, tracking tunnels, wax tags and chewcards as monitoring devices have greater operational costs than glueboards because of the additional costs of identifying the marks on the devices. These costs are not high as identification of marks usually takes less than 60 seconds for a trained operator (G. Morriss, pers. comm.). Identification can be difficult if the devices are heavily marked, but that is unlikely to be the case in most situations where glueboards are used. Mistakenly attributing a mark to a rodent could engender significant additional costs through the need to set devices to capture and/or kill the supposedly-present rodents. Failure to correctly identify a mark made by a rodent could potentially result in future costs of rodent eradication, increased costs to control the infestation at some future time, and direct (product contamination) and indirect (reputational damage) costs to business. The electronic mouse-monitoring units have significant potential as their design is supposed to preclude triggering by anything other than mice (or small rats).

Single-catch kill traps for rodents are also a potential alternative to glueboards for monitoring, costing $4–$12 but with a usable life of months/years whereas glueboards are discarded after a single capture or use (as efficacy of glue declines once exposed to the environment). While traps are often baited with food, which might cause contamination issues at some sites (e.g. food processing areas), they can just as easily be baited with non-food lures, such as essential oils. Any difference in costs of servicing traps versus glueboards is likely to be minor. The advantage that glueboards offer is that they can be deployed in a wider range of situations than alternative devices, because of their physical dimensions. This particularly applies, for example, to their use underneath machinery or behind pipes where traps could not be set, thus enabling monitoring of a wider range of places and situations where rodents may be active.

A glueboard, depending on its size, has some capacity to detect/catch more than one rodent, particularly mice, and often does so if mouse numbers are high (Tripathi et al. 1994; G. Curran, pers. comm.). Multi-catch traps have the same capability. With tracking tunnels, wax tags and similar devices, it is sometimes difficult to determine whether they have been marked by more than one rodent (although rat marks can be distinguished from those of mice), except potentially for those devices that provide samples for DNA analysis (although the cost of that analysis and time to receive results would preclude its use in most situations

where glueboards are used, and DNA analysis may not distinguish between closely-related individual mice, such as litter mates).

Ability to detect rodents declines with time for most devices. Glueboards are susceptible to environmental conditions, and wet or dusty conditions may rapidly reduce their catching ability to hours or days rather than weeks (B. Paynter, E. VanEssen, pers. comm.). Similarly, baits on traps dry out and become less attractive. Passive devices such as tracking tunnels, wax tags and chewcards are less prone to such effects. The need to replace devices and/or baits is one of the factors that impacts on the overall relative cost-effectiveness of the different devices.

While glueboards can provide incontrovertible evidence of the presence of rodents – which may or may not be achievable by alternative methods – regardless of the device used, absence of detections by surveillance or monitoring devices does not necessarily mean there are no rodents present. Again information about the detection probabilities of glueboards and alternative surveillance and monitoring devices would be needed to make a comparative assessment.

5.4 Methods for controlling rodents

5.4.1 Rodent control methods other than glueboards

The main methods used for rodent control and those considered to be potential replacements for glueboards in at least some situations are summarised in Table 1. Because the use of toxins is prohibited or highly restricted in many situations where glueboards are used, discussion of toxins as an alternative to glueboards is focused on more general use of glueboards as a rodent control tool. Fertility control is not discussed as an alternative because there are no fertility control products currently registered for use in New Zealand against rodents, and none commercially available globally, although various formulations have been used in China (e.g. Liu et al. 2013) and a product (ContraPest® ; http://senestech.com, accessed 4 March 2014) is currently being evaluated for rodent control in the New York subway system. The use of diseases or parasites as biological control is also not considered, as risks associated with those methods are likely to be unacceptable to industry, and there are currently no suitable candidates.

