Screw-worm fly

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Text under development

In this manual, text placed in square brackets [xxx] indicates that that aspect of the manual remains contentious or is under development; such text is not part of the official manual. The issues will be further worked on by experts and relevant text included at a future date.

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DISEASE WATCH HOTLINE: 1800 675 888

The Disease Watch Hotline is a toll-free telephone number that connects callers to the relevant State or Territory officer to report concerns about any potential emergency disease situation. Anyone suspecting an emergency disease outbreak should use this number to get immediate advice and assistance.

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Edition 2
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Edition 3
Version 3.0, 2007 (major update and inclusion of new cost-sharing arrangements)

Edition 5
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Photo credit: AHA (2017). Old World Screw-Worm Fly: A Diagnostic Manual, Third Edition. Animal Health Australia, Canberra

1 Introduction

1.1 This manual

1.1.1 Purpose

This response strategy outlines the nationally agreed approach for the response to an incident – or suspected incident – of screw-worm fly (SWF) in Australia. It has been developed to guide decision making and so support the implementation of an efficient, effective and coherent response.

1.1.2 Scope

In this response strategy, SWF encompasses both Old World SWF (*Chrysomya bezziana*) and New World SWF (*Cochliomyia hominivorax*).

This response strategy provides information about:

- the disease (Section 2)
- the implications for Australia, including potential pathways of introduction, social and economic effects, and the critical factors for a response to the disease (Section 3)
- the agreed policy and guidelines for agencies and organisations involved in a response to an outbreak (Section 4)
- declared areas and premises (Section 5)
- quarantine and movement controls (Section 6)
- surveillance and establishing proof of freedom (Section 7).

The key features of SWF are described in the **Screw-worm fly Fact Sheet** (under development).

1.1.3 Development

The strategies in this document for the diagnosis and management of an outbreak of SWF are based on risk assessment. They are informed by the recommendations in the World Organisation for Animal Health (OIE) *Terrestrial Animal Health Code* (Chapter 8.12) and the OIE *Manual of diagnostic tests and vaccines for terrestrial animals* (Chapter 3.1.13). The strategies and policy guidelines are for emergency situations and are not applicable to policies for imported animals or animal products.

This manual has been produced in accordance with the procedures described in the AUSVETPLAN ***Overview***, and in consultation with Australian national, state and territory governments; the relevant livestock industries; nongovernment agencies; and public health authorities, where relevant.

In this manual, text placed in square brackets [xxx] indicates that that aspect of the manual remains contentious or is under development; such text is not part of the official manual. The issues will be worked on by experts and relevant text included at a future date.

1.2 Other documentation

This response strategy should be read and implemented in conjunction with:

- other AUSVETPLAN documents, including the operational, enterprise and management manuals; and any relevant guidance and resource documents. The complete series of manuals is available on the Animal Health Australia website[1]
- relevant nationally agreed standard operating procedures (NASOPs).[2] These procedures complement AUSVETPLAN and describe in detail specific actions undertaken during a response to an incident. NASOPs have been developed for use by jurisdictions during responses to emergency animal disease (EAD) incidents and emergencies
- relevant jurisdictional or industry policies, response plans, standard operating procedures and work instructions
- relevant Commonwealth and jurisdictional legislation, and legal agreements (such as the Emergency Animal Disease Response Agreement – EADRA[3]), where applicable.

1.3 Training resources

EAD preparedness and response arrangements in Australia

The EAD Foundation online course[4] provides livestock producers, veterinarians, veterinary students, government personnel and emergency workers with foundation knowledge for further training in EAD preparedness and response in Australia.

1 www.animalhealthaustralia.com.au/our-publications/ausvetplan-manuals-and-documents

2 www.animalhealthaustralia.com.au/what-we-do/emergency-animal-disease/nationally-agreed-standard-operating-procedures

3 https://animalhealthaustralia.com.au/what-we-do/emergency-animal-disease/ead-response-agreement

4 www.animalhealthaustralia.com.au/emergency-animal-disease-training-program

2 Nature of the disease

The larval stages (maggots) of the screw-worm fly (SWF) feed on the living tissues of warm-blooded animals, including humans. Infestation of, and damage to, animal tissues by SWF larvae (myiasis) causes serious livestock production losses and public health issues in countries where the flies occur.

World Organisation for Animal Health listing

SWF is a World Organisation for Animal Health (OIE)–listed disease.[5]

2.1 Aetiology

SWF myiasis is caused by the larvae of two species of flies from the family Calliphoridae (calliphorid flies): *Chrysomya bezziana* (Old World SWF) and *Cochliomyia hominivorax* (New World SWF). The adult fly of both species is typical of calliphorid blowflies in shape and basic colour, having a metallic blue/green/black body with a yellowish-orange face.

Several studies, using different analytical techniques, have attempted to identify differences between Old World SWF strains sourced from various locations throughout the fly's range (Hall et al 2001, Mahon 2002a, Wardhana et al 2012). Although different lineages (and sublineages) may exist, their potential significance for SWF control is not clear (see also Section 2.9).

2.2 Susceptible species

All warm-blooded animals are susceptible to SWF myiasis. The greatest economic losses are experienced in cattle, sheep and goats.

Australian native fauna have been shown to be susceptible. Old World SWF has been found in a red kangaroo and agile wallabies (held in a zoo in Malaysia), and in a wallaby and a tree kangaroo in Papua New Guinea (Spradbery & Vanniasingham 1980, Spradbery 2001).

2.2.1 Zoonotic potential

Humans, particularly the young, elderly and infirm, are potential hosts for SWF.

5 OIE-listed diseases are diseases with the potential for international spread, significant mortality or morbidity within the susceptible species, and/or zoonotic spread to humans. OIE member countries that have been free from a notifiable disease are obliged to notify the OIE within 24 hours of confirming the presence of the disease.

2.3 World distribution

For the latest information on the distribution of New World and Old World SWF, refer to The World Animal Health Information System.[6]

2.3.1 Distribution outside Australia

Old World SWF occurs throughout much of Africa, the Middle East, the Indian subcontinent and Southeast Asia (including Indonesia, Timor-Leste, the Philippines and Papua New Guinea).

New World SWF is endemic in parts of Central and South America as far south as Argentina. New World SWF has been eradicated from the United States (most recently in 2016), Mexico and several Central American countries.

The two species have similar biological and climatic requirements. Although they normally exist in different geographical regions of the world (see Figure 2.1), there is no reason why their respective geographical ranges could not increase and/or overlap, especially from the movement of SWF-infested animals or humans. Warming global temperatures may result in an extension of the geographic distribution of both species.

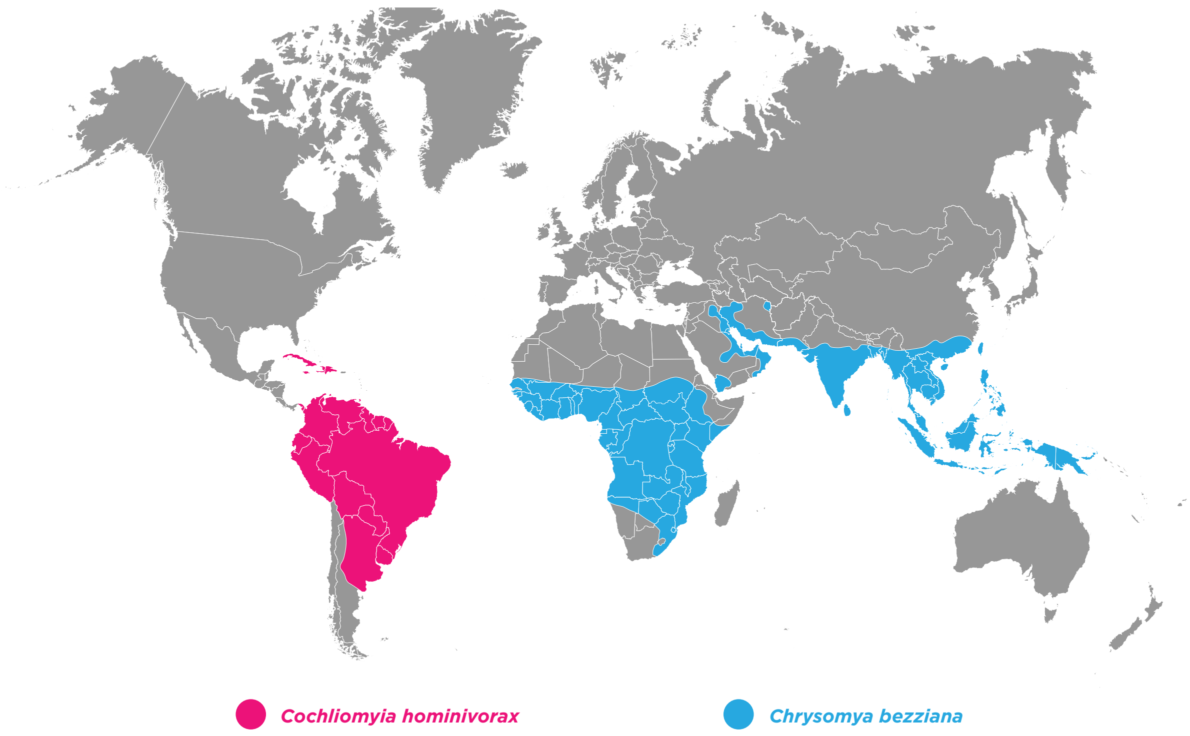

Figure 2.1 Distribution of New World and Old World screw-worm fly

Source: AHA (2017)

6 www.oie.int/animal-health-in-the-world/the-world-animal-health-information-system/the-oie-data-system

2.3.2 Occurrence in Australia

Although there have been three reported detections of SWF in Australia (one associated with an empty livestock vessel and two associated with people – see below), SWF has never become established.

In 1988, several adult Old World SWF were trapped in an empty livestock vessel in Darwin harbour. The vessel had just returned from delivering cattle to Brunei (Rajapaksa & Spradbery 1989). This incident led to intensive monitoring of livestock ships; however, no on-board SWF activity was detected (Thompson 1992). Livestock transport ships entering Australian waters are required to activate insectocutor traps.

In 1992, New World SWF larvae were identified in a lesion on the back of the head of a person who had just returned to Australia from a visit to Brazil and Argentina (Searson et al 1992). In 2012, New world SWF larvae were identified in a lesion behind the ear of a person returning from the Amazon in northeastern Peru (Lau et al 2015). Larvae were removed before they had a chance to pupate.

Other *Chrysomya* species are present in parts of Australia.

2.4 Epidemiology

2.4.1 Incubation period

Not relevant.

2.4.2 Persistence of agent and modes of transmission

General properties

SWF is highly susceptible to a broad range of insecticidal chemicals (see Appendix 1). For practical reasons, most insecticides used against SWF target the larval stages. Some insecticides, however, do have a significant repellent effect against adult SWF.

The temperature tolerance and environmental preferences of SWF are outlined in the discussion of their lifecycle (below) and in Section 2.4.3.

Because larvae of SWF are obligate parasites of living animals, there is little risk of viable larvae being transported in or on animal products or byproducts. However, viable larvae may be present in the carcases of recently killed animals (especially if chilled soon after death).

Soil or manure from stockyards or paddocks housing infested animals, or washings from livestock transport equipment may contain viable SWF pupae.

Lifecycle

The lifecycle of Old World SWF is illustrated in Figure 2.2; the lifecycle of New World SWF is similar. Under ideal conditions, the lifecycle of SWF can be completed in 20 days.

The eggs are laid on the edges of wounds or in body orifices of live animals in masses of up to 250 for Old World SWF and up to 400 for New World SWF. The egg mass is characteristically white and compact compared with those of secondary *Chrysomya* species (ie flies that strike existing lesions, which lay yellowish eggs in loose masses that can be readily brushed off the host's body). Under experimental conditions, SWF eggs hatch in approximately 10 hours at 37 °C, 20 hours at 27 °C and 50 hours at 20 °C. Egg masses on host cattle have been observed to hatch 12–20 hours after being laid (AHA 2002).

