Industry Biosecurity Plan for the Grains Industry
Threat Specific Contingency Plan

Wheat bug
Nysius huttoni

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1 Purpose of this Contingency Plan

This Contingency Plan provides background information on the pest biology and available control measures to assist with preparedness for an incursion into Australia of Wheat bug (*Nysius huttoni*). It provides guidelines for steps to be undertaken and considered when developing a Response Plan to this pest. Any Response Plan developed using information in whole or in part from this Contingency Plan must follow procedures as set out in PLANTPLAN and be endorsed by the National Management Group prior to implementation.

2 Pest information/status

2.1 Pest details

2.1.1 General information

Taxonomic position – Class: Insecta; Order: Hemiptera; Family: Orsillidae

Common names: Wheat bug or New Zealand wheat bug (see Crop Protection Compendium 2008; www.nappfast.org).

Scientific name: *Nysius huttoni* Buchanan-White

Nysius huttoni is a polyphagous species that predominantly breeds and feeds on a large number of weeds and crops including wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.). The wheat bug is endemic in New Zealand and considered a hitchhiker previously found on apple fruit packages exported from New Zealand raising major quarantine risks to countries that trade with New Zealand. Studies on the feeding effects of *N. huttoni* have mostly concentrated on wheat grain. On wheat the damage is essentially observed when the grain is attacked at the milk-ripe stage resulting in damage to the baking quality of the dough.

N. huttoni is small to medium in size (3-4 mm long) and with remarkably varying body forms, wing-development and colour, and the body above is covered with long and erect pubescence (Sweet 2000).

N. huttoni feeds on grain in the milk-ripe stage of development. *N. huttoni* sucking mouthparts pierce through the glumes into the developing grain. During feeding the wheat bug injects saliva into the grain through one stylet whilst nutrients are sucked out through the other one. The saliva contains an enzyme which breaks down the dough structure, producing a runny sticky fluid that becomes unusable for bread making purposes (Every *et al.* 1998). Only a very low percentage of grain needs to be damaged (3-4 grains per 1000) to make the whole production line considered unsuitable for baking.

N. huttoni is currently widely distributed across New Zealand with limited distribution occurring in Belgium and the Netherlands. *N. huttoni* has not yet been recorded in Australia and entry potential as a hitchhiker is considered possible.

Given the widespread distribution of cereal crops, Brassicaceae, lucerne and clovers across Australia, a substantial food source exists in Australia for *N. huttoni*. Furthermore the pest is considered an adaptable feeder and when the necessity arises the pest can live on almost any cultivated plant as well as weeds. *N. huttoni* is a seed feeder but may also feed on foliage (He and Wang 2000). In New Zealand, *N. huttoni* is a significant pest of wheat usually on average every ten years when dry conditions cause *N. huttoni* to move from margin areas and waste land to the crop feeding on wheat grain in the milk-ripe stage. Brassica seedlings (canola, swede, turnip, cabbage etc) are usually more susceptible than cereal crops.

Evidence has shown that *N. huttoni* is found mainly on weeds, moving to the wheat when weeds have matured and died off. As weeds are generally smothered by the crops during the crop growing season, *N. huttoni* are generally confined to the edge of wheat crops. As well as damaging wheat and Brassicacea, *N. huttoni* can also do considerable damage to young cruciferous crops. As *N. huttoni* feed, they produce punctures around the stems of the seedlings at ground level, resulting in a cankerous growth of the tissue that interferes with the sap flow and often resulting in collapse of the plant (He and Wang 1999).

2.1.2 Life cycle

It has been reported that *N. huttoni* can have three to four generations per year in the lower North Island of New Zealand. *N. huttoni* is distributed throughout New Zealand from sea level to 1800m altitude (Eyles and Ashlock 1969). In the Netherlands and Belgium, *N. huttoni* was found in dry, warm waste grounds and roadsides with sparse vegetation. The number of generations was unclear but related species in the region have 1 to 2 generations per year. Temperature is a critical factor to influence the development, survival and reproduction of *N. huttoni* and it's likely that temperature also effects geographic distribution and abundance. The insect is an adaptable feeder living on almost any cultivated plant as well as weeds when the necessity arises.

Early reports have shown that *N. huttoni* females laid eggs in the soil but not on or in plants where *N. huttoni* congregate whilst later research reports eggs in the soil and on the flowers of chickweed. Adults migrated to overwintering sites in the autumn aggregating under dead leaves, under bark of trees and within grass swards, with adult survival greatest in sheltered sites under pine bark (Farrell and Stufkens 1993). Cases have been reported where diapauses do not seem to occur as the species can complete its life cycle if conditions remain warm (Eyles 1965).