Table 1. Methods used for rodent control

Rodent control method	Potential replacement for glueboards
Fumigation	Yes - limited applicability
Trapping: live traps	Yes - commonly
Trapping: kill traps (breakback)	Yes - commonly
Trapping: kill traps (electrocution)	Yes - limited applicability
Trapping: kill traps (CO_2)	Yes – limited applicability
Poisoning: anticoagulants	Yes - where applicable
Poisoning: other toxins	Yes - where applicable
Non-toxic lethal compounds	No - evidence of efficacy lacking
Repellents: chemical	Yes - limited applicability

Repellents: ultrasonic, electromagnetic and ionic devices	**No - evidence of efficacy lacking**
Biological control: diseases and parasites	**No**
Biological control: fertility control	**No**

Fumigation is most commonly used to treat rodent burrows in outdoor situations or where whole facilities such as warehouses or shipping containers need to be treated. Rodent infestations requiring such extensive control would probably require more than just the use of glueboards. Although fumigants are often used for control of stored-products pests, including rodents (e.g. www.dowagro.com/profume/us/about, accessed 9 January 2014), the most commonly used fumigants for rodent control in New Zealand (aluminium and magnesium phosphide) are unlikely to be suitable replacements for glueboards in most situations because of high cost and the lengthy downtime necessary for the fumigation procedure.

Live traps for rodents are readily available in New Zealand in a wide variety of designs. They are of two types, mesh traps and solid-wall traps, and cost c. $10–$40. Live traps of both types are available as single-catch and multi-catch designs. One design is convertible from a single-catch trap to a bait station, providing flexibility in use for pest control operators (www.garrards.co.nz/latest-product-news/170-rodent-control-solutions, accessed 13 January 2013). Live traps are a potential replacement for glueboards, particularly those live traps with solid walls that reduce the risk of environmental contamination. However, the animal welfare impacts of the method used to kill live-trapped rodents needs to be taken into account, as well as the use of glueboards inserted in multi-catch live traps to facilitate handling and removal of trapped rodents (Corrigan 2003).

Kill traps for rodents are also readily available in New Zealand in a wide variety of designs with different killing mechanisms, and as stand-alone traps or enclosed in a solid-walled container. Both single-kill and multi-kill traps are available. Costs vary widely, from c. $4 for the simplest single-kill mouse snap-trap to c. $170 for the Goodnature multi-kill rat trap (http://goodnature.co.nz, accessed 9 January 2014). A recent marketing innovation is the kill-and-seal trap system; once a mouse is caught, the door of the trap seals in the mouse and prevents environmental contamination (e.g. www.victorpest.com/user/bm265-12?startimg=2, accessed 9 January 2014). Enclosed single- and multi-kill traps for mice and rats that kill by electric shock have also become readily available (e.g. http://www.ratzapper.co.nz; www.victorpest.com, accessed 13 January 2014). Kill traps are a potential replacement for glueboards, particularly those traps housed in a solid-walled container to reduce the risk of environmental contamination.

There is very little information about the comparative efficacy of single and multi-catch live or kill traps. Industry experience (P. Sayer pers. comm.) suggests the live trap models are not effective for rat control, but may be effective for mouse control.

A novel approach to lethal rodent control is the RADAR trap system, which uses carbon dioxide as the lethal agent (www.rentokil.co.nz/technical-support/our-products-and-services/rodent-control/mouse-radar/index.html, accessed 9 January 2014). The trap box has an entrance at each end of the unit, allowing mice to run through its passageway. When the mouse breaks two consecutive infrared beams, it trips a circuit that immediately closes and tightly seals both entrances and releases carbon dioxide gas. Risk of contamination is minimised as the mouse remains completely contained. This trap system is a potential replacement for glueboards and costs c. $150 a year, which includes all servicing costs.

However, the use of carbon dioxide for rodent euthanasia is subject to ongoing discussion about its humaneness and the parameters of best-practice administration (Hawkins et al. 2006).

In New Zealand, Kiwicare markets a rodent control product called 'Natural No Rats', which is claimed to be lethal to rodents but non-toxic to other animals and people, to cause no secondary poisoning, and to be 100% natural. The active ingredient is listed as 94% powdered corncob in the form of a pellet (www.kiwicare.co.nz/pest/products/product-list/natural-no-rats, accessed 6 January 2014). Similar corncob-based products have been marketed in other countries, for example Natrocell (UK), Safe+Kill (USA) and Rodetrol (USA, Canada). The mode of action of these corncob-based products is unclear, but is attributed to their high cellulose content and its effects on the digestive system. Questions have been raised about the welfare impacts of the products (Schmolz 2010).There are also few published studies of their efficacy (Lodal 2002; Grech et al. 2004; Schmolz 2010), but the balance of opinion suggests the corncob baits are generally unpalatable even in the absence of other foods and so kill few rodents. The issue of palatability is emphasised in the Kiwicare directions for use, which state, 'It is very important that other sources of food for the rodents are removed. Natural NO Rats must be the major source of food for the rodents over a period of several days.' In two-choice tests with mice, Schmolz (2010) observed low consumption of cellulose-based bait over 15–34 days and no mortalities. It therefore seems unlikely that this or similar cellulose-based products would be an effective, acceptable alternative to glueboards in any situation.