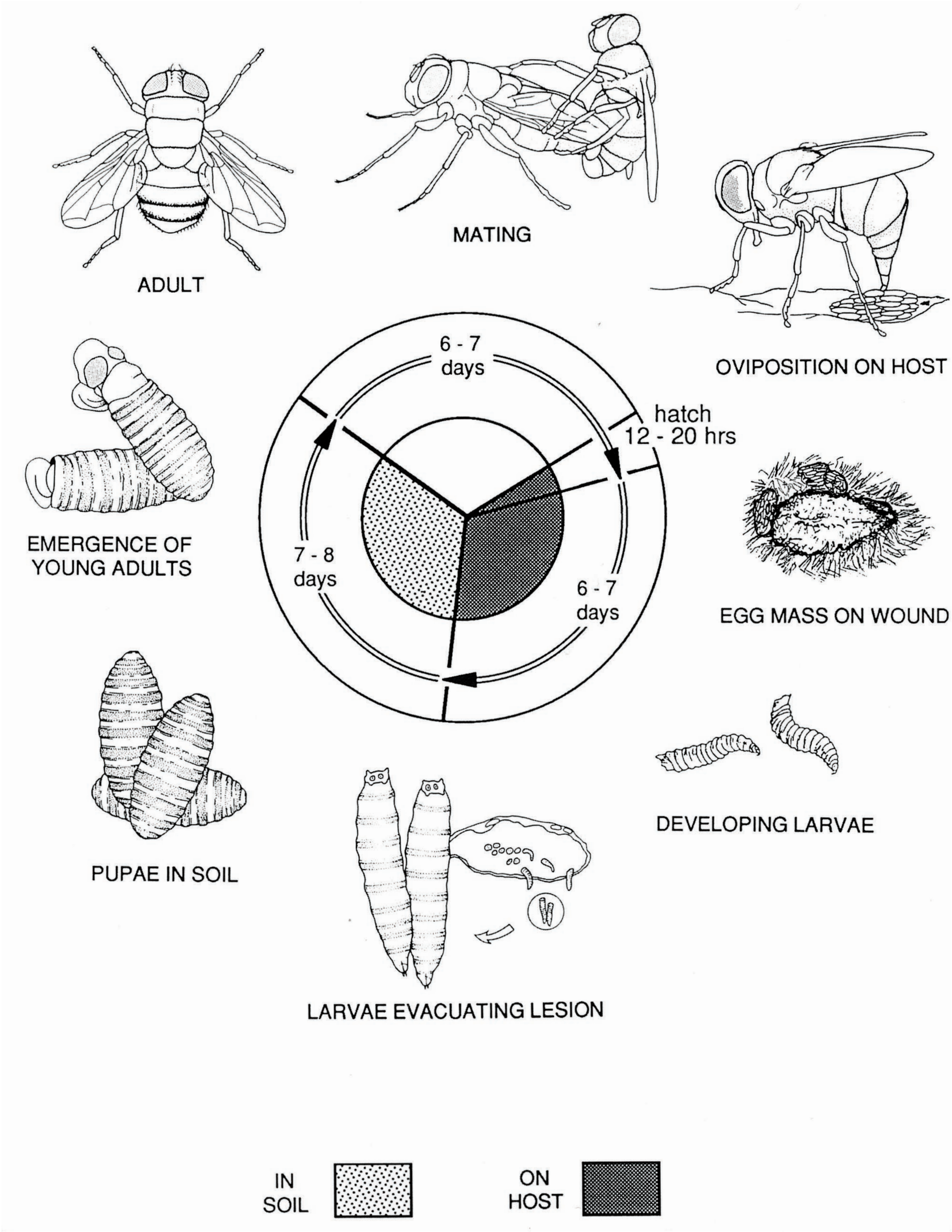

Figure 2.2 Life cycle of ***Chrysomya bezziana***

Source: AHA (2017)

Larvae emerge and immediately begin to feed on the wound fluids and underlying tissues. Larval development occurs over 5–8 days, and most larvae have evacuated the wound after 7 days of feeding. Larval evacuation occurs mainly during darkness, peaking between midnight and dawn. After larvae vacate the wound and fall to the ground, they burrow 2–3 cm into the soil and pupate within 24 hours.

Adult emergence from pupae occurs after 7 days at 28 °C but may be considerably delayed if the weather is cool. Most flies emerge just before dawn; there is little or no emergence during daylight hours when sunlight and diurnal predators could affect fly survival. The sex ratio of emerging adults is 1:1.

During the first few days of adult life, females become sexually mature and receptive to mating. Females normally mate only once, but a male can inseminate several females during its lifetime. SWF can lay several egg masses during a lifetime, although it is rare to find females in the field laying more than two masses. Observations carried out on the hot coastal plain around Port Moresby in Papua New Guinea, together with laboratory experiments, have shown that females lay their eggs mainly in the late afternoon until dusk. In this way, most egg masses are not exposed to lethal amounts of solar radiation (Spradbery 1979).

The average lifespan of Old World SWF adults is 15 days, but some flies have survived 40 days in the laboratory at 28 °C.

2.4.3 Factors influencing transmission

Key factors influencing the transmission of SWF include the environment, dispersal of the flies, and the availability and husbandry of suitable hosts.

Adult SWF occur in relatively low numbers in the wild, and natural population densities are not thought to exceed 200 flies per square kilometre. Adults prefer well-wooded riverine areas and moist, well-shaded areas. They are unlikely to survive in completely open country, particularly if subjected to intense heat and low humidity. However, they will survive in hot and dry conditions if some vegetation is available as shade and as a carbohydrate source.

The optimal temperature range for the fly is 20–30 °C. Average daily temperature and rainfall influence Old World SWF abundance: increased abundance is associated with warmer and wetter conditions in Malaysia and Hong Kong (Mahon et al 2004, McNae & Lewis 2004).

Cold has a very adverse effect. Flies will not move at temperatures below 10 °C, and they are very sluggish and probably will not mate in the range 10–16 °C. All stages of the fly's lifecycle are susceptible to freezing, so overwintering in frost areas does not occur.

SWF does not actively migrate, but female flies may disperse widely in search of wounded animals. Median dispersal distances during female egg-laying behaviour are dependent on wound availability and environmental factors. Median dispersal distances have been reported as 10.8 km for Old World SWF and 0.17–10 km for New World SWF (Mayer & Atzeni 1993, Spradbery et al 1995). However, there are also reports that Old World SWF may disperse over distances of more than 100 km, and New World SWF up to 290 km (Hightower et al 1965).

The expected rates of spread of SWF outbreaks have been estimated at 10–25 km per week (under favourable conditions) and 2–10 km per week (under less favourable conditions) (DPIE 1990).

Rapid, long-distance spread of SWF could also result from transport of infested animals or contaminated soil and waste material.

2.5 Diagnostic criteria

2.5.1 Clinical signs

Animals

SWF is an obligate wound parasite, requiring soft tissue of live warm-blooded animals for larval development. Clinical signs are frequently related to the site and severity of infestation. Thus, a severe infestation will cause systemic disease in its own right, irrespective of the site, whereas a light infestation may go unnoticed, unless it results in functional disturbance (eg infestation of a limb).

SWF infestations are usually associated with traumatic injury, erosive or ulcerative lesions of the skin, or haemorrhage. Infestation also commonly follows parturition; the navel region of the newborn, and the vulval or perineal region of the dam, particularly when traumatised, are principal sites of infestation. Husbandry procedures such as dehorning, castration, branding, tail docking and ear tagging can lead to SWF infestation. (If SWF were to occur in sheep-producing areas of Australia, mulesing and tail-docking wounds would be susceptible to infestation.) Traumatic injuries due to barbed wire, horns or other penetrating objects are also commonly infested. Skin punctures caused by vaccination or ticks, and the lesions associated with buffalo fly infestations are known to be attractive to SWF. Wounds that are at least 3 days old are reportedly more attractive to SWF (Mahon et al 2004).

In sheep, SWF has the ability to strike the medial canthus of the eye and the perineal region of ewes without obvious trauma or haemorrhage. Foot abscess is another source for myiasis in sheep.

In dogs, weeping skin sores, fight wounds, anal gland abscesses, pododermatitis, eye and ear discharges, and lip fold eczema have been identified as sites for myiasis, and should be closely examined for larvae (McNae & Lewis 2004).

The entry site for SWF myiasis may be small and unobtrusive. Signs of infestation include the presence of a ragged, foul-smelling lesion containing larval SWF, constant licking of the lesion by the animal, and initial hypersensitivity followed by apparent decreased sensitivity of the lesion. Affected animals may show restlessness, fever, lethargy, loss of appetite, debilitation, decreased growth rate, anaemia and hypoproteinaemia. Expansion of lesions into body cavities is common, and peritonitis following navel infestation, sinusitis following dehorning and pleuritis following thoracic infestation all occur. Infestations of the muscles can result in restricted movement. Eggs are frequently seen around the edges of wounds that have been 'struck'.

Under extensive grazing conditions, such as occur in Australia, the first indication of SWF strike in livestock might be an apparent increase in mortality among neonatal calves or lambs, or debility and occasional losses throughout the herd or flock.

Humans

In endemic areas, humans, particularly the young, elderly and infirm, are potential hosts. Myiasis often occurs in the neck or scalp but may occur in other parts of the body (Lau et al 2015). Serious complications, including death, have resulted from infestations of the nose, eyes, ears and mouth. Any weeping sores in people recently returned from regions where SWF is endemic should be closely examined for larvae.

2.5.2 Pathology

After hatching, SWF larvae feed on fresh tissues and associated fluids of live animal wounds.

Photo credit: Skye Fruean, Department of Agriculture, Water and the Environment

Early-stage SWF lesions consist of disrupted epidermis, and aggregations of larvae visible in small cavities containing watery fluid. Within 24 hours, the cavities enlarge, extending into the subcutaneous tissue and muscle. The exudate becomes bloodstained as a result of the progressive liquefactive necrosis of the tissues. Large, cavernous lesions can develop that contain necrotic, fibrinopurulent or liquefied tissue and blood, and emit a characteristic pungent odour.

After 6–7 days in uncomplicated cases, mature larvae leave the wounds, and healing occurs via formation of granulation tissue. However, large infestations can lead to massive soft tissue destruction, wound expansion, necrosis, debility and death.

Images of the pathology caused by SWF are provided in AHA (2017).

2.5.3 Differential diagnosis

SWF should always be included as a differential diagnosis whenever flystrike occurs in cattle and whenever there are deep flystrike lesions in any other animal or in humans (it is possible that the index case may be detected in a companion animal or a human patient).

SWF myiasis is often complicated by secondary blowfly strike. The secondary larvae are normally seen near the surface of the lesions, are hairy (in the case of the common secondary strikers *Chrysomya rufifacies* and *C. varipes*) and are not deeply embedded, unlike SWF larvae.

2.5.4 Laboratory tests

Laboratory identification of both species of SWF has traditionally relied on morphological examination of adult flies, eggs, pupae or larvae. Details on the morphological diagnosis of Old World SWF are available in AHA (2017).

Molecular tests are now available for diagnosis of Old World SWF, using either individual flies or parts of flies (CSIRO Entomology & Biosecurity Australia 2004), and for bulk screening of the contents of adult fly traps (Jarrett et al 2010, Morgan & Urech 2014).

Samples required

Adult flies, eggs and egg masses, larvae and pupae may all be used for diagnosis of SWF. Intact adult flies or third instar larvae are more commonly used:

- Wild adult flies are seldom seen in the field but can be caught in traps baited with specific attractants (eg Bezzilure®) and occasionally in ultraviolet light–based insectocutors.
- Intact third instar SWF larvae (5–20) should be collected from deep in the suspect wound. Forceps may be used, but care must be taken to avoid damaging the larvae. Larvae on the surface of wounds are usually from secondary strike flies and should be avoided.

Transport of specimens

State and territory veterinary diagnostic laboratories, the Northern Australia Quarantine Strategy laboratory in Cairns[7] and CSIRO Entomology are centres for SWF identification.

For further information, see the **AUSVETPLAN management manual *Laboratory preparedness*** and AHA (2017).

Packing specimens for transport

Adult flies for morphological examination should be packed carefully to avoid damage; however, damaged flies may still be useful for PCR testing.

SWF maggot collection kits have been widely distributed in regions of Australia considered to be at greatest risk of an incursion, and should be used to collect and ship specimens for identification. Larvae should be dropped into water that has just boiled and left for 1–2 minutes to kill them, and preserve their shape and colour. They should then be transferred to a container of 70–80% ethanol or methylated spirits. If the larvae are intended for PCR testing, they can be prepared as above and then stored at –20 °C.

Further details on specimen preservation and handling are available in AHA (2017).

2.6 Resistance and immunity

Different species of animals vary in their susceptibility to SWF strike. Susceptibility often correlates with the species' susceptibility to wounding or the presence of favourable sites for adult SWF to lay eggs in the absence of wounds. Cattle and sheep are favoured hosts; sheep are often struck in the absence of an obvious wound, producing a multiplying effect on fly populations.

Bali cattle (*Bos javanicus*) are reputed to be highly resistant to Old World SWF. It is not known whether

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this alleged resistance is due to immunological factors or other innate resistance factors developed through natural selection as a result of repeated exposure to SWF.

2.7 Vaccination

No commercial vaccine is available to protect against SWF myiasis.

Work on the feasibility of such vaccines for Old World SWF indicates that it may be possible to use various larval antigens to inhibit larval growth and even to increase larval mortality. Willadsen (2002) provides an overview of this work and options for development of Old World SWF vaccines.

2.8 Treatment of infected animals

Treatment of infested animals involves cleansing of wounds and manual removal of larvae (eg with forceps), followed by application of an appropriate topical insecticide (to prevent a recurrence of the myiasis) and supportive therapy to facilitate wound healing.

Insect repellents and insecticides may also be used as prophylaxis; in some circumstances, animals may be trained to use self-medicators (eg to reduce the labour required for chemical application or as prophylaxis for wild animals).

Appendix 1 provides details on the use of chemicals as treatment and/or prophylaxis in the control of SWF.

Maggots should be killed by placing them in boiling water or treating them with an appropriate insecticide. (If they are required for diagnosis, boiling water should be used; see Section 2.5.4.)

2.9 Control overseas

The sterile insect technique (SIT) is currently the only method of control that has been effective in eliminating New World SWF. Although SIT has never been used to eradicate Old World SWF, pilot projects in Papua New Guinea and Malaysia have demonstrated that eradication using SIT is likely to be technically feasible (Spradbery et al 1989, Mahon 2002b, Robinson et al 2009).

A significant increase in Old World SWF myiasis and spread of the fly to previously free areas was recorded in Iran, Iraq and Yemen (Robinson et al 2009), prompting urgent action to control the fly using insecticides (as treatment and/or prophylaxis) and limit its spread to neighbouring countries (Al-Izzi 2002). However, it remains endemic throughout the region, largely as a result of continuing social unrest.

New World SWF has been eradicated from the United States, Mexico and several Central American countries, where it was previously endemic, by using SIT (in combination with other control measures, such as insecticide use). In 2016, New World SWF was reintroduced into Florida and subsequently eradicated again. An outbreak of New World SWF in Libya in 1988 was eradicated using SIT (using sterile flies sourced from the joint Mexico–United States New World SWF facility in Chiapa de Corzo, southern Mexico).

Appendix 2 provides guidance on the implementation of a SIT program.

