INDUSTRY BIOSECURITY PLAN
FOR THE GRAINS INDUSTRY

Threat Specific Contingency Plan

Wheat stem maggots

Meromyza saltatrix and *M. americana*

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and Plant Health Australia

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Plant Health AUSTRALIA

GRDC Grains Research & Development Corporation

CRC PLANT biosecurity

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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 stem maggots (*Meromyza saltatrix* and *M. americana*). 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 (Plant Health Australia, 2008) and be endorsed by the National Management Group prior to implementation.

2 Pest information/status

2.1 Pest details

Scientific names	*Meromyza saltatrix, Chlorops hordei*	*Meromyza americana, M. falvipalpis*
Common names	Wheat stem maggot, barley stem maggot, wheat thigh chloropid fly	Wheat stem maggot, greater wheat stem maggot

2.1.1 General information

Taxonomic position – Phylum: Arthropoda; Class: Insecta; Order: Diptera; Family: Chloropidae; Subfamily: Chloropinae.

Meromyza saltatrix and *M. americana* are more commonly known as wheat stem maggots. The adult fly is 4-5 mm long, with clear wings. They have a mostly yellow body (forms can vary) with three dorsal black stripes, swollen hind femurs, the head protruding forward between the eyes, and the corner of the mouth forming a nearly right angle (see Figure 1; Knodel, 2008). Dead specimens lose the bright colouring and fade to yellow with red-brown eyes. See Nishijima (1960) for a thorough description of *M. saltatrix* eggs, larvae, pupae, and adults.

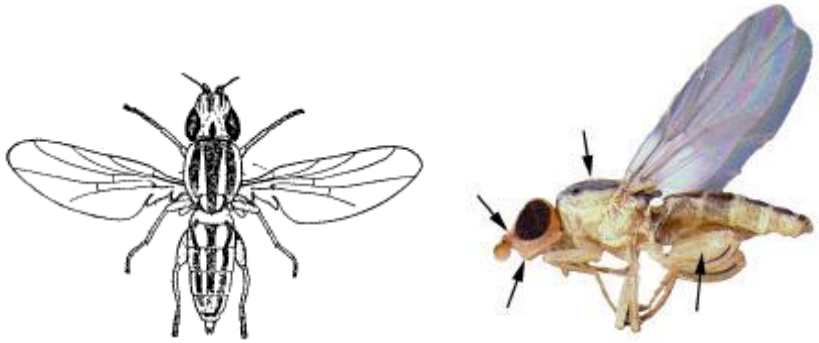

Figure 1. *Meromyza americana adult (Images courtesy of North Dakota State University)*

M. saltatrix is found in natural grasslands as well as cereal crops and pastures. The distribution of *M. saltatrix* is limited to Eurasia and the Pacific Northwest of America between 30° and 60° N latitude (Nishijima, 1960). *M. americana* is found in North America from Mexico to Canada.

Larvae of *Meromyza* enter the stem of wheat or other grass species and feed on the soft inner structures, usually in close proximity to the top node. The resulting damage leads to a weakening of the stem and the seed head dying. Dead seed heads lose their colour resulting in the characteristic white heads produced following stem-boring insect attack.

The paucity of current information on wheat stem maggots indicates that in most countries, it is not considered a major pest. Damage is usually limited, with only 1-5% of plants within a crop affected. Damage can be higher in spring sown wheat during favourable climatic conditions. Control of this fly is mainly through the use of cultural practices, such as delayed planting of crops and rotation with non-susceptible species. The dispersal of this pest primarily occurs through transport of plant materials, such as leaves and stems.

2.1.2 Life cycle

Meromyza commonly completes two generations per year. Overwintering of wheat stem maggots occurs during the larval stage of the life cycle, where the insect resides inside the lower parts of grass stem. Larvae pupate in spring and adults typically emerge in late spring (May/June in China). Females lay up to 60 eggs on the leaves and stems of wheat and other hosts over a 2-3 week period.