Rodent repellents are designed to evoke avoidance of particular objects or sites, or to prevent invasion of sites. They are mainly of two types – those that rely on smell or taste to evoke an avoidance reaction (Meehan 1984; Kimball & Taylor 2010), and those that trigger avoidance through other senses using ultrasonic, electromagnetic or ionic emissions (e.g. www.pestrol.co.nz/pestrol-rodent-free.html, accessed 16 January 2014). Taste or smell repellents have mostly been designed to deter rodents from feeding and gnawing activities, such as crop damage or damage to electrical wiring, rather than to maintain areas free of rodents or to drive rodents out of particular areas. The mode of action of taste repellents generally precludes their use for the latter purposes. Smell repellents, in theory, may have potential for area-wide action but are likely to be offensive to people and/or dangerous to human health at the concentrations that would probably be required (Meehan 1984, 1988). Ultrasonic and other similar emitting devices often claim to provide effective area-wide coverage and to function both to drive out rodents and to prevent invasion (e.g. www.pestrol.co.nz/pestrol-rodent-free.html, accessed 16 January 2014). Despite many glowing testimonials about current devices on company websites, scientific evidence suggests such devices are generally ineffective or have, at most, a short-term effect because rodents habituate to the emissions and/or the devices themselves (Meehan 1984; Bomford & O'Brien 1990; Shumake 1995; Corrigan 2003; Clapperton 2006). It seems unlikely, therefore, that currently-available repellent chemicals and devices could be used alone as replacements for glueboards.

Toxins would be an effective replacement for glueboards as a control method except that their use is not allowed or is restricted in many of the situations where glueboards are currently still used (e.g. food production premises, including manufacturing, preparing, packaging and storage). For example, all the rodenticides approved by the Ministry for Primary Industries as Type C Approved Maintenance Compounds (Non-Dairy) may only be used in premises in accordance of the requirements of a vermin control programme that has

been documented as meeting relevant legislation; may be used in food areas provided there is no exposed product or food ingredient present in the room; and must be removed from edible-food processing areas before processing operations begin. For those reasons they are not considered a suitable alternative to glueboards.

However, toxins would be a suitable replacement for glueboards where toxin use is not restricted or as a means of minimising the risk of invasion of premises by rodents (which might subsequently result in the need for rodent control where toxins could not be used). Corrigan (2003) describes the principles of integrated pest management for protection of food plant warehouses, but the general principles apply to rodent control in all situations. His 'perimeter defence' programme consists of three lines of defence, where the property boundary and the immediate exterior of the building are protected by rodenticides and/or traps, while the interior of the building uses only non-toxic methods, such as multiple-catch traps.

A wide range of toxins and formulations are available in New Zealand for rodent control (see www.foodsafety.govt.nz/industry/acvm/vertebrate-toxic-agents, accessed 4 March 2014) and could be used as replacement for glueboards where toxin use is not restricted. Registered toxin formulations include cholecalciferol and 1080, and the anticoagulants brodifacoum, flocoumafen, bromadialone, coumatetralyl, diphacinone, pindone and difethialone. All of these are efficacious against rodent infestations (although there are no comparative efficacy data), and there is no evidence to date of resistance to anticoagulants in New Zealand rodent populations. All the toxins pose residue risks in target and non-target species, and these are generally higher for the second-generation anticoagulants (brodifacoum, bromadiolone, difethialone and flocoumafen) than the other toxins (Fisher et al. 2004; Crowell et al. 2013). Other than for 1080 and brodifacoum, there is little comparative welfare information to guide pest control operators in their choice of toxin (Fisher et al. 2010). Many of the anticoagulant toxins are available in formulations (such as blocks rather than pellets) that allow the bait to be tethered inside (lockable) bait stations and so minimise risks of bait spillage. Although both bait composition and bait station design/construction have been shown to influence efficacy (Spurr et al. 2007; Morriss et al. 2008), tethered baits in bait stations would appear to be the lowest risk option as a replacement for glueboards for general rodent control. A disadvantage of toxins over glueboards and traps is that they provide no control over where poisoned rodents die.