3 Implications for Australia

3.1 Potential pathways of introduction

The main potential pathways for introduction of screw-worm fly (SWF) into Australia are (Beckett et al 2014):

- importation (legal or illegal) of infested animals
- arrival of SWF on empty livestock vessels returning from overseas ports or on aircraft
- natural dispersal of Old World SWF from Papua New Guinea through Torres Strait to Cape York Peninsula – for example, through the movement of native fauna (deer) from Papua New Guinea to Australian islands in Torres Strait
- arrival of infested travellers from endemic areas.

Australia's biosecurity import controls mitigate the risk of introduction through the first two pathways, but cannot prevent the third or fourth.

Potential hosts for SWF are present throughout most of Australia. In particular, a review by Rodriguez and Raphael (2008) confirmed that suitable hosts for Old World SWF are present on the islands in Torres Strait and on Cape York Peninsula. These include deer, pigs, goats, dogs, cats, domestic and feral cattle, horses, wildlife such as macropods, and humans.

The arrival of infested humans presents a lower risk for introduction of SWF into Australia because detection is expected before the SWF establishes.

3.2 Social and economic effects

An SWF incursion represents a major threat to Australia's pastoral industries: the annual cost has been estimated as close to $500 million in lost production and control measures (DAFF 2015). Extensive cattle properties would suffer the highest losses (73% of total producer losses). Increased costs of mustering over extensive areas and projected lower turn-off rates, largely due to higher mortality among newborn calves as a result of navel strike, account for a high proportion of the projected losses. Properties in areas where economic viability is currently both variable and marginal would suffer the greatest financial impact.

The presence of SWF will require a change in the normal husbandry methods used in extensive areas, which will add to operational costs. For example, animals will need to be treated prophylactically where husbandry results in wounds (eg dehorning, castration, spaying). Alternatively, husbandry methods may need to be rescheduled, to avoid times when adult flies are active. Greater care and attention will be required for newborn animals. In more intensively farmed areas, stock will need to be regularly handled and inspected.

Photo credit: AHA

Although Australian native animals are known to be susceptible to SWF strike (as evidenced both experimentally and at overseas zoos), the impact of an SWF outbreak on the wildlife population has not been evaluated. It is conceivable that the effects could be significant in some species and that surveillance activities by wildlife authorities might be necessary. For further details, see the **AUSVETPLAN *Wild animal response strategy***.

SWF myiasis in people would be a concern to public health authorities.

Cost–benefit analyses

Cost–benefit analyses of previous eradication programs for New World SWF have been uniformly favourable. In the United States, the ratio of benefits to costs exceeded 10:1 in programs in which the pest was progressively eradicated from infested areas.

Bioeconomic modelling studies for Old World SWF have continued to demonstrate that eradication of an SWF incursion using the sterile insect technique (SIT) will be biologically and economically feasible (Beckett et al 2014). This modelling has also indicated that, in some cases, incursions may be controlled by chemical means before they become widely established.

If a SIT response is not implemented for several years after an incursion, as may be expected in Australia, modelling indicates that a later SIT-based eradication program would still be feasible and would be economical using a large-scale facility producing around 200 million flies per week (Beckett et al 2014). The success of such a program would depend on the released flies being competitive with fertile flies.

3.3 Critical factors for an Australian response

The critical factors for the response to SWF in Australia include the following:

- Because SWF may also infest people, public awareness of the risks will be important to safeguard public health.
- It is assumed that the behaviour of SWF in Australia will be similar to its behaviour in countries where it is endemic. Bioeconomic models have been used to predict rates of spread and limits of incursions; however, these are still hypothetical.
- If native or feral animals are involved, effective surveillance and the implementation of control strategies will be challenging. There may also be public concern for the wellbeing of wildlife species.
- SWF is present at low density in the wild, and existing trapping approaches have low predicted efficiency. Therefore, surveillance to determine the extent of SWF distribution will be difficult.
- SIT is currently the only method of control that has the capacity to eliminate SWF from an area, once it becomes established. This technology is not currently available in Australia.
- Currently, no permits are in place to allow the use of insecticides or insect repellents against SWF in Australia.
- Resistance to available insecticides may develop with extended use (as may be expected in the response to SWF).
- Self-medicators for external parasites in both domestic and wild animals have not been used in Australia. The technology would need to be adapted for use on extensive Australian pastoral properties.
- Close liaison with community leaders in areas where there are free-roaming pets (especially dogs) will be required to better understand the management of these populations, foster engagement and support, and implement control measures appropriate to the community.

4 Policy and rationale

4.1 Introduction

4.1.1 Summary of policy

The default policy is to contain and eradicate screw-worm fly (SWF) as soon as possible after an incursion, to minimise its economic and ecological impacts. Implementation of this policy will initially involve a combination of strategies, including:

- early recognition and laboratory confirmation of cases
- an immediate assessment of the epidemiological situation, including surveillance of susceptible animals and fly trapping, to determine the zone of SWF activity and SWF-free areas
- movement controls based on inspection and treatment in declared areas to prevent the movement of infested animals
- tracing and surveillance to determine the source of the infestation and to provide proof of freedom from the disease
- surveillance of native and feral animals that may play a role in maintaining infestation
- population suppression of SWF by large-scale prophylaxis in declared areas, where appropriate
- treatment of individual animals and groups to prevent or cure infestation, especially before movement of animals
- decontamination and disinsectisation of larval-contaminated areas, equipment and other materials
- a public awareness campaign to encourage rapid reporting of suspected infestations, and cooperation from industry and the community.

If SWF becomes established in Australia, the sterile insect technique (SIT) will need to be implemented to initially control and ultimately eradicate the fly. This may necessitate construction or modification of a suitable facility in Australia, or importation of sterile flies from an appropriate facility overseas.

Successful implementation of the policy will depend on industry cooperation and compliance with control and eradication measures. Successful eradication could take several years.

4.1.2 Case definition

For the purpose of this manual, an incursion of SWF is defined as:

- the detection of adult *Chrysomya bezziana* (Old World SWF) or *Cochliomyia hominivorax* (New World SWF) at a location or trap other than at a port; or
- an animal that displays myiasis due to larvae of *Chrysomya bezziana* or *Cochliomyia hominivorax*.

Photo credit: AHA (2017). Old World Screw-Worm Fly: A Diagnostic Manual, Third Edition. Animal Health Australia, Canberra

Notes:

- AUSVETPLAN case definitions guide when a response to an emergency animal disease (EAD) incident should be undertaken. AUSVETPLAN case definitions do not determine when international reporting of an EAD incident is required.
- At the time of an outbreak, revised or subsequent case definitions may be developed (with the agreement of the Consultative Committee on Emergency Animal Diseases – CCEAD).

4.1.3 Cost-sharing arrangement

In Australia, SWF is included as a Category 2 emergency animal disease in the Government and Livestock Industry Cost Sharing Deed in Respect of Emergency Animal Disease Responses (EAD Response Agreement).[8] When cost sharing of the eligible response costs of an incident is agreed, Category 2 diseases are those for which costs will be shared 80% by government and 20% by industry.

4.1.4 Criteria for proof of freedom

The World Organisation for Animal Health (OIE) has not defined freedom from SWF. Proof of freedom for Australia would require:

- SWF remaining a notifiable disease in all states and territories
- regular monitoring of livestock (eg at abattoirs, saleyards and live export facilities)
- active surveillance at or near higher-risk areas
- no evidence of SWF infestation for an extended period.

4.1.5 Governance

Governance arrangements for the response to EADs are outlined in the ***AUSVETPLAN Overview***.

Information on the responsibilities of a state coordination centre and local control centre is available in the **AUSVETPLAN management manual *Control centres management*, Parts 1 and 2**.

8 Information about the EAD Response Agreement can be found at www.animalhealthaustralia.com.au/what-we-do/emergency-animal-disease/ead-response-agreement.

4.2 Public health implications

Work health and safety (WHS) legislation in Australia requires businesses and workers to, as far as reasonably practicable, ensure the health and safety of themselves and others. Jurisdictional WHS authorities should be consulted on their legislative requirements.

Measures to manage the risks of SWF exposure to people include keeping wounds clean and covered, improving the general hygiene of the local environment (to minimise attraction of SWF), and using insecticides and repellents to manage local SWF populations.

Any personnel with suspected myiasis should promptly seek medical attention.

4.2.1 Food safety

Carcases from animals affected by SWF myiasis detected at postmortem inspection will either be condemned (if the damage is extensive) or trimmed to remove contaminated areas. Meat from affected animals slaughtered through a registered abattoir is therefore considered safe to enter the human food chain, provided there has been compliance with relevant withholding periods for chemicals used to treat the animals.

4.3 Control and eradication policy

The overall objective of an SWF response will be eradication. This is likely to involve implementation of an appropriate SIT program (see Section 4.4), which will take years to establish. The initial response to an incursion of SWF will be planning for the implementation of a SIT program, and implementation of a control and containment program. A control and containment program will include the use of movement restrictions, tracing, surveillance, a public awareness campaign, and treatment and prevention programs designed to limit buildup and spread of the SWF population. These strategies will need to be implemented rapidly in the state or territory of the initial incursion. Similar activities will need to follow in other at-risk jurisdictions, and it is vital that these activities are coordinated across state borders.

4.3.1 Epidemiological assessment

Epidemiological investigation or assessment draws on multiple sources of information to build understanding of the disease and how it is behaving in an outbreak. This informs response decision making.

If SWF is detected in Australia, the key objectives for an epidemiological assessment will be to identify the:

- spatial distribution of SWF and SWF-infested animals, including free-roaming animals
- source of infection
- incidence, and predicted incidence, of clinical disease
- pathways of spread and their risk profiles
- predicted size of the outbreak, taking into consideration modelling outputs, where available
- risk factors for the presence of infestation and susceptibility to disease.

Epidemiological assessment, and tracing and surveillance are interrelated activities. The initial tracing and surveillance findings (eg on the spatial distribution of infestation) will be used as inputs for the initial epidemiological assessment. In turn, the outcomes of the epidemiological assessment will guide further tracing and surveillance activities. This iterative cycle will continue throughout the response.

The epidemiological assessment will be used initially to support decisions on whether SWF can be eradicated. It will also help with identifying appropriate response measures and assessing the progress of SWF control measures. Ongoing epidemiological assessment is important for any EAD response; this is particularly so for long-term responses, to aid evaluation of the continued effectiveness and value of response measures.

The Old World SWF spatial model[9] can be used to predict the likely spread of an Old World SWF outbreak. The model also provides a tool for examining alternative strategies and developing the most effective and economical approach.

4.3.2 Quarantine and movement controls

Guidance on declared areas and premises classifications can be found in the **AUSVETPLAN guidance document *Declared areas and allocation of premises definitions in an EAD response***.

Quarantine

Quarantine will be immediately imposed on all premises and areas where infestation is either known or suspected.

Controls may be placed on the movement of infested or potentially infested animals, and contaminated or potentially contaminated things. These will be implemented through the declaration of premises and areas, and linking permitted movements to each area (see Section 5).

Movement controls

Section 6 outlines the recommended movement controls for live animals, carcasses, animal products, waste products and effluent, and other items (eg equipment and vehicles) that might be contaminated.

4.3.3 Tracing and surveillance

Guidance on tracing and surveillance can be found in the **AUSVETPLAN guidance document *Tracing and surveillance***.

Tracing

Rapid trace-back and trace-forward of the movements of animals from properties where infestation is confirmed (infected premises – IPs) should be undertaken.[10] Tracing activities may prioritise the movement of animals from or to areas with higher likelihood of infestation (as indicated by modelling), but should not ignore the possibility of infestation in areas of modelled lower likelihood of infestation.

The trace-back period (used to help identify the source of infection) will be determined by factors such as the expected lifecycle period of the SWF under the climatic conditions at the time, the prevalence of the SWF and whether a delay in detection is suspected. Trace-back is recommended over a period of at least 6 weeks (equivalent to two generations of SWF) before the presumed first infestation. Additional tracing may be required if there is evidence that other properties in the area may also be infested by

9 The model is available through the Screwworm Fly Surveillance and Preparedness Program managed by Animal Health Australia.

10 The Australian Government Department of Agriculture will work with export establishments to trace relevant exported animals and commodities whose status may be affected by the outbreak. The department will notify importing countries of any affected consignments and manage them as required by the importing government authority.

SWF or if no likely source of infection is identified from the initial tracing.

Trace-back of free-roaming wild animals is unlikely to be practicable. Trace-back of wild animals in care (eg in zoos) may be warranted and feasible.

Trace-forward of movements of animals and potentially contaminated items from IPs (used to help identify other animals or people that may be infested) should cover the period from 6 weeks before infestation was identified up until the time that quarantine was imposed on the premises.

Follow-up investigation and management of potentially exposed animals identified by tracing should be prioritised on the basis of the likelihood of transmission, the potential for further transmission (and therefore animal and public health risks), and the potential consequences for disease control activities.

Where disease occurs in a food-producing animal, animal products and byproducts that may have entered the food chain should be traced (eg meat and meat products derived from the animal). If animals have been slaughtered in a registered abattoir, no further tracing of products and byproducts is required.

Where livestock need to be traced, information management systems should be used to support tracing activities, as well as farm records, and interviews with farm workers and managers. Databases for the National Livestock Identification System and documents such as National Vendor Declarations or Animal Health Statements should be used to assist with tracing and epidemiological investigations.

Surveillance

The critical aims of a surveillance program during an SWF incursion are:

- to initially define the boundaries of SWF-infested areas
- to allow infested areas to be readily redefined
- to assess whether SWF populations are expanding or contracting in infested areas
- to measure the progress of control and eradication activities
- to verify when areas are free from SWF.