Eggs hatch within 3-5 days of laying and the resulting larvae (maggots) enter the stem of the wheat or grass plant and burrow into the tender tissues inside. Larvae are 6-7 mm in length and pale-green or cream coloured and this stage lasts for approximately 20 days. These larvae consume the inside of the stem, killing the upper part of the stem and the head, resulting in “white head” or “silver head” typical of stem-boring insects. The larva pupates within a cigar-shaped, pale green puparium contained within the stem.

Adults emerging mid-summer typically lay eggs on wild grasses or volunteer grain. The resulting larvae overwinter in the stems of these plants and re-emerge in the following spring.

2.2 Affected hosts

2.2.1 Host range

Meromyza spp. preferentially attack wheat plants (*Triticum* spp.), but will also attack barley *(Hordeum vulgare*), rye (*Secale cereale*), oats (*Avena sativa*), bluegrass (*Poa* spp.), millet (*Pennisetum glucum*, *Setaria italica*, *Panicum miliaceum* and *Eleusine coracana*), quackgrass (*Elytrigia repens*), wild barley (*Hordeum spontaneum*) and timothy (*Phleum pratense*). Red fescue (*Festuca rubra*) and smooth-stalked meadowgrass (*Poa pratensis*) also act as wild hosts for this pest. Other members of the Poaceae may also be hosts.

2.2.2 Geographic distribution

M. saltatrix is known to occur between 30° and 60°N latitude, but in most countries is found above 35-40°N. It is present in Russia, China, Mongolia, Siberia, Kazakhstan, throughout European countries, and the north-western regions of the USA (Nishijima, 1960). No infestations have been reported outside these areas. In the north-western region of the USA, it tends to occur only where average

rainfall is above 380mm (Rockwood *et al*, 1947). *M. americana* is found in North America from Mexico to Canada.

2.2.3 Symptoms

Wheat plants affected by *Meromyza* show stunting, distortion and decreased tillering. The most obvious symptom is the presence of the "white head" condition typically produced by stem-boring insects. In this condition the seed head dies and turns white while the lower stem regions and leaves remain green. Infested stems will pull out very easily, and contain a single maggot just above the last node. In most cases the infestation rates of autumn wheat will be less than 3% of the total crop (Rockwood *et al* 1947), and these are scattered randomly throughout the crop.

2.3 Entry, establishment and spread

When the Industry Biosecurity Plan for the Grains Industry was prepared in 2004, and more recently reviewed in 2009, Wheat stem maggot (*M. saltatrix*) was given an overall risk rating of medium on oats, triticale and wheat, and as a consequence, this contingency plan was commissioned. During preparation of this contingency plan, literature searches undertaken by the author have shown that this pest causes limited damage to autumn sown wheat, and only causes significant damage to spring sown wheat following unusually high rainfall in summer. As a consequence, the threat summary tables in the Industry Biosecurity Plan for the Grains Industry have been updated to show an overall risk rating of very low. In addition, the literature reviews of the author have identified that *M. americana* is also an identified risk to the Australian grains industry. Therefore, this pest has also been added to the threat summary tables using the ratings below.

2.3.1 Entry potential

Rating: Low

The most likely way of viable *Meromyza* entering Australia is as a larva or pupa in living plant tissue. Host plants of *Meromyza* are not allowed to enter Australia under current quarantine regulations. Adult flies could potentially hitchhike on people or freight. High altitude migration is known to occur in other members of the Chloropidae (Johnson *et al*, 1962), but is unlikely to be a pathway for *Meromyza* given its distribution being limited to the northern hemisphere.

2.3.2 Establishment potential

Rating: Medium-High

Wheat and barley are sown in most regions of Australia, providing many host plants for *Meromyza* establishment. *M. saltatrix* is limited to higher latitudes in the northern hemisphere, and therefore the establishment potential of this species is greatest in Tasmania and decreases as you move north across the mainland, and therefore the establishment potential is considered as medium. *M. americana* is likely to be more suited to conditions in mainland Australia and therefore has a high establishment potential.