Rodent experts contacted in the UK and Germany were not aware of any official advice provided in those countries in relation to alternatives rodent control methods to glueboards other than the use of existing live and kill traps and toxins (J Jacob, J Talling pers. comms).

5.4.2 A comparison of glueboards and alternatives for rodent control

The cited advantages of glueboards are that they are (1) non-toxic and (2) non-contaminating; (3) they hold the carcass in one place; (4) they have a 100% capture rate for animals that encounter them; (5) no licence is required for their use; and (6) they are low cost. Additional advantages are that they can be deployed in places where other types of traps could not be set (e.g. in very narrow spaces such as under manufacturing equipment) and they can be used to provide an effective barrier against rodent incursions to or within premises where there has been a temporary breach of structural integrity. The former use can be addressed in some situations by surrounding machinery with temporary physical barriers and traps and driving mice out of concealment using high pressure non-toxic gas (see www.youtube.com/watch?v=-vTCRcYP4Z4 accessed 30 April 2014). The latter use is

considered particularly important by food producers. It is not known whether a similarly effective barrier could be implemented using a combination of traps and temporary physical barriers.

Glueboards have no moving parts so are not prone to false triggering. It is also claimed that they are an effective tool for dealing with trap-shy rodents and, more generally, that they are an essential component of any integrated rodent pest management programme where best practice recommends a variety of control methods (e.g. Garrards 2010). For example, where there is urgency to deal with a rodent infestation after its detection, such as on aircraft or in food preparation premises, glueboards may be used in conjunction with other methods such as snap traps to maximise chances of rodent capture. Some references suggest glueboards are less effective against rats than against mice (e.g. www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74106.html, accessed 16 January 2014).

Physical exclusion is the ultimate non-toxic solution to rodent problems and improvements in that area should always be considered as part of any integrated rodent management plan. From the range of available methods for rodent control discussed above, those that have been suggested as or potentially offer an alternative to glueboards include fumigation; trapping (live and kill traps); poisoning using a non-toxic lethal compound; and ultrasonic, electromagnetic and ionic devices. The extent to which these alternative control tools for rodents have the potential to meet the cited advantages of glueboards is summarised in Table 2.

There is clearly a lack of well-designed studies comparing the efficacy and cost-effectiveness of glueboards and other methods and this limits firm recommendations about suitable alternatives.

Table 2. The extent to which alternative control tools for rodents meet the cited advantages of glueboards

Criterion	Glueboards	Alternatives
Non-toxic	Manufacturers and retailers of glueboards usually do not state the composition of the glue used or it is only stated in general terms, such as 'composed of mineral oils, resins, and synthetic rubber'. All 10 material safety data sheets from different glueboard rodent control products that were examined stated they contained no 'hazardous substances' as defined under the relevant legislation. Some non-target captures may be able to be removed from glueboards without physical harm.	Fumigation using non-toxic methods such as controlled atmosphere may be usable in large-scale situations, such as shipping containers and warehouses, but not food production facilities. Trapping does not involve the use of toxic substances. Cellulose-based baits lethal to rodents are commercially available but there is very limited scientific evidence to support claims of their efficacy. Ultrasonic or electromagnetic devices are non-toxic but there is very limited scientific evidence to support claims of their efficacy.
Non-contaminating	Glueboards are generally non-contaminating but may not always keep urine from trapped rodents or mobile ectoparasites (such as fleas) contained (Frantz & Padula 1983; Corrigan 1998).	Fumigation with inert gases or controlled atmosphere is non-contaminating but faeces, urine and mobile ectoparasites from dying rodents and inaccessible rodent carcasses may contaminate the environment. Traps are non-contaminating but, where the trap is not enclosed, bait material and faeces, urine and mobile ectoparasites from dead rodents may contaminate the environment. Cellulose-based baits may contaminate the environment through scattering of bait from bait stations and rodent hoarding of bait. Ultrasonic or electromagnetic devices are non-contaminating.
Utility	Glueboards may be used with covers to protect the glue. If used uncovered their physical dimensions enable them to be used in a wide variety of situations. Because glueboards have no moveable parts they are not susceptible to accidental triggering. Glueboard efficiency declines with time due to reducing glue adhesiveness. Glueboards often serve a dual purpose for both rodent and insect detection/control. Glueboards are used extensively as barrier traps. Their effectiveness relative to other methods is not	Traps may be used covered or uncovered but their height precludes their use in some of the confined spaces where glueboards could be used. Bait stations suffer from the same problem. Traps may be inadvertently set off by causes other than rodents.(e.g. movement on ships or aircraft) Traps may require re-baiting if they are left in place for more than 1–2 days. Traps may also be used for barrier trapping, Their effectiveness relative to other methods is not known.