The use of wounded sentinel animals as part of surveillance is unlikely without clear epidemiological and ethical justification.

Section 7 provides more details on surveillance for SWF and SWF-infested animals, including recommended protocols for surveillance traps and animals.

4.3.4 Zoning and compartmentalisation for international trade

Where it is not possible to establish and maintain disease freedom for the entire country, establishing and maintaining disease-free subpopulations, through zoning and/or compartmentalisation,[11] may be considered.

In the case of a limited disease outbreak, a containment zone[12] may be established around the areas where the outbreak is occurring, with the purpose of maintaining the disease-free status of the rest of the country outside the containment zone.

11 With zoning, disease-free subpopulations are defined primarily on a geographical basis. With compartmentalisation, disease-free subpopulations are defined primarily by management practices (such as the biosecurity plan and surveillance practices of enterprises or groups of enterprises).

12 The OIE defines a 'containment zone' as an infected zone within a previously free country or zone, which includes all suspected or confirmed cases that are epidemiologically linked and where movement control, biosecurity and sanitary measures are applied to prevent the spread of, and to eradicate, the infection or infestation. The Australian Government Department of Agriculture and Water Resources commissioned a report on what would be required for the establishment of containment zones in Australia. This report is available at www.ausvet.com.au/wp-content/uploads/2019/03/Containment-zones-formatted.pdf.

Photo credit: AHA

All zoning applications would need to be prepared by the Australian Government in conjunction with the relevant jurisdiction(s) and agreed to by the CCEAD. Compartmentalisation applications would require input from the relevant industries. Recognition of both zones and compartments must be negotiated between the Australian Government and individual overseas trading partners. Zoning and compartmentalisation would require considerable resources that could otherwise be used to control an outbreak. Careful consideration will need to be given to prioritising these activities, because the resulting competition for resources could delay the quick eradication of the disease and recognition of disease freedom.

Agreements between trading partners take time to develop, consider and finalise, because of the need to provide detailed information on activities such as biosecurity, surveillance, traceability and diagnostics to support the approach that is developed. An importing country will need assurance that its animal health status is not compromised if it imports from an established disease-free zone in Australia. Trading partners may not accept a zoning or compartmentalisation proposal, regardless of the information provided. Eradication of disease may be achieved before zoning or compartmentalisation applications are finalised.

General guidelines for zoning and compartmentalisation are in Chapter 4.4 of the OIE Terrestrial Code.

4.3.5 Biosafety and biosecurity for personnel

To minimise the risk of exposure, all people working in SWF-infested areas should keep wounds covered. On leaving high-risk premises (IPs, suspect premises – SPs, trace premises – TPs, and dangerous contact premises – DCPs) and on leaving the restricted area (RA), personnel should ensure that clothing and footwear are free from gross contamination with soil and wastes that may contain any SWF life stages.

4.3.6 Biosecurity for equipment

On leaving high-risk premises (IPs, SPs, TPs and DCPs) and on leaving the RA, all equipment and vehicles should be cleaned to ensure that they are free from gross contamination with soil and wastes that may contain any SWF life stages. Vehicles should also be sprayed with an appropriate insecticide to prevent the inadvertent movement of adult SWF.

More information on decontamination is provided in Section 4.3.13; information on the use of insecticides is provided in Sections 4.3.17 and Appendix 1.

4.3.7 Animal welfare

Guidance on managing livestock welfare can be found in the **AUSVETPLAN operational manual *Livestock welfare and management***.

Animal welfare should be monitored during implementation of disease control measures (such as quarantine and confinement of animals), particularly when the measures are applied over a prolonged period. Animal welfare issues may particularly arise if movements of intensively housed animals are restricted.

4.3.8 Vaccination

No vaccine is available for control of either Old World or New World SWF.

4.3.9 Treatment of infected animals

Treatment of infested animals involves cleansing of wounds and manual removal of larvae (eg with forceps), followed by application of an appropriate topical insecticide (to prevent a recurrence of the myiasis) and an appropriate systemic insecticide, where available. Supportive therapy to facilitate wound healing may also be implemented.

Section 4.3.17 and Appendix 1 provide more information on the use of insecticides and insect repellents for prophylaxis and treatment.

4.3.10 Treatment of animal products and byproducts

Treatment of animal products and byproducts is not necessary.

4.3.11 Destruction of animals

Destruction plans should be developed for each premises on which animals may be destroyed. Guidance on destruction methods can be found in the **AUSVETPLAN operational manual *Destruction of animals***.

Stamping out (slaughter of all infested and exposed animals, followed by disposal and decontamination) is not needed for the control or eradication of SWF. Some individual animals may need to be destroyed for animal welfare reasons.

4.3.12 Disposal of animals, and animal products and byproducts

Disposal plans should be developed for each quarantined premises. Guidance on disposal options and methods can be found in the **AUSVETPLAN operational manual *Disposal***.

Carcasses, wastes and bedding on high-risk premises (IPs, DCPs, SPs and TPs) that may be contaminated should be treated with insecticide to kill any SWF eggs, pupae or larvae before disposal. The disposal method chosen will be influenced by the type of material to be disposed of, the resources available, the local environment, the prevailing weather, legislative requirements (including environmental protection legislation) and the risk of spreading SWF.

All equipment and machinery involved in on-site disposal should be cleaned and sprayed with insecticide (see Section 4.3.13).

Disposal must also be in accordance with the requirements in Section 6, and auditable in terms of biosecurity, traceability and financial requirements.

4.3.13 Decontamination

Decontamination plans should be developed for each premises to be decontaminated. General guidance on decontamination can be found in the **AUSVETPLAN operational manual *Decontamination***.

After larvae vacate a wound, they seek a suitable environment in which to pupate – usually 2–3 cm deep in nearby soil. If larvae leave a wound while the host animal is confined (eg in a stockyard or transport vehicle), pupation can occur in cracks or crevices, or in other areas where there is a buildup of protective organic material such as faeces. Consequently, vehicles that may have carried infested animals need careful cleaning and decontamination.

To minimise the likelihood of these larvae burrowing into soil and successfully pupating, transport vehicles should be inspected and cleaned in yards or wash-down areas with concrete or otherwise toughened and sealed floors.

Inspection areas that are likely to be contaminated with larvae should be regularly steam cleaned and sprayed with an appropriate insecticide (see Section 4.3.17). Faeces and soil deposits in livestock transport vehicles are best removed by steam cleaning followed by high-pressure hosing to ensure destruction of both larvae and pupae.

4.3.14 Wild animal management

Guidance on wild animal management can be found in the **AUSVETPLAN *Wild animal response strategy***.

Native and feral animals should not be disturbed unless it is absolutely necessary. All warm-blooded animal species may be affected by SWF, and any disturbance may increase dispersal of the flies. Activities that are likely to result in animals dispersing from the RA or being injured, thereby producing additional oviposition sites, must be avoided. For these reasons, recreational and commercial hunting should be prohibited in the RA.

Although disturbance of native and feral animals is detrimental to disease control, measures to contain these animals within known infested areas could be considered, where practical.

Native and/or feral animals may be useful for surveillance.

Wildlife health and ecology experts (including experts on the ecology of free-roaming and wild dogs and cats, as appropriate) and environmental agencies must be consulted in planning, monitoring, surveillance and control programs.

4.3.15 Vector management

Not applicable.

Photo credit: Northern Territory government

4.3.16 Public awareness and media

Guidance on managing public information can be found in the ***Biosecurity incident public information manual***.

Public awareness will be critically important for the surveillance and control of SWF. Resources may be limited, and the public can assist by servicing adult SWF traps; maintaining sentinel animals (see Section 7.1) and submitting appropriate samples; regularly inspecting pets and recreational animals; and immediately reporting myiases in these animals, wild animals or humans.

Industry, the public and the media will need to be informed about SWF, and the control and eradication measures being adopted. Wide use of media resources will be required in the initial phase of the control program to keep the public clearly informed, and to seek their cooperation and assistance, including in submission of samples.

Roles and responsibilities of veterinary and medical practitioners, local government, and wildlife and public health authorities should be clearly identified in all communications and made known to all concerned.

National coordination of public information and engagement messaging in the event of an SWF incident in Australia may occur through:

- activation of the National Biosecurity Emergency Communication Network[13] to coordinate animal health information, and liaise with public health and environmental agencies
- activation of the National Health Emergency Media Response Network to coordinate public health

13 Previously known as the Primary Industries National Communication Network (NCN). More information is available at www.outbreak.gov.au/about/biosecurity-incident-national-communication-network.

information, and liaise with animal health and environmental agencies. The Australian Government Department of Health will produce and manage public and media messages (including appropriate public health warnings) about the human health aspects of the incident.

4.3.17 Other strategies

Other strategies that will be implemented in response to an incursion of SWF include review of animal handling equipment and techniques (for routine husbandry practices) to limit wounding that could make animals prone to SWF strike, and use of insecticides as treatment and/or prophylaxis against SWF.

Use of insecticides

In the event of an SWF incursion into Australia, the use of chemical pesticides (insecticides) to treat infestations and protect animals from flystrike will be a significant component of the response.

No products are registered for use against SWF in Australia. However, products that are registered for other uses may be suitable for the control of SWF (see Appendix 1). The use of these products in response to an SWF incursion would require an emergency permit from the Australian Pesticides and Veterinary Medicines Authority (APVMA).

Should importation of other pesticides or veterinary medicines be required for the control of SWF, importation would be subject to the issuing of import permit(s) from the Australian Government Department of Agriculture, Water and the Environment. Supply and use of these products would also require an emergency permit and consent to import from the APVMA. Importation, distribution, use and disposal of a product that is a genetically modified organism must also be licensed by the Office of the Gene Technology Regulator or permitted under an Emergency Dealing Determination by the minister

Photo credit: AHA

responsible for gene technology, or other relevant and appropriate processes.

Appendix 1 provides guidance on the use of insecticides for treatment and/or prophylaxis of SWF.

4.3.18 Stand-down

Guidance on the stand-down of EAD responses can be found in the **AUSVETPLAN management manual *Control centres management*, Part 1**.

Stand-down of the response will occur once SWF has been eradicated; when eradication of SWF is no longer considered feasible, cost-effective or beneficial; or when the National Management Group formally declares that the outbreak is over. Relief and recovery activity will need to continue after disease control and eradication programs have wound down.

4.4 Other control and eradication options

To achieve eradication of SWF, it is likely that implementation of a SIT program will be required. It has been agreed (through the then Primary Industries Standing Committee) that an SWF-specific SIT facility will not be built in Australia before an incursion. Instead, once an incursion has been confirmed in an area and predictive epidemiology indicates that the incursion may become permanent, SIT capacity will be developed as soon as is practical. Substantial planning arrangements (eg engineering design briefs, identification of possible sites, draft funding arrangements) have been put in place. Even with this preplanning, a SIT response is unlikely to be implemented for some years after an incursion.

More details on the implementation of SIT programs is provided in Appendix 2.

If eradication of SWF is not achieved through a SIT program, or is not otherwise achievable, a long-term control program would need to be considered through discussion between governments, livestock industries and other relevant stakeholders (eg wildlife agencies).

4.5 Funding and compensation

Details of the cost-sharing arrangements can be found in the Government and Livestock Industry Cost Sharing Deed in Respect of Emergency Animal Disease Responses. Details of the approach to the valuation of, and compensation for, livestock and property in disease responses can be found in the **AUSVETPLAN operational manual *Valuation and compensation***.

5 Declared areas and premises

5.1 Declared areas

Detailed guidelines for declared areas are provided in the **AUSVETPLAN guidance document *Declared areas and premises classifications***.

Figure 5.1 illustrates the recommended minimum distances between the boundaries of an infected premises (IP), the restricted area (RA) and the control area (CA), in the initial stages of a response to screw-worm fly (SWF).

Infected premises	Restricted Area	Control Area	Outside area
	Minimum 150km	Minimum 150km	

Figure 5.1 Recommended minimum distances between the borders of an infected premises, the restricted area and the control area

5.1.1 Restricted area (RA)

For SWF, an RA will be declared to include all infected premises (IPs) and dangerous contact premises (DCPs), and as many suspect premises (SPs), trace premises (TPs) and dangerous contact processing facilities (DCPFs) as practicable. The distance of the boundaries of the RA from the boundaries of high-risk premises (IPs, DCPs, DCPFs, SPs and TPs) will be based on risk assessment, taking into consideration available information on:

- the known distribution of SWF and its expected dispersal, and the level of certainty in this knowledge (eg as informed by prevailing weather conditions and geographical features)
- the location and distribution of any populations of susceptible animals (including feral and native animals) in the area, and patterns of livestock movements
- the length of time SWF is thought to have been present in the area
- the location of key elements in industry supply chains (eg abattoirs, artificial breeding centres, truck wash-downs)
- the impacts on the industry of SWF control measures applied in the RA compared with the expected benefits of disease control
- resources available to implement SWF control measures, taking into account the expected rate of SWF spread.

It is recommended that the boundaries of the RA be a minimum of 150 km from the nearest IP, DCP, DCPF, SP or TP (to allow for two generations of infestation and dispersal of 25 km per week for 6 weeks).

Photo credit: AHA

5.1.2 Control area (CA)

For SWF, the dimensions of a CA will be based on risk assessment, taking into consideration the factors used to inform the boundaries of the RA. Depending on the circumstances, the boundaries of the CA may extend up to 150 km from the boundaries of RA(s) within it.

5.2 Other areas

Not applicable.

5.3 Declared premises

Detailed guidelines for declaring premises status are provided in the **AUSVETPLAN guidance document *Declared areas and allocation of premises classifications in an EAD response***.