2.3.3 Spread potential

Rating: High

Little information is available regarding the spread and dispersal abilities of *Meromyza* species. However, other members of the Chloropidae are known for high altitude migration (Johnson *et al*, 1962).

2.3.4 Economic impact

Rating: Low

In the Pacific Northwest (USA) *M. saltatrix* seems to be limited to localities that have an average annual rainfall of 380mm or more and does not significantly damage autumn sown wheat. More severe damage (10-75% of tillers affected) has been recorded from spring sown wheat, but only in years following unusually high rainfall in late summer (Rockwood *et al*, 1947). *M. americana* infestations rarely affect more than 5% of heads and usually less than 2% (McBride *et al*, 1996; Manitoba Agriculture). In California a reduction in the number of tillers causes the most damage, but significant damage does not occur and insecticide applications are not recommended (Strand *et al*, 1990). Heavy infestations of wheat stands may kill a significant portion of the tillers (Manitoba Agriculture). In South Dakota (USA) yield loss to *M. americana* was highest in spring wheat, followed in descending order by winter wheat, rye, and barley. No estimate of loss exceeded 9%, and most estimates in wheat and rye of between 1 and 3% (Kieckhefer & Morrill, 1970).

Meromyza does not infest seeds and should not impact export markets.

2.3.5 Environmental impact

Rating: Low

No adverse environmental impacts are expected with the establishment of *Meromyza*.

2.3.6 Overall risk

Rating: Very Low

2.4 Diagnostic information

2.4.1 Diagnostic protocol

Traditional taxonomic methods based on keys and descriptions are adequate for identification of *Meromyza* spp. adults (Nishijima, 1960). A key to the Australian Chloropinae is available (Spencer, 1986) and has been updated by Ismay (1996). Larvae will require rearing to adulthood for species determination. Distinguishing *M. saltatrix* from other species of the *Meromyza* genus requires dissection of the prostgonite of the male genetalia (see Figure 2).

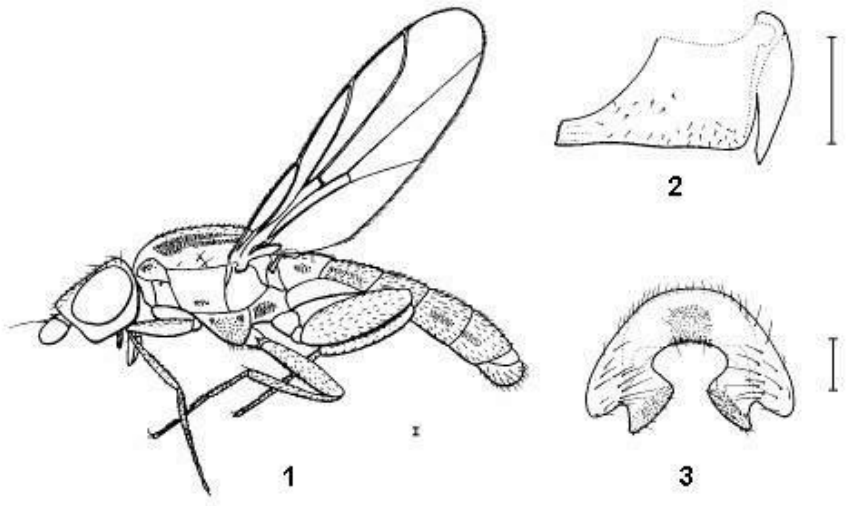

Figure 2. *Morphological detail of M. saltatrix showing (1) Habitus (2) postgonite of male genitalia, lateral view (3) epandrium of male genitalia, apical view. Image © John Ismay.*

2.5 Response 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 & McKirdy (2005)[1] in the Technical Guidelines for Development of Pest Specific Response Plans.

[1] Available on the Plant health Australia website (**www.planthealthaustralia.com.au/biosecurity**)

2.6 Delimiting survey and epidemiology study

Delimiting surveys should comprise local surveys around the area of initial detection concentrating on symptomatic areas. Delimiting surveys are useful to determine the extent of spread of the pest and provide information for review and further development of the Response Plan.