Flight trapping has shown that parts of the population emerged from the annual weeds when new patches of crop were colonized. This same study in the north eastern region of the South Island of New Zealand showed that between 47 and 80% of all females collected during the 1st generation were gravid (mated) females, but only 0-9.6% of the 2nd generation were gravid females (Farrell and Stufkens 1993). Other findings showed adult survival during late winter was greatest under pine bark and during early spring overwintered adults would migrate to patches of annual weeds where they fed and reproduced.

The phenology of the first generation of *N. huttoni* was initiated by overwintering females' ovipositing in September and October with the adult emerging in November and December. This same phenology was observed earlier for *N. vinitor* in Victoria (McDonald and Smith 1988). Evidence in New Zealand suggests that some first generation adult female *N. huttoni* oviposited in the weed habitat to form a second generation from which only a small proportion formed a much smaller third generation (Farrell and Stufkens 1993).

Major damage to wheat in New Zealand at the flowering and grain filling stages of growth usually occurred at 10 year intervals and usually after spring droughts (Swallow and Cressey 1987). Wheat damage increases when warm dry conditions during development of the first generation promotes early emergence of adults or the early migration as a result of host plant desiccation occurring.

N. huttoni survival in New Zealand is well documented and can be linked to their flexibility in behaviour and habitat arising from its multiple options during the life cycle. *N. huttoni* is mobile and polyphagous feeding on a series of crops and annual weeds. Other behavioural features include: the ability of the adult to emigrate to a new food source or exploit the resources at the breeding sites; eggs may be attached to seed heads or buried in the ground; selection of overwintering sites may be an exposed

habitat or migration to sheltered areas; or second generation adults may reproduce of diapauses (Farrell and Stufkens 1993).

There are 7 stages in the development of the *N. huttoni* from the egg (stage 1); 5 nymphal immature instars (stage 2-6) before *N. huttoni* reaches maturity emerging as an adult (stage 7). Survival and development of immature stages is dependent on temperature. At 10°C and 15°C *N. huttoni* could not complete its life cycle but the high tolerance of its nymphs to these temperatures suggests that its immature stages can survive lengthy shipment and possibly establish in countries that trade with New Zealand. More than 50% of *N. huttoni* adults could also survive for at least 100 days at 15°C or less and then reproduce after being maintained for 100 days at 10°C and then transferred to 20°C (He *et al.* 2003). Again these findings imply that adults can survive normal shipping at 10°C through infected fruit packages and establish in countries with a temperature higher than 15°C.

2.2 Affected hosts

2.2.1 Host range

N. huttoni is a polyphagous species which feeds on a large number of weeds and crops. In New Zealand, it is mainly reported as a pest of wheat and Brassicaceae but it can also feed on many other plant species. It can attack; *Triticum aestivum* (wheat), *Hordeum sativum* (barley), *Avena sativa* (oat), *Secale cereale* (rye); *Brassica* spp.; *Medicago sativa* (lucerne); *Trifolium dubium*, *T. pretense, T. repens,* (clovers); *Bromus,* and *Lolium*. The following weeds have also been reported as hosts; *Anagallis arvensis, Calandrinia caulescens, Capsella bursa-pastoris, Cassinia leptophyla, Chenopodium album, Coronopus didymus, Hieracium, Polygonum aviculare, Rumex acetosella, Senecio inaequidens, Silene gallica, Soliva sessilis, Spergularia rubra,* and *Stellaria media*. There is evidence to suggest that the presence of mosses (e.g. *Ceratodon, Sphagnum, Polytrichum* spp.) may also be crucial for the overwintering period (Farrell and Stufkens 1993; He and Wang 1999; Wang and Shi 2004; European Plant Protection Organisation (EPPO) 2006).

2.2.2 Geographic distribution

Nysius huttoni is widespread across the North and South Islands of New Zealand. Its only distribution outside of New Zealand is the extreme Southwest of the Netherlands and the adjacent Northwestern part of Belgium. Pathways of introduction of *N. huttoni* into Europe are unknown, but wheat bug is suspected of arriving accidently from New Zealand through the Antwerpen harbor (EPPO 2006). *N. huttoni* has not been recorded in Australia.

2.2.3 Symptoms

N. huttoni attacks the wheat kernels in the water ripe to milky stages of development by piercing the grain then sucking out the juices. When the damaged grain matures it is characterized by a dark insect feeding puncture mark surrounded by a pale area on the surface. When the damaged seed is cross-sectioned, the pale area is usually seen to be associated with a white mealy area in the endosperm surrounded by dark vitreous endosperm. Damaged kernels may also be distorted around the puncture sites, often with shrivelled kernels (Every *et al.*1990).

Once the grain is pierced, *N. huttoni* injects a salivary proteinase to facilitate ingestion that remains within the grain until maturity. This enzyme acts by hydrolysing the high molecular weight glutenin subunits of gluten protein causing severe quality deterioration in bake products including sticky dough, poor loaf volume and poor bread texture (Every *et al.* 1998).