5.3.1 Premises status classifications

For SWF, the premises classifications to be used are:

- infected premises (IP)
- suspect premises (SP)
- trace premises (TP)
- dangerous contact premises (DCP)
- dangerous contact processing facility (DCPF)
- approved processing facility (APF)
- approved disposal site (ADS)
- at-risk premises (ARP)
- premises of relevance (POR)
- resolved premises (RP)
- unknown status premises (UP)

- zero susceptible species premises (ZP).

In the response to an SWF incursion, all premises with susceptible animals in the area of known SWF distribution will be considered DCPs.

5.3.2 Qualifiers

The following qualifying category may be added to a property status:

- assessed negative (AN).

5.3.3 Other disease-specific classifications

Not applicable.

5.4 Reclassifying premises and declared areas

Detailed guidelines for reclassifying previously declared areas are provided in the **AUSVETPLAN guidance document *Declared areas and allocation of premises classifications in an EAD response***.

For SWF, the key principles for reclassifying a previously declared area to one of a lower risk status include the following:

- The area should be epidemiologically distinct from other declared areas.
- All TPs and SPs have been investigated and reclassified, and all IPs, DCPs and DCPFs in the area have been reclassified as RPs.
- All tracing and surveillance associated with disease control has been completed satisfactorily, with no evidence or suspicion of infestation in the area.
- A minimum period of 6 weeks has elapsed since predetermined disease control activities and risk assessment were completed on the last IP or DCP in the area.
- An approved surveillance program (including the use of sentinel animals, if appropriate) has confirmed no evidence of infection in the RA.
- SWF monitoring and absence of transmission studies indicate that SWF is not active.

6 Movement controls

6.1 Principles of movement controls

General principles for movement controls for managing emergency animal diseases are provided in the **AUSVETPLAN guidance document *Movement controls***.

Key considerations for quarantine practices and movement controls for managing screw-worm fly (SWF) are as follows:

- SWF myiasis may not be obvious in all cases.
- Removal of gross contamination and application of insecticides will help prevent the inadvertent transport of different SWF life stages.
- The use of insecticides may have implications for work health and safety of response personnel, the environment, and the application of withholding periods and/or slaughter intervals for treated animals.

6.2 Recommended movement controls

General permits (GPs) and special permits (SpPs) may not be available until the relevant chief veterinary officer gives approval for movements, and this approval may not have been given in the early stages of a response.

SpPs are used for higher-risk movements. They require formal application and individual risk assessment by the relevant government veterinarian or gazetted inspector of stock. An SpP may only be issued if the assessed risk can be managed by the application of acceptable mitigation measures.

6.2.1 Live susceptible animals

Movements other than to slaughter

Managing the movements of live susceptible animals in declared areas will be particularly challenging in an SWF incident because of the wide range of susceptible animals (all warm-blooded animals) and differences in their management, as well as the expected size of declared areas. Examples are as follows:

- Pets and recreational animals (eg horses, dogs) may need to be moved for regular exercise to prevent animal welfare issues from arising (depending on their usual housing and space availability). Where large numbers of pets are present in declared areas, managing the volume of permit applications may be challenging and consume significant amounts of response resources. On the other hand, these animals may be more likely to be closely observed, and there may be higher confidence that preventive insecticide treatments may be applied, and any signs of SWF infestation detected and reported.

- In remote communities, the ownership and role of free-roaming dogs (eg use in hunting for food) may involve different considerations, and alternative means may be needed to manage the potential exposure of these animals (and potential spread of SWF). These should be developed in close consultation with the relevant community.
- Movements of commercial livestock may involve larger numbers of animals, but application of preventive insecticide treatments may still be feasible. There may be animal welfare considerations for the movements of some livestock (eg intensive grow-out species such as chickens and pigs). The husbandry of these animals may vary (eg with intensive or extensive production systems), which may affect the likelihood that any signs of SWF infestation following movement would be detected and reported.

The following guidance is provided but should be adapted to the incident, species and prevailing animal management practices:

- Movements (other than to slaughter) of live animals from premises in the restricted area (RA) should be prohibited, except under SpP following risk assessment on a case-by-case basis. Where these movements are permitted, the following should be considered
  - confidence that the animals are free from clinical disease (including inspection by an authorised officer where the assessed risks are high)
  - application of an appropriate insecticide (eg ivermectin) 7–14 days before movement (under the oversight of an authorised officer where the assessed risks are high)
  - avoiding the movement of different SWF life stages with the animals (eg by cleaning vehicles before movement, avoiding soil contamination, applying an insecticide)
  - cleaning of vehicles following movement and appropriate disposal of any potentially contaminated material
  - restrictions on the onward movement of animals and emphasis on the need to report any clinical signs of SWF infestation
  - identification of the animals permitted to move.

Photo credit: AHA

- Movements of live animals onto quarantined premises (infected premises – IPs, dangerous contact premises – DCPs, dangerous contact processing facilities – DCPFs, suspect premises – SPs, and trace premises – TPs) should be prohibited, except under SpP following risk assessment on a case-by-case basis. As these premises are subject to a range of disease control measures, the introduction of additional susceptible stock is not recommended. However, it may be considered under exceptional circumstances, informed by risk assessment and taking into consideration the context of the individual incident, the species, animal welfare principles and animal management on the premises.
- Similarly, movements of live animals onto other premises in the RA should be prohibited, except under SpP following risk assessment on a case-by-case basis. This risk assessment should take into consideration the context of the individual incident, the species, animal welfare principles and animal management on the premises.
- Decisions on the implementation of movement controls for susceptible species within the control area (CA) or from the CA to the outside area (OA) should be made in the context of the incident. It may be advantageous for such movements to be subject to GP (eg to aid traceability); however, it may be difficult to monitor compliance (especially where the CA is large).

Movements to slaughter

Movements to slaughter of live susceptible animals from premises in the RA should be prohibited, except under SpP following risk assessment on a case-by-case basis. The primary considerations in this risk assessment include:

- confidence that the animals being moved are not infested with SWF
- whether a suitable alternative abattoir is available in the RA (abattoir capacity in the RA should be reserved as much as possible for processing of animals originating in the RA; animals should not move outside the RA unless no suitable abattoir is available in the RA)
- preventing the inadvertent movement of any life stages of SWF to areas outside the RA
- using processing facilities where ante- and postmortem inspections occur, appropriate biosecurity measures are in place (eg waste management), and there is confidence that any signs of infestation would be reported immediately to an authorised officer
- confidence that the animals will be slaughtered in a timely manner and not remain in lairage for extended periods (or be moved elsewhere).

Similarly, movements to slaughter in the RA of live susceptible animals from premises in the CA or OA should be prohibited, except under SpP following risk assessment on a case-by-case basis. The primary considerations in this risk assessment include:

- whether a suitable alternative abattoir is available in the CA or OA (abattoir capacity in the RA should be reserved as much as possible for processing of animals originating in the RA)
- preventing the inadvertent movement of any life stages of SWF to the CA or OA on return of the vehicle and equipment involved in transporting the animals
- confidence that the animals will be slaughtered in a timely manner and not remain in lairage for extended periods (or be moved elsewhere).

Movements to slaughter of live susceptible animals originating in the CA to an abattoir in the CA or OA should be subject to GP (to aid traceability), with the following conditions:

- The animals were born on, or have been resident on, the premises of origin for at least 60 days.
- The animals are not showing signs of SWF infestation.
- The animals are identified.

- The animals will not be moved to other premises.
- The animals will be slaughtered within 72 hours.
- Any signs of SWF infestation will be reported immediately to an authorised officer.

Movements to slaughter of live susceptible animals originating in the OA to an abattoir in the CA or OA should be allowed without restriction.

6.2.2 Carcasses

Movement of carcasses from quarantined premises (IPs, DCPs, SPs and TPs) is prohibited except under SpP, subject to risk assessment on a case-by-case basis. Where permitted, such movements may be to an approved disposal site (ADS) for biosecure disposal. The carcasses should be treated with an insecticide to kill any SWF eggs, pupae and larvae; all vehicles and equipment involved in the transport should be cleaned and disinfested following the movement; and appropriate biosecurity should be maintained at the ADS.

6.2.3 Semen and embryos from live susceptible animals

No restrictions.

6.2.4 Meat and meat products

No restrictions apply to the movement of meat and meat products, provided that the meat and meat products originate from animals slaughtered in a registered abattoir. Meat and meat products not originating from animals slaughtered in a registered abattoir should be inspected and certified free from SWF contamination before they enter the human or animal food chains, or should be destroyed.

6.2.5 Milk and dairy products

No restrictions.

6.2.6 Eggs and egg products

No restrictions.

6.2.7 Hides, skin, wool and other fibres

No restrictions apply to the movement of hides, skin, wool and other fibres, provided that these products originate from animals that were free from clinical disease.

6.2.8 Other animal byproducts

No restrictions.

6.2.9 Waste products and effluent

Material that could contain viable SWF pupae, such as soil or manure from stockyards or washings from livestock transport equipment, should not be removed from declared areas but should be disposed of in a biosecure manner (see Section 4.3.12).

6.2.10 Vehicles, including empty livestock transport vehicles and associated equipment

Managing the movements of all vehicles within declared areas is likely to be logistically challenging and so should be risk based, taking into consideration the context of the incident and:

- the origin, route and destination of the movement (eg solely in urban areas on sealed roads, off-road in infested areas)
- whether animals are being transported by the vehicle (and any associated equipment)
- the species and number of animals being moved (eg vehicles involved in the movement of a single caged bird will present a different risk from those involved in the movement of large numbers of livestock in rural areas)
- the potential for any stages of SWF to accompany the vehicle and equipment (eg through presence of contaminated soil).

The following guidance is provided, but should be adapted to the incident and the nature of the movement under consideration:

- Movements of empty livestock transport vehicles and associated equipment onto and off quarantined premises (IPs, DCPs, DCPFs, SPs and TPs) and other premises in the RA should be prohibited except under SpP, subject to risk assessment on a case-by-case basis. These movements may be permitted on condition that, under the supervision of an authorised officer, the vehicles and equipment are cleaned and disinfested following the movement, with appropriate management of waste material.
- Movements of other vehicles and equipment that originate in the RA and may be contaminated with potentially infested soil or other materials should be prohibited except under SpP, subject to risk assessment on a case-by-case basis. These movements may be permitted on condition that, under the supervision of an authorised officer, the vehicles and equipment are cleaned and disinfested following the movement, with appropriate management of waste material.
- Movements of other vehicles originating in the RA should be allowed. Public awareness of measures to prevent the inadvertent movement of SWF life stages (and encouragement to undertake these measures) should be enhanced.
- Movements of vehicles and equipment originating in the CA and OA should be allowed.

6.2.11 Nonsusceptible animals

No restrictions apply to the movement of cold-blooded (nonsusceptible) animals.

6.2.12 People

No restrictions apply to the movement of people, although the requirements for the movement of equipment, including personal items (see Section 6.2.15), and vehicles (see Section 6.2.10) must be met.

6.2.13 Specimens

Specimens should be collected according to Section 2.5.4, and packed and transported according to the guidelines of the International Air Transport Association.

6.2.14 Crops, grains, hay, silage and mixed feeds

No restrictions apply to the movement of crops, grains, hay, silage and mixed feeds, provided that these materials are free from gross contamination with soil or wastes that may contain early SWF life stages.

6.2.15 Equipment, including personal items

Equipment, including personal items such as footwear and clothing, that may be contaminated with soil or wastes that may contain early life stages of SWF should be cleaned before it is removed from high-risk premises and declared areas, or disposed of.

6.2.16 Sales, shows and other events

Sales and shows for susceptible animals may proceed in declared areas at the discretion of the relevant jurisdictional chief veterinary officer (CVO).

Decisions on events will be based on risk assessment, taking into consideration the location of the event, the origin of the animals attending and available resources to ensure compliance. People movements for such sales, shows and events should be in accordance with Section 6.2.12.

6.2.17 Stock routes and rights of way

Access to stock routes and rights of way in declared areas will be at the discretion of the relevant jurisdictional CVO. Decisions on access will be based on risk assessment, taking into consideration the potential presence, density and distribution of SWF in relation to the stock routes and rights of way, and the available resources to ensure compliance.

6.2.18 Animal movements for emergency (including welfare) reasons

Permission for the movement of animals for emergency (including welfare) reasons will be based on risk assessment and subject to appropriate conditions to mitigate the identified risks.

6.2.19 Other movements

Permission for other movements will be based on risk assessment and subject to appropriate conditions to mitigate the identified risks.

7 Surveillance and proof of freedom

7.1 Surveillance

7.1.1 Specific considerations

It is important to establish the geographical distribution of screw-worm fly (SWF) as soon as possible after its initial detection and to continue to monitor its spread thereafter. Active surveillance should be implemented in an area around the detection site. In determining the size of the surveillance area, consideration needs to be given to the likely dispersal of female SWF from the area. Where the density of appropriate hosts is low, the surveillance distance needs to be extended to at least 150 km (to allow for two generations of infestation and dispersal of 25 km per week) from the detection site to take into account the likely dispersal of female SWF. The surveillance techniques used for initial detection are also appropriate for determining the geographical extent of an outbreak.

Surveillance should include areas – such as saleyards, abattoirs and livestock export facilities – where large numbers of animals from a wide area congregate, providing a high-density source of stock. Because the role of native and feral animals in maintaining infection has not been determined, opportunities to extend surveillance to nondomesticated species must be explored.

Australia maintains active surveillance for SWF in identified high-risk areas (such as Torres Strait, the northern Australian coastline and ports) through the Northern Australia Quarantine Strategy and the Ports Surveillance Program. These programs will also support surveillance in a response.