2.6.1 Sampling method

There are no specific scouting techniques or thresholds that have been developed for monitoring wheat stem maggot. *Meromyza* infestations can be detected by walking through crops looking for characteristic “white heads”. Samples of affected stems can then be removed and dissected to retrieve larvae and pupae, from which adults can be reared for identification. Adults may have already emerged by the time white heads are detected. As other stem boring insects cause similar symptoms, retrieval of larvae or pupae and confirmation of their identity by rearing adults for identification is essential to ensure correct diagnoses. Note that symptoms of root disease can be similar, but usually additional plant parts turn white.

Any personnel collecting insect or leaf samples for assessment should notify the diagnostic laboratory prior to submitting samples to ensure expertise is available to rear the larvae and undertake the diagnosis. General protocols for collecting and dispatching samples are available in Appendix 3 of PLANTPLAN (Plant Health Australia, 2008).

2.6.1.1 NUMBER OF SPECIMENS TO BE COLLECTED

Collect as many larvae or maggots as possible if numbers are low. The larvae must be reared to adults for identification and there is likely to be some mortality in transport or during the rearing process. If prevalent, 30-50 larvae should be collected.

2.6.1.2 PREFERRED STAGE TO BE COLLECTED

Of the four life stages (egg, larva, pupa and adult) only adults are identifiable to species level using morphological features. Adults may be able to be collected using a sweep net or vacuum sampler. However, capturing adult flies may be difficult, in which case larvae and pupae need to be collected for rearing in the laboratory.

2.6.1.3 HOW TO COLLECT

Check stems showing characteristic symptoms by pulling the stem out of the sheath and checking for larvae or pupae to determine the proportion of symptomatic stems that have *Meromyza* present. Cut symptomatic plants below the location of larvae and place entire stems between sheets of newspaper and into a closable plastic bag for shipment to diagnostic centre. Ensure package is sealed to prevent emerging flies from escape and advise diagnostic centre that live, potentially exotic insects, have been dispatched.

To obtain adult flies, infested stems may be placed in a large jar for rearing in the laboratory. For rearing, try to maintain temperatures of 25-30°C and around 60% relative humidity. Ensure adult flies cannot escape from the jar. Adults can then be killed by freezing and shipped to a diagnostic centre.

2.6.1.4 HOW TO COLLECT PLANT SAMPLES IF REQUIRED

As above.

2.6.1.5 HOW TO PRESERVE PLANT SAMPLES

Leaves and stems with larvae can be stored between sheets of dry newspaper.

2.6.1.6 HOW TO PRESERVE FLIES

Adults and larvae can be placed in 70% ethanol and stored indefinitely, although their colour fades gradually with time. Adults can also be pinned or put on points and deposited with the appropriate entomological museum. Specimens required for molecular diagnostic work should be killed and preserved in absolute ethanol or frozen (-80°C).

2.6.1.7 HOW TO TRANSPORT FLIES

Flies can be transported in vials of ethanol that are sealed to avoid leakage and packed with cushioning material in a strong box.

2.6.1.8 HOW TO TRANSPORT PLANT SAMPLES

Leaves and stems with suspect pupae or larvae should be mailed as a flat package between sheets of dry newspaper in a sealed container to prevent escape of emerging adults.

2.6.2 Epidemiological study

The degree of spread would be dependent on the life cycle of the pest and the availability of host plants, particularly during summer and autumn. Annual population densities of *M. saltatrix* in China is correlated with the amount of rainfall and average temperatures (Yang, 1983) which is likely related to the number of volunteer crop and wild hosts available. In outbreaks observed or reported in the north west of the United States rainfall had been heavy in the preceding August or September (late summer; Rockwood *et al*, 1947).

2.6.3 Models of spread potential

None known. A related fly, the eye gnat, *Hippelates pusio* (Diptera: Chloropidae), has been shown to be able to disperse over 1 km, but averaged 266 m (Williams & Kuitert, 1974).