The degree of damage is dependent on the number of insects present and their development stage. In an early study investigating the effect of *N. huttoni* on 5 brassica species Eyles (1965) showed that adults or nymphs caused similar damage and the effect on the different species was also the same. In contrast a later study showed that adults were significantly more damaging than immature stages at any density levels (He and Wang 1999) with the degree of damage also increasing with the development from nymph to adult stage. No differences were detected between adult female and male suggesting that both sexes consumed similar quantities of seedling sap.

2.3 Entry, establishment and spread

Entry potential: Low/Medium

The most likely method of *N. huttoni* incursion into Australia is as a hitchhiker through the importation of commodities from fruit packages exported from New Zealand where *N. huttoni* is endemic. Nymphs and adults can survive for up to 100 days at 10-15°C, and then continue development when temperatures are increased. These insects are small (adults 3-4mm) and may not be readily detected, eggs and nymphs are much smaller and may escape unnoticed. If individuals occur in low abundance detection may be difficult.

N. huttoni has been found throughout New Zealand and frequently intercepted in apples exported from New Zealand and from kiwifruit, tomato, apricots, peaches, persimmons and nectarines imported into Australia from New Zealand (www.agric.wa.gov.au/content/PW/Q/appleresponseIRA.pdf) with a high likelihood of being present in source orchards in New Zealand.

The probability of entry for *N. huttoni* would be rated as low where consignments have passed verification inspection in New Zealand and Australia and Pest Prevalence monitoring and control and pre-export inspection in New Zealand and Australia.

Establishment potential: High

The Australian climate is very suitable for *N. huttoni* establishment and would promote regular outbreaks particularly in the cereal production areas of the eastern and western Wheat belts, as the climatic conditions in New Zealand is comparable to those of Australia. *N. huttoni* is an adaptable feeder and can feed on almost any cultivated plant as well as a variety of weeds.

The probability of establishment for *N. huttoni* is therefore high.

Spread potential: Medium

Migratory potential of *N. huttoni* is unknown but adults possess wings and can fly. There is no evidence that *N. huttoni* flies further than short distances to find food or search for overwintering sites or evidence of long distance directional movement (Farrell and Stufkens 1993). With the exception of extreme easterly storms from New Zealand it is highly unlikely that *N. huttoni* will enter Australia by wind dispersal.

The climate of Australia is suitable for the spread of *N. huttoni* and coupled with the adults' to fly, the probability of spread for *N. huttoni* is high.

Economic impact: High

The impact on yield and cost of protection for *N. huttoni* is rated as high as, once established, *N. huttoni* may be impossible to eradicate and will require the implementation of Integrated Pest Management plans to contain outbreaks. The initial economic outlay in research, trials and implementation will be high. During this time, the loss of yield in cereal production regions due to *N. huttoni* may also be high. Trade restrictions in the sale and movement of fruit within specific districts, regions and between states within Australia would occur in an unabated incursion of *N. huttoni*. Trade and movement of wheat and canola to Australia's international markets would also be affected. The quality of wheat would also be downgraded as infested wheat infested contains a salivary proteinases resulting in sticky dough and poor bread texture (Every *et al.* 1998).

Overall risk: Medium/High

Specific action is required, generic risk treatment plans should be adopted as soon as possible in the interim.

2.4 Diagnostic information

2.4.1 Diagnostic protocol

Traditional taxonomic methods based on keys and descriptions are adequate for identification of *N. huttoni* adults. Nymphs will require rearing to adulthood for species determination. Eggs are too small and cannot be identified to species with certainty. The description provided below is sufficient for preliminary identification of the adult stages of the pest, but examination of male and female genitalia is required for confirmation.

The dark form has the corial margins subparallel at base and then distinctly lamellately dilated; the corial disk is mottled brownish throughout; the membrane is streaked with fuscous and white, giving a criss-cross effect when folded, in some marked black basally but is entirely clear apically. The pale form has the corium entirely testaceous except for sinuate black markings at the apical margin; the costal margins are less dilated in some specimens; the membrane is clear or more or less cloudy posteriorly. The femora vary from a spotted piceous condition to uniform piceous except at apices.

Diagnostic images of *N. huttoni* are provided on the Pest and Disease Image Library (PaDIL) web site (www.padil.gov.au/viewPestDiagnosticImages.aspx?id=143).

2.5 Response checklist

2.5.1 Checklist

Guidelines for Response Checklists are still to be endorsed. The following checklist provides a summary of generic requirements to be identified and implemented within a Response Plan:

- Destruction methods for plant material, soil and disposable items
- Disposal procedures
- Quarantine restrictions and movement controls
- Decontamination and farm cleanup procedures
- Diagnostic protocols and laboratories

- Trace-back and trace-forward procedures
- Protocols for delimiting, intensive and ongoing surveillance
- Zoning
- Reporting and communication strategy

Additional information is provided by Merriman and McKirdy (2005) in the Technical Guidelines for Development of Pest Specific Response Plans.