Photo credit: AHA

Sentinel animals

On animal welfare grounds, wounded cattle, sheep or goats, which are preferred hosts of SWF, are unlikely to be used as sentinel animals without clear epidemiological and ethical justification. If the use of sentinel animals is approved, neonatal calves and lambs are useful as sentinels because they provide a very attractive natural wound in the umbilical stump and are relatively easy to handle. Dogs may also be useful sentinels.

To be effective, a sentinel group of animals would require a susceptible wound to be available within the group at all times. If enough naturally wounded animals are not available, consideration may have to be given to deliberate wounding of sentinels. Such action would require approval from relevant animal welfare authorities. Where deliberate wounding is used, several animals are required for each sentinel group so that at least one wound is available while surveillance is undertaken. All sentinel animals should be provided with appropriate care and protection.

A sentinel animal grid (up to 150 km radius) maintained around the initial focus for 12–16 weeks will provide useful monitoring of SWF activity. Sentinels should be concentrated according to livestock density and other factors such as weather conditions, geography (eg river systems, accessibility) and personnel availability.

As a guide, if practical, provide for:

- 30 sentinel groups within a 50 km radius of the initial detection focus
- a similar number of sentinel groups at a radius of 50–100 km
- a similar number of sentinel groups at a radius of 100–150 km.

Location of the sentinel groups will depend on animal availability, access to suitable sites and geographic limitations. Large areas of northern Australia are undeveloped and have limited access. Placing sentinel animals or traps in a geometric grid will not be feasible.

Beckett et al (2014) proposed that inspecting 500 individual animals would result in a 95% likelihood of detection once SWF had established in northern Australia.

The emphasis of the above strategies is to detect any spread from the initial focus (using a higher concentration of sentinel groups closer to the initial focus). Once spread from the initial focus is established, surveillance aims should be to assess the extent or rate of spread. This would require the concentration of sentinel groups to be redirected away from the initial focus. However, such a change would require more sentinel groups, to maintain a similar surveillance density as was initially applied within the 50 km radius.

Sentinels can be kept in holding paddocks, existing yards or portable yards. If possible, they should be placed under light vegetation near watercourses. Wounds should be monitored daily, and any egg masses or larvae should be collected for identification. Appropriate treatment should be provided to the animals to minimise suffering while maintaining their susceptibility to infection.

Adult SWF traps

Adult SWF traps can be used to supplement sentinel animal surveillance. Whether such traps could completely eliminate the need for sentinel animal surveillance remains unclear, as current understanding is that surveillance based on adult trapping is inferior to that based on wounded animals.

Various systems are available for trapping adult SWF. Some traps use combinations of organic chemicals as attractants, while others rely on ultraviolet (UV) radiation to attract flies. Different trapping mechanisms are used, including sticky boards, enclosures with insecticide strips, lured buckets and electrocution.

Where adult traps are used for surveillance, their exact positioning would depend on geographical and stock density considerations at the time of the outbreak. As a guide, a network of 80 traps is distributed within a radius of 150 km from the initial focus, as follows:

- 30 within 50 km radius
- 30 at 50–100 km radius
- 20 at 100–150 km radius.

As with sentinel animal groups, this trapping strategy is designed for detection of spread from an initial point, with trap density being greater closer to that point. To assess the extent or speed of spread from a known point, trapping density should ideally be the same at all distances from the last known point. However, such a strategy would be demanding of resources and could be prohibitively expensive.

Preferably, traps used for active surveillance would be serviced daily, or more frequently if required. This servicing and the laboratory examination of trapped flies will require considerable resources, especially if other related calliphorid flies are plentiful. The traps are best positioned in light tree cover such as thickets, because adult SWF tend to avoid areas devoid of cover. It may also be preferable to modify the trap pattern according to the location of watercourses in the area.

Any improvements to attractants would be beneficial. It is theoretically possible that a very efficient attractant could have a major effect on adult female densities, especially in areas of intense activity ('hot spots').

Insectocutor traps that use UV light will catch SWF, because the flies are attracted to UV light. However, UV traps are inefficient in most situations where adult SWF density is comparatively low. In certain situations (eg on ships, in stables, in other enclosed areas), insectocutors may be used to supplement a grid of traps that use chemical attractants.

Guidance on the location and operation of traps is available in the *Fly Trapping Work Instruction* (AHA 2018).

Inspection of animals

An important surveillance technique is the regular inspection of animals on premises such as farms, feedlots, abattoirs, saleyards, livestock export facilities and zoos. SWF-infested wounds produce a characteristic odour that, to an experienced 'nose', can be an initial indication of infestation in a group of animals. Extensively grazed animals can be inspected from horseback or vehicle. Although not developed for SWF to date, other very sensitive technologies for detecting specific smells, such as sniffer dogs and 'electronic noses', should be able to assist in the detection of SWF lesions. SWF surveillance could be complemented by surveys of feral animals and wildlife. (See the **AUSVETPLAN *Wild animal response strategy*** for survey techniques.)

Community-assisted (passive) surveillance

As well as the active surveillance techniques described above, an appropriate public awareness program should be implemented. The program should describe the signs to look for and encourage reporting by healthcare providers, veterinary practitioners, farmers, wildlife carers and rangers, owners of pets and the general community (see also Section 4.3.3). This should cover a much larger area than active surveillance.

Well-informed and cooperative members of the public can effectively carry out inspections, especially if they are likely to suffer economic loss from the disease. All myiasis cases should be treated as suspect and investigated.

7.2 Proof of freedom

SWF can be difficult to detect at low levels of infestation, as would occur towards the end of an eradication program. For this reason, all forms of surveillance must be continued for up to 16 weeks after the last clinical case or fertile egg mass is detected.

For eradication using the sterile insect technique (SIT), aerial dispersal of sterile flies will be continued for a minimum of 8 weeks after the last evidence of fertility in SWF egg masses. Unlike many other diseases, proof of freedom from SWF in Australia would be more important to us than to our trading partners.

Sentinel animals, if used, should be monitored for 16 weeks after the last clinical case. Sentinel animals may also be used in surveillance for SWF and for monitoring the progress of a SIT program (see Appendix 2).

A1 Appendix 1

INSECTICIDES AS TREATMENT AND/OR PROPHYLAXIS IN THE CONTROL OF SCREW-WORM FLY

The use of insecticides for treatment and prophylaxis will be essential in any program to control an incursion of screw-worm fly (SWF) in Australia. The availability of chemicals for the control of SWF in Australia was reviewed by James et al (2005), and the efficacy of some chemicals registered in Australia for use against cattle ectoparasites was evaluated in pen studies (James 2014). Details of products registered in Australia, and their permitted use, can be found by searching the website of the Australian Pesticides and Veterinary Medicines Authority.

James (2014) found three ectoparasiticides registered for other purposes to be effective against 2- and 4-day-old induced strikes in Javanese thin-tail hair sheep:

- ivermectin topical (64 µg/L mixture in water)
- spinosad aerosol (2.8 g/kg)
- a mixture containing cypermethrin and chlorfenvinphos (diluted in water to 400 µg/L and 2.21 g/L, respectively)

Registered chemicals that provide residual protection against Old World SWF are limited to ivermectin, closantel and chlorfenvinphos/cypermethrin (James 2014).

James et al (2005) also listed a number of other chemicals potentially able to offer protection against SWF infestation, but none of these is registered for that purpose, and many are no longer available in Australia. They include long-acting (injectable), bolus and capsule (oral) formulations of ivermectin; pour-on doramectin; oral closantel; and ear tags impregnated with zeta-cypermethrin.

Other products that may provide some control include products based on organophosphates, synthetic pyrethroids, insect growth regulators and macrocyclic lactones.

Ivermectin

James (2014) demonstrated 12 weeks of protection against induced Old World SWF strikes with an 80 mg controlled-release ivermectin oral capsule and a 50 g/L dicyclanil spray-on formulation in two 8 mL overlapping bands on the backline. He used Javanese thin-tail hair sheep as his experimental model.

Comprehensive in vitro, pen and field trials, including dose titration studies, demonstrated the efficacy of injectable ivermectin (Spradbery et al 1985). At 200µg/kg bodyweight (with or without clorsulon – a sulfonamide fasciolicide), the residual protection provided against Old World SWF was a minimum of

14 days in pen trials and 16–20 days in field trials, using cattle with castration and branding wounds. Treatment of Old World SWF strikes containing larvae 2–5 days old led to complete mortality of larvae up to 2 days old and a progressive decline in mortality with age of larvae to 21% at 5 days old. Injectable ivermectin at 200μg/kg bodyweight protected newborn calves against navel strike and prevented reinfestation of Old World SWF wounds for 10–11 days (Perkins 1987). Subcutaneous injections of either ivermectin or doramectin, both at 200 μg/kg, provided protection for 2–4 weeks (James 2014).

The attractiveness of wounds to SWF does not appear to be affected by ivermectin, so gravid females will still oviposit on the wounds of treated animals. However, the larvicidal effect of ivermectin is such that, for 16–20 days after treatment, no emerging larvae will survive. James et al (2005) mentioned prevention of infection for up to 20 days.

The use of ivermectin requires a withholding period, which needs to be considered for animals moving to slaughter.

Other products

Slow-release bolus formulations of the macrocyclic lactones, which can give more than 100 days protection in cattle, are registered in New Zealand (Holdsworth 2002), but not in Australia. Slow-release capsules are registered for endoparasite control in sheep and offer the possibility of prolonged protection, but have not been assessed against Old World SWF.

Slow-release ear tag formulations of zeta-cypermethrin, currently registered in Australia for buffalo fly control in cattle, have been reported to provide extended protection against SWF infestation (Tozer & Spradbery 2002), and therefore could play an important protective role against Old World SWF. Some caution has been expressed that zeta-cypermethrin protection may be due to a repellent property of the pyrethrin rather than insecticidal action, and that this may cause adult SWF to disperse more widely (Wardhaugh & Mahon 2002). However, because there are very few proven, long-acting chemicals for SWF protection, the tags could be considered for use, especially in areas where frequent mustering is impractical. Clearly, any dispersal effect would need to be assessed as part of an ongoing research and development program.

A sheep flystrike dressing containing a mixture of propetamphos and eucalyptus oil was found not to give satisfactory efficacy against 4-day-old SWF strikes (James 2014).

Use in native and feral animals

If SWF becomes established in feral or native animals, application of chemical treatments will only suppress the SWF population and will not result in eradication in the absence of other control strategies (such as the implementation of a sterile insect technique program).

Application of chemical treatments to native or feral animals is unlikely to be practical in most situations. However, there may be a small number of species- or situation-specific circumstances where limited but effective treatment or prophylaxis is feasible. For example, wombats can be treated with pour-on insecticide using the burrow flap method, and feral goats could be corralled. Deer in the Florida Keys outbreak were preventively treated with an antiparasitic medication using remote self-medication stations or oral medication treatments (Borden-Billiot 2017). (Self-medicators are not available in Australia, but their potential use here is being explored.)

Other considerations

Although efficacy against SWF is the prime consideration in choice of chemicals, other aspects must also be considered. These include residues in meat and milk, and consequent market restrictions; the impact on dung-breeding fauna; and the potential for development of resistance to chemicals

(Wardhaugh & Mahon 2002). There is also the possibility of insecticide toxicity if chemical dose rates are extrapolated from other species (eg toxicity in wildlife if dose rates are extrapolated from domestic livestock species).

Residues

Off-label use of any chemical comes with the risk of tissue residues of unknown magnitude and duration, which will have to be considered when deciding the eventual fate of treated animals.

The potential for residues will be a particular issue in lactating dairy cattle, where it will limit chemical options. However, dairy cattle are yarded frequently and can readily be inspected, and any new SWF infestations can be treated with nonpersistent chemicals. Zeta-cypermethrin ear tags have a nil milk withholding period and may be a particularly useful tool for managing SWF in dairy cattle. Most meat withholding periods are 6 weeks or less and are probably manageable in an incursion. However, the ivermectin bolus has a 180-day withholding period, and is therefore not likely to be suitable for cattle intended for export or domestic consumption.

Resistance

A review by Green et al (2005) concluded that there is relatively little insecticide resistance in Old World SWF populations around the world. Thus, an incursion of Old World SWF is unlikely to have pre-established resistance, especially to the chemicals that would be used in Australia. However, any control program that relied heavily on a limited range of chemicals for an extended period would exert strong selection pressure for resistance in the introduced strain of SWF (and other parasites). According to Green et al (2005), some insecticide resistance has been detected in some strains of New World SWF in the Americas. However, macrocyclic lactone resistance has not been reported, in spite of the widespread use of these chemicals in South America.

Environmental use of insecticides

The widespread use of aerial insecticides is expensive, resource intensive, nonselective, dangerous to operators and the environment, and unlikely to be efficient for use against adult SWF over extensive areas. Therefore, it is not recommended.

A2

Appendix 2

STERILE INSECT TECHNIQUE

The sterile insect technique (SIT) is currently the only method of screw-worm fly (SWF) control that has the capacity to eliminate the pest. The technique, which was first developed for New World SWF in the United States, is greatly aided by the fact that a female SWF mates only once. Saturation of an infested area with artificially reared sterile SWF results in the majority of wild females mating with sterile males, thereby producing sterile egg masses. This can dramatically reduce SWF populations in treated areas and, if maintained for several generations, can achieve eradication. The technique is applicable to other insects, and there is now a substantial body of research evidence demonstrating the feasibility of SIT-based eradication for Old World SWF (Spradbery et al 1989, Mahon 2001).

The effectiveness of SIT depends heavily on the mating competitiveness of sterile male flies compared with their wild counterparts. Studies with sterile Old World SWF have shown relatively poor competitiveness values. Further research and development is needed to improve the competitiveness of factory-reared flies and solve some residual production process problems (see Mahon (2002c)). If not completed before an incursion, this work would be crucial to the delivery of an effective and efficient SIT response.

