QUEENSLAND FRUIT FLY ERADICATION PROGRAMME

Proposed by the WA Department of Agriculture

Report and Recommendations of the Environmental Protection Authority

Environmental Protection Authority
Perth, Western Australia
Bulletin 400 August 1989

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Summary and Recommendations

Western Australia is currently infested by two introduced species of tephritid fruit flies. The Mediterranean fruit fly (*Ceratitis capitata*) has been in WA since the early 1900's and is widespread throughout the southwest of the state. The Queensland fruit fly (*Bactrocera tryoni*) was first detected in Dalkeith in February 1989. The current infestation of Queensland fruit fly is the first of this species in WA, and it has spread throughout a 100 km^2 area of the metropolitan region shown in Figure 1. Queensland fruit fly is a more efficient pest than the Mediterranean fruit fly because of greater mobility, greater reproductive capacity, and a wider range of target fruit and vegetable species.

The WA Department of Agriculture states that state-wide infestations of Queensland fruit fly would severely disadvantage the State's fruit growing industry, and would require considerable, ongoing chemical intervention to ensure unaffected fruit. The Department also states that environmental impacts likely to arise from chemical treatment of state-wide infestations of Queensland fruit fly would be significantly greater and more wide-spread than those likely to arise from the proposed eradication programme.

An intensive ten-month programme aimed at total eradication of the limited infestation of Queensland fruit fly in the Perth metropolitan area is therefore proposed by the Western Australian Department of Agriculture. The proposed eradication programme is based on baits formulated with either male only or combined male and female lures and containing between 1 and 2 g of the insecticide malathion, followed by a strategic release of sterile male fruit flies. Urgent implementation of the eradication programme is proposed to avoid the spread of this pest to the major fruit growing areas of southwest Western Australia. The Mediterranean fruit fly was successfully eradicated from the Carnarvon area in 1986 using a similar programme based on protein baiting and sterile male release. There were no reported negative environmental impacts arising from this programme. Similar programmes have been undertaken in New South Wales, South Australia and overseas.

Department of Agriculture entomologists propose that there is little chance of accidental poisoning of children or household pets during the proposed baiting programme. This is because the malathion insecticide will be either impregnated into small caneite blocks nailed high in the canopy of selected trees or it will be mixed with protein attractant (10 g/l) and 100 ml of the mixture squirted into the foliage of fruiting trees. Because of the method of application and the low mammalian toxicity of malathion, it is considered highly improbable that enough malathion could be ingested to cause adverse effects. Birds or beneficial insect species are not likely to be attracted to the malathion baits which are designed to attract only fruit flies.

Depending on the degree of success of the proposed baiting programme, the Department of Agriculture may want to spray the ground beneath heavily infested fruit trees in isolated 'hot-spots' with another insecticide. This measure is not included in the proposed programme, and if required, will be the subject of a separate proposal in early 1990 which will require further assessment by the Environmental Protection Authority.

The Department of Agriculture intend to comprehensively monitor the progress, including location of baits, amount of chemical (malathion) used, fruit fly population dynamics and householder reaction to the programme.

The Environmental Protection Authority concludes that the Queensland fruit fly eradication programme described in the WA Department of Agriculture Notice of intent is environmentally acceptable.

The Environmental Protection Authority therefore recommends that;

1 **The proposed Queensland fruit fly eradication programme, as described in the WA Department of Agriculture Notice of Intent, may begin immediately.**

2 **Regular reporting of the effectiveness of the programme in controlling Queensland fruit fly, and any adverse impacts of the programme on the environment, be made to the Authority in a form suitable for public release.**

1 Introduction

A breeding population of the Queensland fruit fly (*Bactrocera tryoni*) was discovered in Dalkeith in February 1989. Entomologists from the WA Department of Agriculture immediately initiated an extensive trapping programme to determine the geographic distribution of the invading population. Queensland fruit flies have been detected in an area covering about 100 km^2, centred on the suburbs of Nedlands and Dalkeith (Figure 1).

Western Australia is also infested by the Mediterranean fruit fly (*Ceratitis capitata*), which has been in WA since the early 1900's. The Mediterranean fruit fly is widespread throughout the southwest of the State and was successfully eradicated from the Carnarvon area in 1986 using a programme based on protein baiting and sterile male release. There were no reported adverse environmental impacts arising from this programme.