2.6.4 Pest Free Area guidelines

The establishment and maintenance of Pest Free Areas (PFAs) can be a resource-intensive process. Prior to development of a PFA due consideration should be given to alternative methods (e.g. treatments, enclosed quarantine) that achieve an equivalent biosecurity outcome to a PFA. A benefit-cost analysis is useful for this purpose.

Where an evaluation justifies the establishment and maintenance of a PFA, the requirements of ISPM No. 4 (IPPC 1995) should be met. This standard describes the requirements for the establishment

and use of PFAs 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).

Points to consider in developing PFA guidelines for *Meromyza*:

- Statistical field survey for symptoms on host plants
- Design of a statistical delimiting survey for the presence or absence of *Meromyza* adults, larvae or pupae
- Plant or soil sampling using appropriate diagnostic tests
- Survey around irrigation systems, waterways, refuge habitats, etc

2.7 Availability of control methods

The main methods for the control of *Meromyza* are cultural practices that limit infestation of the following season's crop by breaking the lifecycle over summer (see Cultural Control 2.7.4). Parasitoids that attack *Meromyza* are known in North America, but their impact on *Meromyza* populations is not well understood. Chemical control is not considered to be an effective option.

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
- After surveys are completed, destruction of the infested crop is an effective control
- On-going surveillance of infested paddocks to ensure *Meromyza* is eradicated

2.7.2 Control if small areas are affected

If small areas are affected and eradication is deemed feasible infested crops should be removed and destroyed. Prior to destruction the infested plants should be dissected to ensure adult flies have not already emerged. If adults have already emerged susceptible hosts should be removed within the vicinity. There is no information on dispersal or spread of *Meromyza* so it is not possible to say over what area this would need to occur, but a minimum of 500 m from the site of infestation is suggested.

2.7.3 Control if large areas are affected

If large areas are affected growers should follow the cultural practices below to minimise damage. Most growers should already be following these practices for other pests and diseases already present in Australia.

2.7.4 Cultural control

Practice good crop hygiene, this includes the destruction of crop residues (stems and stubbles). Remove volunteer crop plants and/or alternative hosts and delay planting. This reduces carryover of *Meromyza* from one growing season to the next, and will help limit the most damaging attacks on young crops early in the growing season. Crop rotation with non-susceptible species, such as corn, sunflowers, flax, soybeans, safflower or legumes can reduce the numbers of wheat stem maggot.

2.7.5 Host plant resistance

Currently there are no commercial lines of wheat known to be resistant to this pest, but previous breeding programs have shown limited success in generating resistance (Cheo *et al,* 1976). Some early work in the United States observed that early maturing varieties were least infested (Forbes, 1884; Webster, 1903; Allen & Painter, 1937), but there is a conflicting report that suggests that late maturing varieties tend to sustain less damage from *Meromyza* (McBride *et al*, 1996). Resistance of spring wheats to *M. americana* was tested in the United States, but there was no significant difference in the number of infested tillers per plant or in the number of infested heads per plant between *Triticum aestivum* and *Triticum durum* (Branson, 1971).

2.7.6 Chemical control

Chemical treatment is not recommended in California (Strand, 1990) and treatments considered to be effective are not available (McBride *et al*, 1996). Systemic insecticides may be effective against *Meromyza*. The insecticides parathion and dichlorvos are reported to have provided good control of *M. saltatrix* in China (Lei *et al,* 1981).

2.7.7 Mechanical control

Destruction of plant hosts and deep ploughing of crop residues and volunteers may assist with control by breaking the life-cycle and reducing carryover to the following season.

2.7.8 Biological control

Several parasites attack the wheat stem maggot but do not provide reliable annual control (McBride *et al*, 1996). In the United States, parasitoids such as *Bracon meromyzae* and *Coelinidea meromyzae* attack wheat stem maggots, but they are not considered to be important in maintaining pest populations at low densities. There is a fungus known to attack adult *Meromyza*, but is ability to control natural populations is unknown. The principal factors influencing the abundance of *Meromyza* are climatic (Rockwood *et al*, 1947).