	known. Glueboards may be the final set of devices in an integrated control programme that has already involved traps (such as the three lines of defense – Corrigan 2003)	
Carcass held in one place	Glueboards generally hold the carcass in one place but Frantz and Padula (1983) and Corrigan (1998) observed boards being dragged away by partially-captured rodents. A carcass held in a non-covered glueboard is exposed to the environment.	Fumigation provides no control over the ultimate location of carcasses. Traps hold carcasses in one place. Carcass or live animals may or may not be exposed to the environment, depending on the trap type (e.g. mesh cage vs solid-walled cage) or trap system (trap enclosed in a container that may or may not have sealing doors). Cellulose-based baits provide no control over the ultimate location of carcasses. Ultrasonic or electromagnetic devices are claimed to work by driving rodents out of premises or preventing their entry and provide no control over the ultimate location of those rodents.
100% capture rate for animals that encounter them	No control device or method consistently captures or kills 100% of rodents. Escapes from glueboards undoubtedly occur, and have been observed for both mice and rats in trials in the laboratory and in commercial buildings (Anonymous 1970; Corrigan 1998 and references therein). Fitzwater (1982) and Corrigan (1998) noted that glueboards may not work well at very low or high temperatures or in damp or dusty environments because of effects on the adhesiveness of the glue. Corrigan (1998) also reports observations of rodents depositing debris on glueboards. Of concern is Corrigan's (1998) finding that most of the mice captured in his trials were juveniles, suggesting glueboards might be less effective against adult mice. However, glueboards, used as a primary control tool, may be very effective at reducing high density mouse populations (Advani 1992). Frantz and Padula (1983) noted differences in efficacy between two types of glueboard. Gupta et al. (2004) noted differences in efficacy between different types of glue.	No control device or method consistently captures or kills 100% of rodents. Fumigation is claimed to be able to eradicate rodent infestations. Traps can provide effective control in most situations (Meehan 1984; Prakash 1988; Corrigan 2003). There are few direct comparisons of the efficacy of traps vs glueboards. Corrigan (1998) reported on two small trials where traps had significantly higher catch rates than glueboards. However, results may depend on the type of trap used as Tripathi et al. (1994) found glueboards superior to one trap type but not another. Kill traps may be lethal to non-target species. Cellulose-based baits are commercially available but have very limited scientific evidence to support claims of their efficacy. Ultrasonic or electromagnetic devices are claimed to work by driving rodents out of premises or preventing their entry. Some websites claim 100% success but supporting data are absent.
Effective against trap-shy rodents	Rats and mice may display both	Switching trap type and/or baits may