The current infestation of Queensland fruit flies is the first in WA and it has spread rapidly throughout the metropolitan area. Entomologists from the WA Department of Agriculture believe that the Queensland fruit fly will cause considerable economic damage to the State's fruit and vegetable growing industries, as well as to home gardeners, if left unchecked. If the Queensland fruit fly population is allowed to multiply through another summer without stringent measures being taken against it, eradication will certainly become more difficult and expensive, and hence probably impractical (Bateman 1989).

The WA Department of Agriculture engaged the services of Dr A Bateman, a consultant with considerable experience in fruit fly control in the Eastern States of Australia, to prepare a management programme aimed at complete eradication of the Queensland fruit fly infestation in an environmentally acceptable manner. The proposed programme is based on Bateman's report to the WA Department of Agriculture.

2 Ecology of the Queensland fruit fly

Queensland fruit flies lay their eggs in small groups just below the skins of fruit and some vegetable species. When the larvae hatch, they often make their way to the centre of the fruit. Their feeding, and the rotting action of organisms introduced when the eggs are deposited, soon destroy the fruit. Fruit fly larvae are often referred to as maggots and are typically creamy-white in colour, 7-9 mm long and taper towards the head (McMaugh 1985).

When fully grown, the larvae leave the fruit and burrow into the soil beneath the tree where they pupate. The brown pupal cases are about 5 mm long. Females are capable of laying eggs about one week after emergence and may live for many weeks. Normally, females are capable of laying fertile eggs for life after a single mating. The flies commonly overwinter in the adult form and become active in the warmer months.

Queensland fruit fly is a more efficient pest than the Mediterranean fruit fly because of its greater mobility, greater reproductive capacity, and a wider range of target fruit and vegetable species (Bateman 1989). Target species for the Queensland fruit fly include apples, avocados, bananas, capsicum, citrus, egg fruit, feijoas, figs, grapes, guavas, loquats, olives, passionfruit, persimmons, quinces, stonefruit, tomatoes and walnuts (McMaugh 1985).

3 The proposed control programme

The proposed control programme involves an initial reduction of the male fly population using baits, followed by a further baiting programme to attract and eliminate both sexes. The third phase of the programme will involve the release of sterile male flies.

3.1 The male control programme

This involves the use of a 50 mm by 50 mm block of caneite which has been soaked in a male sex attractant (cuelure) and around 2 g of the insecticide malathion. Male Queensland fruit flies are avidly attracted to the odour of the cuelure and are killed when they come into contact with the insecticide in the caneite block. This formulation is expected to remain active for up to 6 months.