2.6 Delimiting survey and epidemiology study

Delimiting surveys should comprise local surveys around the area of initial detection concentrating on areas strongest symptoms of poor growth, also should include weeds and other vegetation growing on waste lands or roadsides in the vicinity of crops. The extent of the survey beyond the initial infected crop should be guided by results from the surrounding crops.

2.6.1 Sampling method

Plants should be assessed for the presence of adult and immature insects and their damage to stems and leaves as well as to developing seed kernel.

The occurrence of the insects in cereal grain crops is usually recorded by routine inspection using a metric 50 x 50 cm frame or an entomological sweeping net. In countries where Wheat bug is known to occur, wheat is assessed by inspecting the grains at the milk-ripe stage still on plants. On the surface of the soil inspection is done using metric frames. In this way, the average density per square metre is established. Insect collection with sweeping net is more superficial, and leads to more approximate results because insects on the soil surface are not recorded.

For diagnostic purposes, adult and nymph *N. huttoni* can be hand collected into glass vials or vacuum collected either with vacuum sampler, or swept from foliage with a hand net. All life stages are normally found on the foliage. Mature nymphs for rearing to adults can be collected with plant material and kept in rearing cages in a constant temperature room for regular checking, if necessary plant material in rearing cages may need to be replaced with fresh material every few days.

Where possible it is advisable to collect a large number of specimens of all life stages. With adult stages collect a number of specimens of varying size and colour depicting variation in the morphology of the species. Collection of different life stages can assist in diagnosis. Also collect specimens in duplicate that are clean and in good condition (i.e. that is complete with appendages such as antennae, wings and legs). Kill specimens by either freezing for 24 hours or in ethyl acetate vapour. If specimens need to be sent away for identification, they need to be either dry mounted or preserved in 70% ethanol. As the adult bugs are very active and can easily escape during transit, it is not advisable to send them as live specimens through post. Label each sample clearly using an alcohol-proof marker. If possible retain and store a duplicate sample in a secure location.

Any personnel collecting insect samples for assessment should notify the diagnostic laboratory prior to submitting samples to ensure expertise is available to undertake the diagnosis. General protocols for collecting and dispatching samples are available within PLANTPLAN (2008) Appendix 3.

Number of specimens to be collected

A large sample of specimens would be preferable. The aim is to obtain adults of both sexes and of various forms, colour and wing-development depicting range of variation within the species. Nymphs are not identifiable to species with certainty so need to be reared through to adults.

Preferred stage to be collected

Of the three life stages (egg, nymph and adult) only adults are identifiable to species using morphological features. If only nymphs are available they need to be collected and reared through to adults for identification.

How to collect specimens

Adults and nymphs can be hand collected into glass vials or swept from foliage with a hand net. However, as these bugs generally live on weeds and crops close to the ground, the most practical and reliable method is searching and hand collecting from these situations.

How to preserve specimens

Adults and nymphs can be placed in 70% ethanol and stored indefinitely, although their colour fades gradually with time. Specimens required for molecular diagnostic work should be killed and preserved in absolute ethanol or frozen (-80°C).

How to transport specimens

Vials of ethanol should be sealed to avoid leakage and packed with cushioning material in a strong box.

2.6.2 Epidemiological study

In *N. huttoni*, fluctuations in population density from one year to another are related to the physiological conditions of the individuals as well as the biotic and abiotic ecological factors.

Changes in population density can also be observed by monitoring populations over consecutive years in cultivated fields and overwintering areas.

The use of insecticides, and local movements after the main migration, may affect population densities, but in the overwintering areas the population densities are more constant.

2.6.3 Models of spread potential

No modelling data are available for spread of Wheat bug.

2.6.4 Pest Free Area (PFA) guidelines

Pest free area guidelines relevant to this pest. Points to consider are:

- Statistical field survey for symptoms on host plants: consignments of pot plants and produce left on the premises should be inspected. Inspect 200 stems or units from each consignment.

- Plant or soil sampling using appropriate diagnostic tests.
- Survey around irrigation systems, waterways, roadside and refuge habitats etc.

Additional information is provided by the IPPC (1995) in Requirements for the Establishment of Pest Free Areas. This standard describes the requirements for the establishment and use of pest free areas as a risk management option for phytosanitary certification of plants and plant products. Establishment and maintenance of a PFA can vary according to the biology of the pest, pest survival potential, means of dispersal, availability of host plants, restrictions on movement of produce, as well as PFA characteristics (size, degree of isolation and ecological conditions).

2.7 Availability of control methods

There are many different methods for controlling *N. huttoni* however; there is no attempt to eradicate *N. huttoni* in its current distribution, only to control outbreaks. The methods utilised for this purpose include chemical, mechanical and cultural control.