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 PFA) or a measure to eliminate an established pest (establish a PFA). 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, infested 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
- Infested crops should be ploughed in
- Insecticides are unlikely to be effective
- Farm machinery used in destruction processes need to be thoroughly washed, preferably using a detergent or farm degreaser

3.1.2 Decontamination protocols

Machinery, equipment and vehicles in contact with infested plant material or soil or present within the Quarantine Area should be washed (or alternatively steam cleaned) to remove soil and plant material using high pressure water or scrubbing with products such as a farm degreaser or a 1% bleach (available chlorine) solution in a designated wash down area. 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 Appendix 18 of Plant Health Australia (2008))
- Disposable overalls and rubber boots should be worn when handling infested soil or plant material in the field. Boots, clothes and shoes in contact with infested soil or plant material

should be disinfested at the site or double-bagged to remove for cleaning. Non-disposable clothing should be washed in hot water at 60°C or higher (Sallam & Allsopp, 2002).

- Skin and hair in contact with infested plant material or soil should be washed

3.1.3 Priorities

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

3.1.4 Plants, by-products and waste processing

- Infested plant material should be destroyed by (enclosed) high temperature incineration, autoclaving or deep burial

3.1.5 Disposal issues

- Particular care must be taken to minimize the transfer of infested plant material from the area as larvae or pupae may be present.

3.2 Quarantine and movement controls

3.2.1 Quarantine priorities

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

3.2.2 Movement control for people, plant material and machinery

Movement controls need to be put in place to minimise the potential for translocation of the pest as a contaminant of plant material, soil or other articles.

Movement of people, vehicle and machinery, from and to affected farms, must be controlled to ensure that infested plant debris is not moved off-farm on clothing, footwear, vehicles or machinery. The following measures can be used to effect controls on movement:

- Signage to indicate quarantine area and/or restricted movement in these zones
- Fenced, barricaded or locked entry to quarantine areas
- Movement of equipment, machinery, plant material or soil by permit only

- Clothing and footwear worn at the infested site should either be double-bagged prior to removal for decontamination or should not leave the farm until thoroughly disinfested, washed and cleaned
- Hay, stubble or crop residue must not be removed from 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 a hard surface, preferably a designated wash-down area, to avoid mud being re-collected from the affected site onto the machine
    - Whilst the adults may not be seen, adults, larvae and pupae may still be present on vehicles and machinery used on the site. All machinery and equipment should be thoroughly cleaned down

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 infested property to other infested properties.

3.3.1 Destruction Zone

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.

The entire crop or pasture should be destroyed after the level of infestation has been established. The delimiting survey will determine whether or not neighbouring host crops are infested and need to be destroyed. The Destruction Zone may be defined as contiguous areas associated with the same management practices as the infested area (i.e. the entire trial, paddock or farm if spread could have occurred prior to the infestation being identified). It is important to remember that some non-crop grasses can also serve as hosts.

Particular care needs to be taken to ensure that plant material is not moved into surrounding areas, as eggs and larvae can be present without obvious symptoms.

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 or properties. These restraints may include restrictions or movement control for removal of plants, people, soil or contaminated equipment from an infested 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 infested premises and suspected infested 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 infested premises and all suspected infested 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

Decontamination 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 infested 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 detergent, a farm degreaser or a 1% bleach (available chlorine) solution in a designated wash down area as described in 3.1.2
- Infested plant material should be disposed of by autoclaving, high temperature incineration or deep burial
- At a minimum, crops should be ploughed in, raked and burned. Herbicides may not be an effective decontamination procedure depending on the growth stage of *Meromyza.* However, they may be of use to eliminate alternative host plants and volunteer wheat

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

- In small areas such as a nursery or greenhouse, infested plant material should be disposed of by autoclaving, high temperature incineration or deep burial.
- In larger areas where the above is not feasible, crops should be ploughed in, raked and burned.