Overseas use

Using SIT in combination with intensive animal inspection, wound treatment, animal movement controls and quarantine, New World SWF has been eradicated from the United States, parts of Central America and several Caribbean islands. An incursion of (exotic) New World SWF into Libya in 1987 was also eradicated using sterile flies from the North American program.

Sterile New World SWF used in the North American program has been produced at a factory in Mexico for more than 20 years. Now that New World SWF has been eradicated from North America and the northern part of Central America, authorities intend to maintain an SWF-free zone in Panama through ongoing release of sterile flies. Production of sterile New World SWF for the SWF-free zone will move to a smaller facility that is being established in Panama. The North American program has been an enormous undertaking. It began in Florida in the 1950s and has since operated virtually nonstop, with factory production operating 24 hours a day, 7 days a week. A factory for the production of sterile Old World SWF would operate on similar lines, with modifications of the rearing system.

The economics of New World SWF eradication programs have been very favourable, despite the high costs involved. Benefit–cost ratios in the United States exceeded 10:1. Bioeconomic analyses have continued to indicate that eradication of Old World SWF from Australia using SIT (and complementary controls) would be both feasible and economic, despite the cost and time that would be required to mount and implement an effective SIT program.

The Australian SWF bioeconomic model (originally developed by the Queensland Department of Primary Industries and Fisheries on behalf of the Australian Government Department of Agriculture and Water Resources) provides a tool for examining possible strategies for controlling an incursion of Old World SWF in Australia. Beckett et al (2014) used the Queensland Department of Primary Industries and Fisheries lifecycle model to undertake sensitivity analyses when considering the risk of entry of SWF into Australia.

Fruean and East (2014) used the Multi-Criteria Analysis Shell for Spatial Decision Support (MCAS-S) from the Australian Bureau of Agricultural and Resource Economics and Sciences to assess Australia's targeted surveillance to detect an incursion of Old World SWF. This analysis determined that the area of greatest risk was the north coast of northern Australia and the north of Cape York Peninsula.

Both studies concluded that the area at risk from an Old World SWF incursion may be limited by climatic extremes and vegetation cover. Animal Health Australia has the capacity to run further simulations, as necessary.

The costs involved in SIT are very high but worthwhile when considered in terms of a benefit–cost analysis and the chances of a successful outcome.

Colony establishment

Genetic material for establishing a large-scale SIT colony in Australia could be sourced initially from an overseas colony (if available) or from the incursion. Even if material is imported, a very high priority would be to establish one or more colonies based on genetic material obtained from the incursion. Selection over several generations (at least 6 months) is necessary to adapt wild strains to an efficient laboratory colony. Given the time needed to construct a production facility and Australia's policy of not building a facility before an incursion, there should be ample time to develop colony strains adapted from the incursion.

Production and emergence facilities

Engineering design briefs for an Australian SIT program for Old World SWF have been developed for a large-scale (250 million flies per week) production facility (APC 2001a) and multiple emergence facilities (APC 2001b). These design briefs, as well as cost estimates for the proposed facilities (APC 2001c), are held by the Australian Government Department of Agriculture, Water and the Environment, and Animal Health Australia. Biological aspects of large-scale mass rearing of Old World SWF are described in Spradbery (1990) and Mahon (2001).

Sterile insect production

Rearing involves obtaining eggs from egging cages, incubating the eggs on a starter diet in an initiation room, transferring the young larvae to a finishing diet, harvesting the mature larvae, providing a suitable substrate for pupation, allowing the pupae to mature, and using gamma irradiation to sterilise the pupae 48 hours before adult emergence. The pupae are then packed in fly release boxes (1500 per box) or placed in bulk on trays, and placed in climate-controlled rooms where the adult flies emerge.

Sexual sterilisation of SWF

SWF pupae are subjected to sufficient irradiation to induce total sexual sterility in the resultant adults, hopefully without inducing other significant deleterious effects. Adult males thus produced must be able to actively seek and mate with wild females for SIT to have any chance of success. The irradiator to be used must be large enough to meet the requirements of the SIT program and provide the correct dose of radiation with appropriate operator safety. Provision of an appropriate irradiator could be a limiting factor in delivering a SIT program.

Sterile flies are perishable, and their use requires strict adherence to temperature, packaging, shipping, storage, handling and time criteria. Quality control tests should be carried out on representative samples of each day's production of irradiated pupae to demonstrate the sexual sterility of both male and female SWF by crossing them with fertile flies.

Transport of pupae to emergence facilities

Irradiated pupae can be transported safely if they are packaged appropriately (to allow sufficient ventilation), and held and shipped under controlled temperature and humidity. The North American program used refrigerated semitrailers to transport irradiated pupae from Texas to southern Mexico, a trip of more than 24 hours. The small size and weight of pupae also enable them to be transported efficiently by aircraft. Irrespective of the mode of transport, economic analysis indicates that very large numbers of pupae could be transported large distances for relatively little cost. In fact, the distance between production and emergence facilities has virtually no impact on predicted benefit–cost ratios for any particular SIT program in Australia.

Emergence facilities

Sterile flies are normally released as young adults. Because adult flies are far more susceptible to damage than pupae during storage and transport, standard practice is to emerge sterile flies close to release areas.

The essential elements of the design brief for emergence facilities are:

- each facility to be capable of emerging and packaging for release 125 million adult sterile SWF per week
- facilities to operate 24 hours per day
- irradiated pupae to be delivered daily from the production facility
- emergence facilities (eg buildings, modules) to be transportable and relocatable.

Preferably, emergence facilities should be located close to release areas to optimise the use of release aircraft and to minimise damage to flies during transit. Because release areas will change as the SIT program progresses, the benefit of having emergence facilities close to release areas will need to be 'traded' against the logistical costs of facility relocation.

Sterile insect aerial release

Two technologies are currently available for dispersal of sterile flies. The first involves placing a predetermined number of pupae in small cardboard boxes, then dropping the boxes from aircraft after the flies have emerged. This is labour intensive and has largely been replaced by the 'chilled fly' method.

The 'chilled fly' method entails emerging flies in bulk in a small room and then chilling them so that they become virtually immobilised. When ready for dispersal, chilled flies are loaded into a metal box that is placed in an aircraft designed to hold three boxes, or approximately 4.4 million flies.

Sterile flies are normally distributed by specially modified aircraft that have a dispersal machine and fabricated chute to the exterior. Boxed flies are fed into the chute, where the venturi effect pulls the box apart as it exits the aircraft. Chilled flies are fed (sucked by the same venturi effect) into a tube leading to the exterior of the aircraft. Infested zones and surrounding buffer areas are traversed by parallel flight lines 1.5 km apart. These lines are drawn to minimise deadhead (the distances between the airport and the start of the dispersal line, and between the end of the dispersal line and the airport). Sterile flies are dispersed at a predetermined aircraft speed and height, and at a rate that will result in a ratio of 10–20 sterile flies for every estimated wild fly. Dispersal crew ensure that assigned rates of fly release are achieved and that sampling for quality control is undertaken. When ambient temperatures exceed 25 °C, flights are made during the earlier, cooler part of the day. Precise details of procedures are available for New World SWF from the United States Department of Agriculture. Very similar procedures would likely be adopted for Old World SWF.

Monitoring of SIT effectiveness

Sentinel animals throughout the infested area are monitored on a daily basis, or twice daily if possible. Oviposition occurs more often in the late afternoon, so wounds are best examined in the evening. Egg masses are removed carefully from the edge of the wound with a sharp instrument and sent to the laboratory for culture. If no hatch occurs within 12–24 hours, it can be assumed that the fly that laid the egg mass has mated with a sterile male. Records of each collection and hatch or nonhatch are kept by location and date.

SIT information campaign

The public should be advised of the technical reasons for the SIT program and that the released sterile flies are not harmful. Animal owners must be encouraged to submit samples, as they will play a major role in assessing the effectiveness of the SIT program. Culture of egg masses from sentinels, and submission of larval samples by public and animal health authorities are used to monitor the effectiveness of the program.

Glossary

Disease-specific terms

Calliphoridae	The insect family that includes 'bluebottle' blowflies.
Diurnal	Active or habitually active during the day.
Epidermis	Superficial skin.
Gravid female	A female insect ready to oviposit.
Hypoproteinaemia	Low blood protein.
Instar	A phase between two periods of moulting in the development of insect larvae (in this case, screw-worm fly larvae) or other invertebrate animals.
Mulesing	A radical surgical procedure in sheep to remove wrinkled skin and hence reduce susceptibility to flystrike.
Myiasis	Parasitism of animal tissues by blowfly larvae.
Oviposition	Deposition of eggs by female insects.
Perineal region	The skin surrounding the anus and vulva.
Prophylactic treatment	Preventive treatment.
Pupa	The inactive stage in insects between larva and adult.
Subcutaneous	The tissue layers immediately under the skin.
Topical	Applied to the skin.

Standard AUSVETPLAN terms

Animal byproducts	Products of animal origin that are not for consumption but are destined for industrial use (eg hides and skins, fur, wool, hair, feathers, hoofs, bones, fertiliser).
Animal Health Committee	A committee whose members are the chief veterinary officers of the Commonwealth, states and territories, along with representatives from the CSIRO Australian Centre for Disease Preparedness (ACDP) and the Department of Agriculture, Water and the Environment. There are also observers from Animal Health Australia, Wildlife Health Australia, and the New Zealand Ministry for Primary Industries. The committee provides advice to the National Biosecurity Committee on animal health matters, focusing on technical issues and regulatory policy. *See also* National Biosecurity Committee
Animal products	Meat, meat products and other products of animal origin (eg eggs, milk) for human consumption or for use in animal feedstuff.
Approved disposal site	A premises that has zero susceptible livestock and has been approved as a disposal site for animal carcasses, or potentially contaminated animal products, wastes or things.
Approved processing facility	An abattoir, knackery, milk processing plant or other such facility that maintains increased biosecurity standards. Such a facility could have animals or animal products introduced from lower-risk premises under a permit for processing to an approved standard.

Cont'd

At-risk premises	A premises in a restricted area that contains a live susceptible animal(s) but is not considered at the time of classification to be an infected premises, dangerous contact premises, dangerous contact processing facility, suspect premises or trace premises.
Australian Chief Veterinary Officer	The nominated senior veterinarian in the Australian Government Department of Agriculture, Water and the Environment who manages international animal health commitments and the Australian Government's response to an animal disease outbreak. *See also* Chief veterinary officer
AUSVETPLAN	Australian Veterinary Emergency Plan. Nationally agreed resources that guide decision making in the response to emergency animal diseases (EADs). It outlines Australia's preferred approach to responding to EADs of national significance, and supports efficient, effective and coherent responses to these diseases.
Carcase	The body of an animal slaughtered for food.
Carcass	The body of an animal that died in the field.
Chief veterinary officer (CVO)	The senior veterinarian of the animal health authority in each jurisdiction (national, state or territory) who has responsibility for animal disease control in that jurisdiction. *See also* Australian Chief Veterinary Officer
Compartmentalisation	The process of defining, implementing and maintaining one or more disease-free establishments under a common biosecurity management system in accordance with OIE guidelines, based on applied biosecurity measures and surveillance, to facilitate disease control and/or trade.
Compensation	The sum of money paid by government to an owner for livestock or property that are destroyed for the purpose of eradication or prevention of the spread of an emergency animal disease, and livestock that have died of the emergency animal disease. *See also* Cost-sharing arrangements, Emergency Animal Disease Response Agreement

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Consultative Committee on Emergency Animal Diseases (CCEAD)	The key technical coordinating body for animal health emergencies. Members are state and territory chief veterinary officers, representatives of CSIRO-ACDP and the relevant industries, and the Australian Chief Veterinary Officer as chair.
Control area (CA)	A legally declared area where the disease controls, including surveillance and movement controls, applied are of lesser intensity than those in a restricted area (the limits of a control area and the conditions applying to it can be varied during an incident according to need).
Cost-sharing arrangements	Arrangements agreed between governments (national and state/territory) and livestock industries for sharing the costs of emergency animal disease responses. *See also* Compensation, Emergency Animal Disease Response Agreement
Dangerous contact animal	A susceptible animal that has been designated as being exposed to other infected animals or potentially infectious products following tracing and epidemiological investigation.
Dangerous contact premises (DCP)	A premises, apart from an abattoir, knackery or milk processing plant (or other such facility) that, after investigation and based on a risk assessment, is considered to contain a susceptible animal(s) not showing clinical signs, but considered highly likely to contain an infected animal(s) and/or contaminated animal products, wastes or things that present an unacceptable risk to the response if the risk is not addressed, and that therefore requires action to address the risk.
Dangerous contact processing facility (DCPF)	An abattoir, knackery, milk processing plant or other such facility that, based on a risk assessment, appears highly likely to have received infected animals, or contaminated animal products, wastes or things, and that requires action to address the risk.
Declared area	A defined tract of land that is subjected to disease control restrictions under emergency animal disease legislation. There are two types of declared areas: restricted area and control area.
Decontamination	Includes all stages of cleaning and disinfection.
Depopulation	The removal of a host population from a particular area to control or prevent the spread of disease.