In New Zealand control of this bug is difficult because it feeds on weeds not only in the crops but also in waste ground, roadsides etc. and only migrates to crops under certain circumstances. In NZ no natural enemies are known, the main control or management of *N. huttoni* is by using chemicals. Trought (1975) found that chlorpyrifos, trichloronate, dicrotophos and a mixture of omethoate and azinphos-ethyl gave equivalent control for *N. huttoni* on brassicas.

2.7.1 General procedures for control

- Keep traffic out of affected areas and minimize movement in adjacent areas.
- Adopt best-practice farm hygiene procedures to retard the spread of the pest between fields and adjacent farms. Do not move soil or plant trash from infested paddocks to non-infested paddocks.
- Ensure that seed production does not take place on affected farms and do not use seed from these farms for human consumption.

2.7.2 Control if small areas are affected

In New Zealand where *N. huttoni* is endemic, the main control used is by chemical control of either insects or hosts. As the adults can fly, the response plan must consider the feasibility and practicality of removing host plants and will depend on results from delimiting surveys to assess the extent of establishment.

Other issues that need to be considered for controlling/managing the pest are minimising traffic movement through the infested area and adopting best practice hygiene to manage/control sources of inoculum (e.g. soil, seed, wood, hay, stubble, etc).

The best sustainable Integrated Pest Management procedures include more sophisticated measures such as developing effective pheromone traps, mass releases of parasitoids, application of fungal and bacterial diseases and encouraging *N. huttoni* predators into affected regions.

2.7.3 Control if large areas are affected

If large areas are affected, it will be very difficult to eradicate, since these polyphagous pests have a wide host range and will certainly infest a range of weeds. The control would be same as detailed in 2.7.2.

2.7.4 Cultural control

The most effective cultural control methods for use against the Wheat bug include planting crops earlier or using fast maturing varieties, resulting in the crop maturing out of sync with the pest life cycle. Another method of decreasing the damage is to eliminate all weeds from fields with herbicides both before, and during, cereal crop growth, as green weeds are required to allow feeding on dry grains.

2.7.5 Host plant resistance

No information available, although there is hope that wheat cultivars can be developed that provide resistance against this bug as there is a considerable difference among the cultivars in the damage inflicted upon the kernels (Every *et al.* 1998).

2.7.6 Chemical control

Chemical methods are the most widely used for *N. huttoni* management. The chemicals that have been used for the control of this pest in New Zealand include dicrotophos, trichloronate, chlopyrifos, and a mixture of omethoate and azinphos-ethyl (Trought 1975).

In Australia for the control of the related species *N. vinitor* (Rutherglen bug) various chemicals are being used (see APVMA database, www.apvma.gov.au).

2.7.7 Mechanical control

Mechanical methods of control, such as harvesting eggs and adults and nymphs from crops, or adults from over-wintering sites, would be labour intensive and costly in Australia. Burning the over-wintering sites is a more plausible solution in Australia given the evolutionary history native forest ecosystems have with fire. However, burning would not destroy the entire population and certain over-wintering sites would not permit burning, for example, mountainous regions. In addition, burning sites every year would change the natural vegetation composition and would not be a viable long-term solution.

2.7.8 Biological control

Biological control option is not feasible as no parasites, predators or pathogens have been known to be effective against *N. huttoni.*

3 Course of action – Eradication methods

Additional information is provided by the IPPC (1998) in Guidelines for Pest Eradication Programmes. This standard describes the components of a pest eradication programme which can lead to the establishment or re-establishment of pest absence in an area. A pest eradication programme may be developed as an emergency measure to prevent establishment and/or spread of a pest following its recent entry (re-establish a pest free area) or a measure to eliminate an established pest (establish a pest free area). The eradication process involves three main activities: surveillance, containment, and treatment and/or control measures.

3.1 Destruction strategy

3.1.1 Destruction protocols

- Disposable equipment, infected plant material or soil should be disposed of by autoclaving, high temperature incineration or deep burial.
- Any equipment removed from the site for disposal should be double-bagged.

If containment, eradication and/or best practice hygiene measures are implemented, disposable equipment, infected plant material or soil should be disposed of by autoclaving, high temperature incineration or deep burial. Equipment removed from the site for disposal should be double-bagged. Other methods such as use of methyl bromide and phosphine may be suitable for destroying this pest however little international data exists on specific rates and treatments for Wheat bug.

The Market Access Science Group at HortResearch in Auckland has been working since 1985 to find environmentally and economically sustainable treatments for controlling quarantine pests. The research has focused on the effectiveness of treatments such as heat, controlled, cold atmospheres, safe compounds, energy treatments and various combinations of each treatment. It has been reported that a controlled atmosphere of 1.2% O_2 and 1% CO_2 has the potential to control light brown apple moth (*Epiphyas postvittana)* and *N. huttoni* on Royal Gala and Granny Smith apples. Controls are continuing in New Zealand with heat and cold treatments to select a commercial treatment that control pests without fruit damage.