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.

Initial surveillance priorities include the following:

- Surveying all host growing properties in the pest quarantine area
- Surveying all properties identified in trace forward or trace back 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 *Meromyza* spp. 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 (see 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 in Table 1 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.

Table 1. *Phases to be covered in a survey plan*

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 infested plants. Contact premises may be determined through tracking movement of materials from the property that may provide a viable pathway for spread of the pest. Pathways to be considered are: ○ Storm and rain events and the direction of prevailing winds that result in air-born dispersal of the insect during these weather events ○ Movement of plant material and soil from controlled and restricted areas ○ Items of equipment and machinery which have been shared between properties including bins, containers, irrigation lines, vehicles and equipment ○ The producer and retailer of infested material if this is suspected to be the source of the outbreak ○ Labour and other personnel that have moved from infested, contact and suspect premises to unaffected properties (other growers, tradesmen, visitors, salesmen, crop scouts, harvesters and possibly beekeepers)
Phase 5	• Surveillance of nurseries, gardens and public land where plants known to be hosts of *Meromyza* 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 the wheat stem maggot (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 infestation
- Maintain good sanitation and hygiene practices throughout the year preventing volunteer wheat or other host plants from growing in the area.
- The monitoring traps or sentinel plants should remain in place and be inspected regularly. The frequency of the inspections will depend on the time of the year.
- Surveys comprising plant sampling for *Meromyza* spp to be undertaken for a minimum of 2 years after eradication has been achieved.

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4.1 Websites

CAB compendium (**www.cabicompendium.org/cpc/home.asp**)

High Plains Integrated Pest Management – *M. saltatrix*
(**highplainsipm.org/HpIPMSearch/Docs/wheatstemmaggot-smallgrains.htm**)

Manitoba Agriculture – Wheat Stem Maggot.
(**http://www.gov.mb.ca/agriculture/crops/insects/fad19s00.html**)

NDSU College of Agriculture – wheat stem insect pests and management practices
(**www.ag.ndsu.edu/pubs/plantsci/smgrains/e680w.htm**)

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 (**www.planthealthaustralia.com.au/plantplan**).

Appendix 2. Experts, resources and facilities

The following tables provide lists of experts (Table 2) and diagnostic facilities (Table 3) for use in professional diagnosis and advisory services in the case of an incursion.

Table 2. *Experts who can be contacted for professional diagnostic and advisory services*

Expert	State	Details
Dr. Mallik Malipatil	Vic	DPI Victoria Knoxfield Centre 621 Burwood Highway Knoxfield VIC 3684 Ph: (03) 9210 9224 Fax: (03) 9800 3521
Dr. John W Ismay	U.K.	Oxford University Museum of Natural History Parks Road Oxford, OX1 3PW United Kingdom Ph: +44 1865 272 950 Fax: +44 1865 272 970
Dr. David McAlpine	NSW	Entomology Section Australian Museum 6 College Street Sydney NSW 2010 Ph: (02) 9320 6344 Fax: (02) 9361 5479

Table 3. *Diagnostic service facilities 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

Facility	State	Details
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, Wagga Wagga Agricultural Institute	NSW	PMB Wagga Wagga NSW 2650 Ph: (02) 6938 1999; Fax: (02) 6938 1809
SARDI Plant Research Centre - Waite Main Building, Waite Research Precinct	SA	Hartley Grove Urrbrae SA 5064 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 Appendix 6 of PLANTPLAN (Plant Health Australia, 2008).

Appendix 4. Market access impacts

Within the AQIS PHYTO database, no countries appear to have a specific statement regarding area freedom from *M. saltatrix* or *M. americana* (June 2009). Should *M. saltatrix* or *M. americana* be detected or become established in Australia, some countries may require specific declaration. Latest information can be found within PHYTO, using an Advanced search “Search all text” for *Meromyza saltatrix* or *Meromyza americana.*