	innate and learned trap shyness. The claimed benefit of glueboards for control of such rodents lacks supporting data. Some rodents may be shy of glueboards, as Corrigan's (1998) observation of rodents depositing debris on glueboards suggests. Srivastava and Srivastava (1985) also noted some ship rats avoided glueboards.	deal with trap-shy rodents, but the usual strategy, where applicable, would be to switch to use of toxic baits (Rowe 1973; Taylor et al. 1974; Meehan 1984; Clapperton 2006)
No licence required for use	Use of glueboards in New Zealand does not require a licence but, where their use is currently permitted, there is a legislative requirement regarding the frequency with which they must be checked.	Fumigation can only be carried out by approved operators. Use of traps in New Zealand does not require a licence but there is a legislative requirement regarding the frequency with which live traps must be checked. Use of cellulose-based baits does not require a licence. Use of ultrasonic or electromagnetic devices does not require a licence.
Fate of captured rodents	Glueboards are live traps and their operation therefore requires the handling and humane killing of captured rodents, with associated risks to both rodents and handlers. Although Frantz and Padula (1983) noted mice trapped on glueboards surviving for up to 24h, those experiments were conducted at temperatures in the thermoneutral zone of mice. In New Zealand PCOs report that most mice die overnight. Experiments by Bartlett et al (1953) suggest low ambient temperature and confinement (such as experienced by a mouse trapped on a glueboard in NZ winter) may reduce time to death to a few hours. The situation with rats is not clear, but the physiological consequences of their larger size suggest they probably survive for longer than mice when trapped on glueboards.	Live traps require the handling and humane killing of captured rodents, with associated risks to both rodents and handlers. Multi-catch live traps have additional requirements for handling and humane killing. Kill traps do not have these requirements, but few rodent kill traps available in New Zealand have been formally assessed for humaneness.
Low cost	A single glueboard ($1–$3) is cheaper than the least expensive alternative control tool, the snap-trap ($4–$12). But a glueboard can only be used once and is then discarded whether or not it has caught a rodent.	Cost-effectiveness of traps and other devices may be similar to that of glueboards when all factors are taken into account (such as trapping success, reusability of devices such as traps, etc.), but such analyses have not been done.

5.5 Improving glueboards

Searches of the websites of many of the New Zealand and international companies that sell and/or manufacture glueboards did not discover any improvements to glueboards in the last ten years that would address the perceived welfare issues about their use (Frantz & Padula 1983). Improvements generally related to construction materials including the glue, covers for the traps, methods of applying glue to trap rodents more effectively, better lures and baits, and the use of glueboards in multi-catch traps. While the physical design of glueboards might be altered (e.g. to ensure rodents were trapped in a consistent posture that minimised welfare impacts), searches uncovered no such improvements. Rodent experts contacted in the UK and Germany were unaware of any recent developments in relation to glueboard design or use (J Jacob, J Talling, pers. comms).

Several US patent applications were found, dealing with the use of a sedative compound to reduce suffering of rodents caught in traps, including glueboards (Becker & Connelly 1989; Frisch 2008) and an enclosed glue trap releasing lethal doses of anaesthetic gas (Smith 1986). However, none of these suggested improvements appears to be commercially available, although the RADAR trap applies a similar principle, in killing the live-trapped rodents using gas (carbon dioxide; see Section 5.3.1). Motomco (www.motomco.com) marketed glueboards with glue containing eugenol, which was claimed to be a natural anaesthetic. That claim has since been withdrawn, and the inclusion of eugenol is now claimed to enhance the adhesiveness of the glue.

5.6 Codes of practice for glueboards

In the UK, the Pest Management Alliance (the British Pest Control Association, the Chartered Institute of Environmental Health, the National Pest Technicians Association and UK Pest Controllers Organisation) has drawn up a COP on the humane use of rodent glueboards (Appendix 1). This involved consultations with the Department of Food, Environment and Rural Affairs and Natural England and replaces a previous British Pest Control Association (BPCA) COP for the use of rodent glueboards. A draft COP for glueboards has been developed in New Zealand since the restrictions in use came into force in 2009, largely based on the Pest Management Alliance document (Appendix 2) and the 2006 Australian Environmental Pest Managers Association guidelines. This draft COP is still to be officially adopted by PMANZ members pending any changes that might occur between now and the current phase-out by 2015.

Humane use in these COPs largely involves using of glueboards only once all other options have been considered; use by trained personnel; more frequent checking; humane killing of trapped rodents; and care of trapped non-target animals.

6 Discussion

The UK Royal Society for Prevention of Cruelty to Animals, in discussion about the use of glueboards by the food industry where toxins cannot be used and contamination is a major issue, summed up the situation by saying, ‘Rodent control in such situations causes a

dilemma to which, unfortunately, there is no effective and humane solution' (www.rspca.org.uk/utilities/faq/-/question/ENQWADGlueTraps, accessed 28 January 2014). The same statement could be made about some of the restricted uses of glueboards in New Zealand because it is currently not possible to make an objective comparative assessment of all the economic and welfare costs and benefits or glueboards and potential alternative devices.