3.1.2 Decontamination protocols

Machinery, equipment, vehicles in contact with infected plant material or soil or present within the Quarantine Area, should be washed to remove soil and plant material using high pressure water or scrubbing with products such as a farm degreaser or a 1% bleach solution in a designated wash down. General guidelines for wash down areas are as follows:

- Located away from crops or sensitive vegetation
- Readily accessible with clear signage
- Access to fresh water and power
- Mud free, including entry and exit points, (e.g. gravel, concrete or rubber matting)
- Gently sloped to drain effluent away
- Effluent must not enter water courses or water bodies
- Allow adequate space to move larger vehicles

- Away from hazards such as power lines
- Waste water, soil or plant residues should be contained (see PLANTPLAN 2008 Appendix 18).
- Disposable overalls and rubber boots should be worn when handling infected soil or plant material in the field. Boots, clothes and shoes in contact with infected soil or plant material should be disinfected at the site or double-bagged to remove for cleaning.
- Skin and hair in contact with infested plant material or soil should be washed.
- Decon 90 is a suitable detergent for using to decontaminate equipment or personnel.

Registered fumigants/pesticides for soil use as an alternative to methyl bromide in New Zealand include chloropicrin, metam sodium and dazomet. Non chemical treatments such as natural substrates like composted pine bark, artificial substrates, biological control and steam treatments are also being investigated.

3.1.3 Priorities

- Confirm the presence of the pest.
- Prevent movement of vehicles and equipment through affected areas.
- Priority of eradication/decontamination of infected host material.
- Inform all groups within the industry.

3.1.4 Plants, by-products and waste processing

- Infected plant material should be destroyed by (enclosed) high temperature incineration, autoclaving or deep burial.
- Hay, straw or stubble should be destroyed by burning as eggs and occasionally overwintering/aestivating adults will survive for long periods in dry straw.

3.1.5 Disposal issues

- Particular care must be taken to minimize the transfer of infected soil or plant material from the area as diapausing eggs and nymphs may be present.
- Raking and burning infected crops is not an option as this procedure is likely to spread the pest greater distances during the raking phase.

3.2 Quarantine and movement controls

3.2.1 Quarantine priorities

- Plant material and soil at the site of infection to be subject to movement restrictions.
- Machinery, equipment, vehicles and disposable equipment in contact with infected plant material or soil to be subject to movement restrictions.

- Insects are active and have wings and can move distances hence the establishment of quarantine may be a problem.

3.2.2 Movement control for people, plant material and machinery

Movement controls are usually put in place for flightless pests/pathogens i.e. those that are principally moved as a result of contamination in plant material or soil.

If Restricted or Quarantine Areas are required, movement of equipment or machinery is to be restricted and movement into the Area is to occur by permit only. The industry affected will need to be informed of the location and extent of the disease occurrence. People, vehicle and machinery movements, from and to affected farms, will need to be controlled to ensure that infected soil or plant debris is not moved off-farm on clothing, footwear, vehicles or machinery. Clothing and footwear worn at the infected site should not leave the farm or they are thoroughly disinfected, washed and cleaned before wearing off-farm.

- While *N. huttoni* is a small to medium insect, and therefore can often be readily seen, adults and nymphs may still be present on vehicles and machinery used on the site. All machinery and equipment should be thoroughly cleaned down, with a pressure cleaner prior to leaving the affected farm. The clean down procedure should be carried out on hard standing or preferably a designated wash-down area to avoid mud being recollected from the affected site onto the machine. Any crop seed from the affected site should not be used for planting new crops, feeding stock or for human consumption.
- Hay must not be removed from the site or used for feeding stock due to the risk of moving adults, nymphs or eggs.
- Insects have wings and can move distances, potentially making establishment of quarantine impractical.

3.3 Zoning

The size of each quarantine area will be determined by a number of factors, including the location of the incursion, biology of the pest, climatic conditions and the proximity of the infected property to other infected properties.

3.3.1 Destruction zone

Destruction Zone may be defined as contiguous areas associated with the same management practices as the infected area (i.e. the entire trial, paddock or farm if spread could have occurred prior to the infection being identified).

The size of the destruction zone (i.e. zone in which the pest and all host material is destroyed) will depend on the ability of the pest to spread, distribution of the pest (as determined by delimiting surveys), time of season (and part of the pest life cycle being targeted) and factors which may contribute to the pest spreading. *N. huttoni* is a mobile pest and adults are known to fly long distances, hence establishment of a destruction zone would depend on distribution being believed to be restricted.

If destruction zones are established, all host plants within the initial site of infection should be destroyed to reduce food source and/or refuge for Wheat bug. In addition or alternatively, the Destruction Zone may be defined as contiguous areas associated with the same management practices as the infected

area (i.e. the entire trial, paddock or farm if spread could have occurred prior to the infection being identified).