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Destroy (animals)	To kill animals humanely.
Disease agent	A general term for a transmissible organism or other factor that causes an infectious disease.
Disease Watch Hotline	24-hour freecall service for reporting suspected incidences of exotic diseases – 1800 675 888.
Disinfectant	A chemical used to destroy disease agents outside a living animal.
Disinfection	The application, after thorough cleansing, of procedures intended to destroy the infectious or parasitic agents of animal diseases, including zoonoses; applies to premises, vehicles and different objects that may have been directly or indirectly contaminated.
Disinsectisation	The destruction of insect pests, usually with a chemical agent.
Disposal	Sanitary removal of animal carcasses, animal products, materials and wastes by burial, burning or some other process so as to prevent the spread of disease.
Emergency animal disease	A disease that is (a) exotic to Australia or (b) a variant of an endemic disease or (c) a serious infectious disease of unknown or uncertain cause or (d) a severe outbreak of a known endemic disease, and that is considered to be of national significance with serious social or trade implications. *See also* Endemic animal disease, Exotic animal disease
Emergency Animal Disease Response Agreement	Agreement between the Australian and state/territory governments and livestock industries on the management of emergency animal disease responses. Provisions include participatory decision making, risk management, cost sharing, the use of appropriately trained personnel and existing standards such as AUSVETPLAN. *See also* Compensation, Cost-sharing arrangements
Endemic animal disease	A disease affecting animals (which may include humans) that is known to occur in Australia. *See also* Emergency animal disease, Exotic animal disease
Enterprise	*See* Risk enterprise

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Enzyme-linked immunosorbent assay (ELISA)	A serological test designed to detect and measure the presence of antibody or antigen in a sample. The test uses an enzyme reaction with a substrate to produce a colour change when antigen–antibody binding occurs.
Epidemiological investigation	An investigation to identify and qualify the risk factors associated with the disease. *See also* Veterinary investigation
Epidemiology	The study of disease in populations and of factors that determine its occurrence.
Exotic animal disease	A disease affecting animals (which may include humans) that does not normally occur in Australia. *See also* Emergency animal disease, Endemic animal disease
Exotic fauna/feral animals	See Wild animals
Fomites	Inanimate objects (eg boots, clothing, equipment, instruments, vehicles, crates, packaging) that can carry an infectious disease agent and may spread the disease through mechanical transmission.
General permit	A legal document that describes the requirements for movement of an animal (or group of animals), commodity or thing, for which permission may be granted without the need for direct interaction between the person moving the animal(s), commodity or thing and a government veterinarian or inspector. The permit may be completed via a webpage or in an approved place (such as a government office or commercial premises). A printed version of the permit must accompany the movement. The permit may impose preconditions and/or restrictions on movements. *See also* Special permit
In-contact animals	Animals that have had close contact with infected animals, such as noninfected animals in the same group as infected animals.
Incubation period	The period that elapses between the introduction of a pathogen into an animal and the first clinical signs of the disease.

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Index case	The first case of the disease to be diagnosed in a disease outbreak. *See also* Index property
Index property	The property on which the index case is found. *See also* Index case
Infected premises (IP)	A defined area (which may be all or part of a property) on which animals meeting the case definition are or were present, or the causative agent of the emergency animal disease is present, or there is a reasonable suspicion that either is present, and that the relevant chief veterinary officer or their delegate has declared to be an infected premises.
Local control centre	An emergency operations centre responsible for the command and control of field operations in a defined area.
Monitoring	Routine collection of data for assessing the health status of a population or the level of contamination of a site for remediation purposes. *See also* Surveillance
Movement control	Restrictions placed on the movement of animals, people and other things to prevent the spread of disease.
National Biosecurity Committee	A committee that was formally established under the Intergovernmental Agreement on Biosecurity (IGAB). The IGAB was signed on 13 January 2012, and signatories include all states and territories except Tasmania. The committee provides advice to the Agriculture Senior Officials Committee and the Agriculture Ministers' Forum on national biosecurity issues, and on the IGAB.
National Management Group (NMG)	A group established to approve (or not approve) the invoking of cost sharing under the Emergency Animal Disease Response Agreement. NMG members are the Secretary of the Australian Government Department of Agriculture, Water and the Environment as chair; the chief executive officers of the state and territory government parties; and the president (or analogous officer) of each of the relevant industry parties.
Native wildlife	*See* Wild animals

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OIE Terrestrial Code	OIE *Terrestrial Animal Health Code*. Describes standards for safe international trade in animals and animal products. Revised annually and published on the internet at: www.oie.int/international-standard-setting/terrestrial-code/access-online.
OIE Terrestrial Manual	OIE *Manual of diagnostic tests and vaccines for terrestrial animals*. Describes standards for laboratory diagnostic tests, and the production and control of biological products (principally vaccines). The current edition is published on the internet at: www.oie.int/en/standard-setting/terrestrial-manual/access-online.
Operational procedures	Detailed instructions for carrying out specific disease control activities, such as disposal, destruction, decontamination and valuation.
Outside area (OA)	The area of Australia outside the declared (control and restricted) areas.
Owner	Person responsible for a premises (includes an agent of the owner, such as a manager or other controlling officer).
Polymerase chain reaction (PCR)	A method of amplifying and analysing DNA sequences that can be used to detect the presence of viral DNA.
Premises	A tract of land including its buildings, or a separate farm or facility that is maintained by a single set of services and personnel.
Premises of relevance (POR)	A premises in a control area that contains a live susceptible animal(s) but is not considered at the time of classification to be an infected premises, suspect premises, trace premises, dangerous contact premises or dangerous contact processing facility.
Prevalence	The proportion (or percentage) of animals in a particular population affected by a particular disease (or infection or positive antibody titre) at a given point in time.
Proof of freedom	Reaching a point following an outbreak and post-outbreak surveillance when freedom from the disease can be claimed with a reasonable level of statistical confidence.
Quarantine	Legally enforceable requirement that prevents or minimises spread of pests and disease agents by controlling the movement of animals, persons or things.

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Resolved premises (RP)	An infected premises, dangerous contact premises or dangerous contact processing facility that has completed the required control measures, and is subject to the procedures and restrictions appropriate to the area in which it is located.
Restricted area (RA)	A relatively small legally declared area around infected premises and dangerous contact premises that is subject to disease controls, including intense surveillance and movement controls.
Risk enterprise	A defined livestock or related enterprise that is potentially a major source of infection for many other premises. Includes intensive piggeries, feedlots, abattoirs, knackeries, saleyards, calf scales, milk factories, tanneries, skin sheds, game meat establishments, cold stores, artificial insemination centres, veterinary laboratories and hospitals, road and rail freight depots, showgrounds, field days, weighbridges and garbage depots.
Sensitivity	The proportion of truly positive units that are correctly identified as positive by a test. *See also* Specificity
Sentinel animal	Animal of known health status that is monitored to detect the presence of a specific disease agent.
Seroconversion	The appearance in the blood serum of antibodies (as determined by a serology test) following vaccination or natural exposure to a disease agent.
Serosurveillance	Surveillance of an animal population by testing serum samples for the presence of antibodies to disease agents.
Serotype	A subgroup of microorganisms identified by the antigens carried (as determined by a serology test).
Serum neutralisation test	A serological test to detect and measure the presence of antibody in a sample. Antibody in serum is serially diluted to detect the highest dilution that neutralises a standard amount of antigen. The neutralising antibody titre is given as the reciprocal of this dilution.
Slaughter	The humane killing of an animal for meat for human consumption.

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Special permit	A legal document that describes the requirements for movement of an animal (or group of animals), commodity or thing, for which the person moving the animal(s), commodity or thing must obtain prior written permission from the relevant government veterinarian or inspector. A printed version of the permit must accompany the movement. The permit may impose preconditions and/or restrictions on movements. *See also* General permit
Specificity	The proportion of truly negative units that are correctly identified as negative by a test. *See also* Sensitivity
Stamping out	The strategy of eliminating infection from premises through the destruction of animals in accordance with the particular AUSVETPLAN manual, and in a manner that permits appropriate disposal of carcasses and decontamination of the site.
State coordination centre	The emergency operations centre that directs the disease control operations to be undertaken in a state or territory.
Surveillance	A systematic program of investigation designed to establish the presence, extent or absence of a disease, or of infection or contamination with the causative organism. It includes the examination of animals for clinical signs, antibodies or the causative organism.
Susceptible animals	Animals that can be infected with a particular disease.
Suspect animal	An animal that may have been exposed to an emergency disease such that its quarantine and intensive surveillance, but not pre-emptive slaughter, is warranted. or An animal not known to have been exposed to a disease agent but showing clinical signs requiring differential diagnosis.
Suspect premises (SP)	Temporary classification of a premises that contains a susceptible animal(s) not known to have been exposed to the disease agent but showing clinical signs similar to the case definition, and that therefore requires investigation(s).

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Swill Also known as 'prohibited pig feed', material of mammalian origin, or any substance that has come in contact with this material; it does not include:

- milk, milk products or milk byproducts, either of Australian provenance or legally imported for stockfeed use into Australia
- material containing flesh, bones, blood, offal or mammal carcases that is treated by an approved process1
- a carcass or part of a domestic pig, born and raised on the property on which the pig or pigs that are administered the part are held, that is administered for therapeutic purposes in accordance with the written instructions of a veterinary practitioner
- material used under an individual and defined-period permit issued by a jurisdiction for the purposes of research or baiting.

Refer to jurisdictional legislation for approved processes. Jurisdictions may have approved processes that meet the following minimum standards:

- rendering in accordance with the Australian Standard for the Hygienic Rendering of Animal Products
- under jurisdictional permit, cooking processes subject to compliance verification that ensure that an internal temperature of at least 100 °C for a minimum of 30 minutes, or equivalent, has been reached
- treatment of cooking oil that has been used for cooking in Australia, in accordance with the National Standard for Recycling of Used Cooking Fats and Oils Intended for Animal Feeds
- under jurisdictional permit, any other nationally agreed process approved by the Animal Health Committee for which an acceptable risk assessment has been undertaken and that is subject to compliance verification.

This definition was endorsed by the Agriculture Ministers' Council through AGMIN OOS 04/2014.

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Swill feeding	Also known as 'feeding prohibited pig feed', it includes: • feeding, or allowing or directing another person to feed, prohibited pig feed to a pig • allowing a pig to have access to prohibited pig feed • the collection and storage or possession of prohibited pig feed on a premises where one or more pigs are kept • supplying to another person prohibited pig feed that the supplier knows is for feeding to any pig. This definition was endorsed by the Agriculture Ministers' Council through AGMIN OOS 04/2014.
Trace premises (TP)	Temporary classification of a premises that contains susceptible animal(s) that tracing indicates may have been exposed to the disease agent, or contains contaminated animal products, wastes or things, and that requires investigation(s).
Tracing	The process of locating animals, people or other items that may be implicated in the spread of disease, so that appropriate action can be taken.
Unknown status premises (UP)	A premises within a declared area where the current presence of susceptible animals and/or risk products, wastes or things is unknown.
Vaccination	Inoculation of individuals with a vaccine to provide active immunity.
Vaccine	A substance used to stimulate immunity against one or several disease-causing agents to provide protection or to reduce the effects of the disease. A vaccine is prepared from the causative agent of a disease, its products or a synthetic substitute, which is treated to act as an antigen without inducing the disease.
– adjuvanted	A vaccine in which one or several disease-causing agents are combined with an adjuvant (a substance that increases the immune response).
– attenuated	A vaccine prepared from infective or 'live' microbes that are less pathogenic but retain their ability to induce protective immunity.
– gene deleted	An attenuated or inactivated vaccine in which genes for non-essential surface glycoproteins have been removed by genetic engineering. This provides a useful immunological marker for the vaccine virus compared with the wild virus.

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– inactivated	A vaccine prepared from a virus that has been inactivated ('killed') by chemical or physical treatment.
– recombinant	A vaccine produced from virus that has been genetically engineered to contain only selected genes, including those causing the immunogenic effect.
Vector	A living organism (frequently an arthropod) that transmits an infectious agent from one host to another. A biological vector is one in which the infectious agent must develop or multiply before becoming infective to a recipient host. A mechanical vector is one that transmits an infectious agent from one host to another but is not essential to the lifecycle of the agent.
Veterinary investigation	An investigation of the diagnosis, pathology and epidemiology of the disease. *See also* Epidemiological investigation
Viraemia	The presence of viruses in the blood.
Wild animals	
– native wildlife	Animals that are indigenous to Australia and may be susceptible to emergency animal diseases (eg bats, dingoes, marsupials).
– feral animals	Animals of domestic species that are not confined or under control (eg cats, horses, pigs).
– exotic fauna	Nondomestic animal species that are not indigenous to Australia (eg foxes).
Wool	Sheep wool.
Zero susceptible species premises (ZP)	A premises that does not contain any susceptible animals or risk products, wastes or things.
Zoning	The process of defining, implementing and maintaining a disease-free or infected area in accordance with OIE guidelines, based on geopolitical and/or physical boundaries and surveillance, to facilitate disease control and/or trade.
Zoonosis	A disease of animals that can be transmitted to humans.

Abbreviations

Disease-specific terms

SIT	sterile insect technique
SWF	screw-worm fly
UV	ultraviolet

Standard AUSVETPLAN abbreviations

ACDP	Australian Centre for Disease Preparedness
AN	assessed negative
ARP	at-risk premises
AUSVETPLAN	Australian Veterinary Emergency Plan
CA	control area
CCEAD	Consultative Committee on Emergency Animal Diseases
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CVO	chief veterinary officer
DCP	dangerous contact premises
DCPF	dangerous contact processing facility
EAD	emergency animal disease
EADRA	Emergency Animal Disease Response Agreement

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EADRP	Emergency Animal Disease Response Plan
EDTA	ethylenediaminetetraacetic acid (anticoagulant for whole blood)
ELISA	enzyme-linked immunosorbent assay
GP	general permit
IETS	International Embryo Transfer Society
IP	infected premises
LCC	local control centre
NMG	National Management Group
OA	outside area
OIE	World Organisation for Animal Health
PCR	polymerase chain reaction
POR	premises of relevance
RA	restricted area
RP	resolved premises
SCC	state coordination centre
SP	suspect premises
SpP	special permit
TP	trace premises
UP	unknown status premises
ZP	zero susceptible stock premises

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