As this review has revealed, comparing glueboards and alternative devices is complex for both technical and animal welfare reasons. Glueboards are often used as part of a toolbox of methods within an integrated pest management programme that may already include the use of other devices (particularly traps) that could be considered as replacements for glueboards. A total ban on use of glueboards would therefore remove one tool from the toolbox, with no obvious substitute beyond more and/or smarter use of other existing devices and control methods.

Glueboards for rodents have two distinct advantages over all other currently available methods – they can be used to monitor and/or control rodents in places where other devices cannot fit (and so potentially sample a greater area) and they are not prone to false triggering. The latter advantage can probably be addressed by, for example, the use of electronic triggers on current devices. As described in Table 2, all their other proposed technical advantages, both for monitoring and control, would appear to be matched by the characteristics of other existing devices, particularly single-catch and multi-catch kill traps in enclosed trap stations. What remains to be done is the practical demonstration that such a change would not result in significant increase in the risk of rodent incursion and/or damage in those situations where glueboards are currently considered essential. Transition to use of alternatives is unlikely to cause significant technical problems because most of the pest control contractors using glueboards already use the likely alternatives for rodent control in other situations. However, the move to alternatives will impose additional costs, particularly personnel costs.

No commercially-available modifications to glueboards were found that were likely to reduce glueboard welfare impacts. Reducing welfare impacts would require reducing the time between capture and continuous unconsciousness or death. This might be achieved by inclusion of sedatives/anaesthetics or toxins in the glue that could be absorbed through the skin quickly enough in sufficient amounts. But such an approach would require management of additional hazards.

Firm conclusions about the relative merits of glueboards and alternative devices and the feasibility of transition to other methods for rodent monitoring and control are hampered by an absence of data. To address this there is a need for:

- Better data about the efficacy and cost-effectiveness of glueboards and alternative methods for rats and mice. This would require trials to assess trapping efficiency and to collect data on operational costs.
- Better data about numbers of glueboards used and rats and mice captured, including data on multiple captures on single traps, and the fate (alive/dead, injuries) of captured rodents. Obtaining this information would require close assistance from the pest control industry.
- Comparable welfare data on glueboards and other methods/devices for rats and mice. This would require observational assessments under controlled conditions for some devices and review of existing data.

- Information on the current economic costs of rodent impacts to those sectors currently using glueboards. This could be obtained from the sectors concerned.
- Research into new alternatives to glueboards that are acceptable to industry. This would require assistance from industry with testing.

In the meantime, single- and multi-catch live and kill traps (used with trap covers where applicable) would seem to be a potential practical alternative to glueboards for rodent monitoring and control where the use of toxins was not acceptable. Toxins are also a suitable alternative to glueboards where toxin use is not restricted, particularly when combined with non-toxic control methods in an integrated control programme.

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Appendix 1 – UK Pest Management Alliance Code of Practice for the Use of Glueboards

Pest Management Alliance – Code of Best Practice

Humane Use of Rodent Glue Boards (Issued: February 2010)

In order to protect public health within high-risk environments, the use of rodent glue boards remains an important last option when all other control methods have been considered ineffective. Although glue boards are not designed to physically harm rodents, their use raises valid concerns and they should only be sold to or used by technicians who have been given adequate training and are competent in the effective and humane use of this technique. The following principles must be followed in order to minimise animal welfare concerns.

1. Option of last resort

All other options for rodent control must be considered before glue boards are used. Detailed records must show why other control methods are either considered inappropriate or have failed. Where there is a rodent in a high risk environment, it may be appropriate for glue boards to be placed strategically to ensure immediate control.

2. Check boards frequently

Where rodent boards are used these must be inspected at appropriate intervals. This should be within 12 hours of placing, or at least as soon as is reasonably practicable, including weekends and bank holidays. If unavoidable events cause slight extensions to inspection intervals then the reasons should be recorded. Longer delays must be avoided (see contingency plan below). Where possible and practical, inspection times must be organised to minimise the time rodents are likely to be on the board (e.g. if rodents are known to be active during certain periods, inspection times should be arranged with this in mind). If a caught animal displays signs of undue suffering or serious physical harm, the intervals between inspection times must be shortened. Records must be updated after all inspections.

3. Contingency plan

A contingency plan must be in place so that in the event of an emergency a second competent person can be called upon to inspect the boards and deal with any captures or safely remove the boards as appropriate. Where it is known boards will not be inspected at appropriate intervals they must be taken up (even if only temporarily).