3.3.2 Quarantine zone

The Quarantine Zone is defined as the area where voluntary or compulsory restraints are in place for the affected property(ies). These restraints may include restrictions or movement control for removal of plants, people, soil or contaminated equipment from an infected property.

3.3.3 Buffer zone

A Buffer Zone may or may not be required depending on the incident. It is defined as the area in which the pest does not occur but where movement controls or restrictions for removal of plants, people, soil or equipment from this area are still deemed necessary. The Buffer Zone may enclose an infested area (and is therefore part of the Control Area) or may be adjacent to an infested area.

3.3.4 Restricted Area

The Restricted Area is defined as the zone immediately around the infected premises and suspected infected premises. The Restricted Area is established following initial surveys that confirm the presence of the pest. The Restricted Area will be subject to intense surveillance and movement control with movement out of the Restricted Area to be prohibited and movement into the Restricted Area to occur by permit only. Multiple Restricted Areas may be required within a Control Area.

3.3.5 Control Area

The Control Area is defined as all areas affected within the incursion. The Control Area comprises the Restricted Area, all infected premises and all suspected infected premises and will be defined as the minimum area necessary to prevent spread of the pest from the Quarantine Zone. The Control Area will also be used to regulate movement of all susceptible plant species to allow trace-back, trace-forward and epidemiological studies to be completed.

3.4 Decontamination and farm clean up

Decontaminant practices are aimed at eliminating the pest thus preventing its spread to other areas.

3.4.1 Decontamination procedures

General guidelines for decontamination and clean up

- Refer to PLANTPLAN (Plant Health Australia 2008) for further information.
- Keep traffic out of affected area and minimize it in adjacent areas.
- Adopt best-practice farm hygiene procedures to retard the spread of the pest between fields and adjacent farms.
- Machinery, equipment, vehicles in contact with infected plant material or soil or present within the Quarantine Area, should be washed to remove soil and plant material using high pressure

water or scrubbing with products such as Decon 90 detergent, a farm degreaser or a 1% bleach solution in a designated wash down area as described in 3.1.2.

- Only recommended materials should be used when conducting decontamination procedures, and should be applied according to the product label.

3.4.2 Decontamination if pest is identified in a small or large areas

Where crops are left in situ to dry out, kill any remaining adult and immature wheat bugs with a weekly treatment. The final treatment should be carried out on the night preceding the removal of the crop. If chemicals were used to control, always ensure label requirements are met. The residual crop debris must be removed quickly and efficiently. If material is in a nursery or glasshouse, it should be kept in a covered container, under a polyethene sheet, or in sealed bags, to prevent adult bugs from escaping. Alternatively, crop debris may be disposed of by incineration or by deep burial (at a depth of at least 1 m).

3.4.3 General safety precautions

For any chemicals used in the decontamination, follow all safety procedures listed within each MSDS.

3.5 Surveillance and tracing

3.5.1 Surveillance

Detection and delimiting surveys are required to delimit the extent of the outbreak, ensuring areas free of the pest retain market access and appropriate quarantine zones are established.

For diagnostics to determine Wheat bug damage in harvested grain for trace-back, trace-forward or food safety purposes it may be possible to assess affected grain by taking and assessing subsamples from silos or farms to determine if feeding by Wheat bug had occurred. No known molecular tests for assessing grain affected by Wheat bug were available at the time of document preparation.

Grain affected by Wheat bug can be assessed by measuring proteinase activity. Wheat bug proteinase activity can be detected by the incubated SDS-sedimentation test and the disappearance of HMV gluterin subunits from electrophoretograms (Every *et al*. 1990).

Detection and delimiting surveys are required to delimit the extent of the outbreak, ensuring areas free of the pest retain market access requirements and appropriate quarantine zones are established.

Initial surveillance priorities include the following:

- surveying all host growing properties in the pest quarantine area
- surveying all properties identified in trace forward or traceback analysis as being at risk
- surveying all host growing properties that are reliant on trade with interstate or international markets which may be sensitive to Wheat bug presence
- surveying commercial nurseries selling at risk host plants
- surveying other host growing properties and backyards.

3.5.2 Survey regions

Establish survey regions around the surveillance priorities identified above. These regions will be generated based on the zoning requirements (section 3.3), and prioritised based on their potential likelihood to currently have or receive an incursion of this pest. Surveillance activities within these regions will either: allow for the area to be declared pest free and maintain market access requirements; or establish the impact and spread of the incursion to allow for effective control and containment measures to be carried out.

Steps outlined below form a basis for a survey plan. Although categorised in stages, some stages may be undertaken concurrently based on available skill sets, resources and priorities.

Phase 1:

Identify properties that fall within the buffer zone around the infested premise.

Complete preliminary surveillance to determine ownership, property details, production dynamics and tracings information (this may be an ongoing action).

Phase 2:

Preliminary survey of host crops in properties in buffer zone establishing points of pest detection.

Phase 3:

Surveillance of an intensive nature, to support control and containment activities around points of pest detection.

Phase 4:

Surveillance of contact premises. A contact premise is a property containing susceptible host plants, which are known to have been in direct or indirect contact with an infested premises or infected plants. Contact premises may be determined through tracking movement of materials from the property that may provide a viable pathway for spread of the disease. Pathways to be considered are:

- Items of equipment and machinery which have been shared between properties including bins, containers, irrigation lines, vehicles and equipment;
- The producer and retailer of infected material if this is suspected to be the source of the outbreak;
- Labour and other personnel that have moved from infected, contact and suspect premises to unaffected properties (other growers, tradesmen, visitors, salesmen, crop scouts, harvesters and possibly beekeepers);
- Movement of plant material and soil from controlled and restricted areas; and
- Storm and rain events and the direction of prevailing winds that result in air-born dispersal of the pathogen during these weather events.

Phase 5:

Surveillance of nurseries, gardens and public land where plants known to be hosts of wheat bug are being grown.

Phase 6:

Agreed area freedom maintenance, post control and containment.

3.5.3 Post-eradication surveillance

The period of pest freedom sufficient to indicate that eradication of the pest has been achieved will be determined by a number of factors, including the life cycle duration of Wheat bug (in relation to temperature), cropping conditions, the previous level of infestation and the control measures applied. As a guide, the period of pest freedom required to confirm eradication should be no less than two generations of the pest.

- Establishment of sentinel plants at the site of infection (see Section 2.6.4).
- Maintain good sanitation and hygiene practices throughout the year.
- The monitoring traps or sentinel plants should remain in place and inspected on a fortnightly basis for a further 6 weeks and then on a monthly basis.
- Surveys comprising plant sampling for Wheat bug be undertaken for a minimum of 12 months after eradication has been achieved.

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4.1 Websites

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Crop Protection Compendium (2008) http://www.cabicompendium.org/cpc/home.asp CAB International. Wallingford, United Kingdom.

EPPO reporting service http://www.eppo.org/PUBLICATIONS/reporting/Rse-0602.pdf

www.nappfast.org

5 Appendices

Appendix 1. Standard diagnostic protocols

For a range of specifically designed procedures for the emergency response to a pest incursion refer to Plant Health Australia's PLANTPLAN.

Appendix 2. Experts, resources and facilities

The following table lists the experts who can be contacted for professional diagnostics and advisory services in the case of an incursion.

Expert	State	Details
Dr Mallik Malipatil	Vic	DPI Victoria PMB 15, Ferntree Gully DC Vic 3156 Ph: 03 9210 9222; Fax: 03 9800 3521
Dr Alan Eyles	New Zealand	30 Mahana Road Paraparaumu Beach 5032 New Zealand ph +64 4 298 2360 alan.pat@xtra.co.nz

The following table lists the facilities available for diagnostic services in Australia.

Facility	State	Details
DPI Victoria Knoxfield Centre	Vic	621 Burwood Highway Knoxfield VIC 3684 Ph: (03) 9210 9222; Fax: (03) 9800 3521
DPI Victoria Horsham Centre	Vic	Natimuk Rd Horsham VIC 3400 Ph: (03) 5362 2111; Fax: (03) 5362 2187
DPI New South Wales Elizabeth Macarthur Agricultural Institute	NSW	Woodbridge Road Menangle NSW 2568 PMB 8 Camden NSW 2570 Ph: (02) 4640 6327; Fax: (02) 4640 6428
DPI New South Wales Tamworth Agricultural Institute	NSW	4 Marsden Park Road Calala NSW 2340 Ph: (02) 6763 1100; Fax: (02) 6763 1222
DPI New South Wales	NSW	PMB Wagga Wagga

Wagga Wagga Agricultural Institute		NSW 2650 Ph: (02) 6938 1999; Fax: (02) 6938 1809
SARDI Plant Research Centre - Waite Main Building, Waite Research Precinct	SA	Hartley Grove Urrbrae 5064 South Australia Ph: (08) 8303 9400; Fax: (08) 8303 9403
Grow Help Australia	QLD	Entomology Building 80 Meiers Road Indooroopilly QLD 4068 Ph: (07) 3896 9668; Fax: (07) 3896 9446
Department of Agriculture and Food, Western Australia (AGWEST) Plant Laboratories	WA	3 Baron-Hay Court South Perth WA 6151 Ph: (08) 9368 3721; Fax: (08) 9474 2658

Appendix 3. Communications strategy

A general Communications Strategy is provided in PLANTPLAN

Appendix 4. Market access impacts

Within the AQIS PHYTO database, no countries appear to have a specific statement for Wheat bug (November 2008). Should wheat bug be detected or become established in Australia, some countries may require specific declarations. Latest information can be found within PHYTO, using an Advanced search “Search all text” for *Nysius huttoni.*