4. Protect non-target species

Boards must be placed in such a manner that they do not present a risk to non-target species.

5. Use the correct size board for the pest species

The size of board must be appropriate for the target species.

6. Detailed records

Detailed copies of records and location plans should be available on site at all times for all boards laid during any treatment and must be updated as necessary to ensure traceability. Copies ensure information is available should site records be lost or unavailable.

7. Dispatch of trapped rodents humanely

Rodents trapped on rodent boards must be dispatched quickly and humanely by technicians with appropriate training. Placing the glue board in a clear plastic bag and dealing the rodent a sharp blow to the head with a blunt instrument would be an appropriate mode of dispatch. Drowning is not an acceptable method of dispatch.

8. Non-target animals

In the event that a non-target animal is trapped, a suitable food grade oil or similar emollient should be applied to the animal for removal, or if not a protected species it may be killed humanely. Non-targets should only be released at their site of capture, not elsewhere, and only if they appear to be physically unharmed and their release is not prohibited by law.

9. Remove boards at the end of treatment

At the end of treatment all rodent boards must be accounted for, removed by the technician and the records endorsed accordingly.

10. Dispose of boards safely

Rodent boards should be disposed of with care. The sticky surface should be covered to avoid the accidental trapping of non-target species or subsequent misuse, and the board should be disposed of in accordance with local authority waste requirements.

11. Communication with the customer

This Code of Best Practice must be provided to the customer to make them aware of the standards that the operative is working to.

The humane use of glue boards is the legal responsibility of the pest controller, and cannot be delegated to untrained people. All technicians must be suitably trained and competent in their application, maintenance and ultimate disposal including the dispatch of the target species and safe removal of non-target species.

This Code of Best Practice was produced after consultation with Defra and Natural England. The Pest Management Alliance consists of the British Pest Control Association, the Chartered Institute of Environmental Health, the National Pest Technicians Association and the UK Pest Controllers Organisation.

Appendix 2 – Pest Management Association of New Zealand Draft Code of Practice for the Use of Glueboards

The following procedures are the PMANZ Code of Practice.

1.1. All other options for rodent control should be considered before adopting rodent boards and records must show that other control systems are inappropriate or have failed prior to the adoption of rodent boards as a method of control.

1.2. Where rodent glueboards are laid these must be inspected at appropriate intervals. This will be at least once daily unless monitored by an approved, reliable remote alert facility to initiate response. Arrangements may be made for boards to be checked by a third party, for example site personnel. Such arrangements should be properly documented.

1.3. Glueboards must be placed in such a manner that they do not present a hazard to non-target species and that they may be retrieved and removed at the end of the exercise. The size of the glueboard should be consistent with the target species. For example a rat caught on a board laid for mice may still be able to move the board from its location, making it impossible for the technician to retrieve and despatch the rat.

1.4. Records should be kept of all glueboards laid, to describe that:

(a) the trap must be used only for a specified duration

(b) the trap must be used only in a specified area or a specified layout

(c) the trap must be used only to target certain species of animal

(d) the trap must be used only for a specific purpose

(e) only a specified number of traps must be used

(f) the trap must be of a specified make, type, or size

(g) the trap must be set in a specified way.

1.5. Rodents trapped on rodent boards must be despatched quickly and humanely. This may be achieved by quick and positive dislocation of the neck. Lethal chambers may be used provided that the gas introduced is approved for that purpose. Drowning is not an acceptable method of despatch.

1.6. All rodent boards must be removed by the technician at the end of the specified period (unless required permanently for asset, food, product and public safety in an otherwise secure, rodent proofed structure). On removal the records at 1.4 should be endorsed accordingly.

1.7. Rodent boards should be disposed of with care. If it is not possible to incinerate the boards, the sticky surface should be covered so as to avoid the accidental trapping of non-target animals.

1.8. Technicians must be given adequate training and be competent in the effective and humane use of this technique. Any third party delegated to check boards on behalf of the pest control company should be similarly trained and competent.

1.9. Any promotion of glueboards, or adhesive to make such boards, must conform to the spirit of this Code of Practice. In particular, advertising should not promote the use of glueboards as ‘first choice’ method.