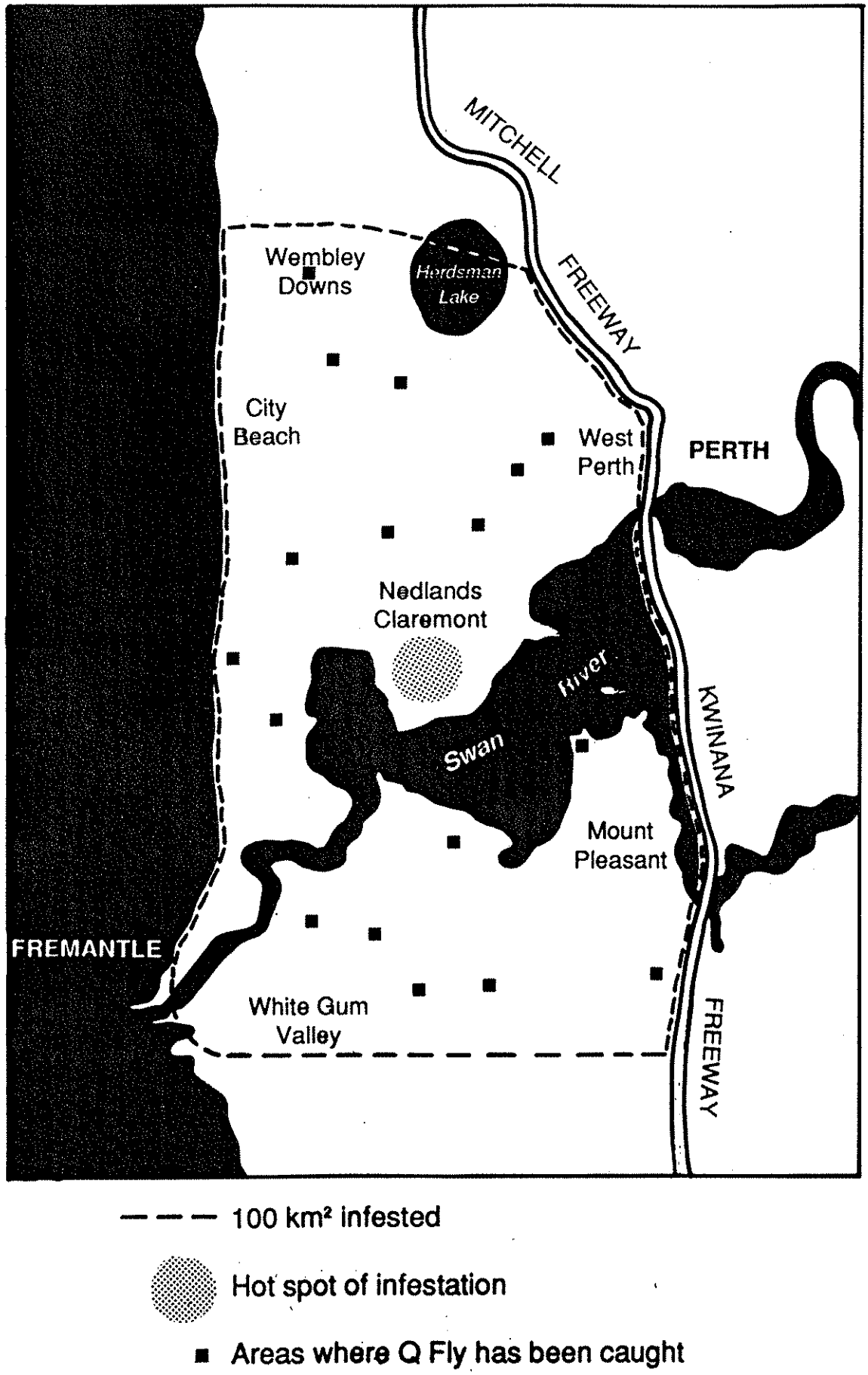

Figure 1 Geographic distribution of Queensland fruit fly in the Perth area

This part of the programme will begin at the end of August. The impregnated caneite blocks will be nailed in selected trees throughout the infested area beginning at the end of August.

3.2 The protein baiting programme

Adult Queensland fruit flies, male and female, young and old, are attracted to the odour of hydrolysed protein preparations. Effective baits consisting of hydrolysed protein and malathion (10 g malathion / litre) can be squirted into the foliage of fruit trees. Ripe and ripening fruit on trees attract the fruit flies into the treated foliage where they are killed by the insecticide in the bait.

This part of the programme will require the squirting of 100 ml of the protein / malathion bait into the foliage of all fruiting trees in the infected area weekly from September 1989 to early February 1990.

3.3 The sterile male release programme

If developing fruit fly pupae are subjected to a short burst of gamma radiation 7-8 days after pupation, the developing gonads are rendered sterile and unable to produce viable gametes in the sexually mature fruit flies. A radiation dose three times that required to sterilize females is required for the complete sterilization of male fruit flies. This ensures that no fertile female fruit flies are released with the sterile males. Any sterile females released during this phase of the programme would help to draw off fertile wild males, and any resulting matings would also fail to produce viable offspring.

This part of the programme involves the release of around 30 million sterile male Queensland fruit flies per week from February 1990 until June 1990.

Female Queensland fruit flies normally mate only once. Large numbers of sterile males will overwhelm the 'wild' fertile male population which would have been severely depleted by the male control (cuelure / malathion) programme. Entomologists from the WA Department of Agriculture believe that this, combined with the protein baiting, should result in complete eradication of the invading Queensland fruit fly population.

3.4 The ecotoxicology of malathion

Malathion is a non-systemic insecticide and acaricide of low mammalian toxicity and brief to moderate persistence. It is generally non-phytotoxic, but may damage some vegetables under glasshouse conditions if sprayed on leaves. It is used to control household insects, animal ectoparasites, and human head and body lice. Table 1 summarizes some of the common uses of malathion. Information on chlorpyrifos and the organochlorine heptachlor are included for comparison.

It can be seen from the acute toxicities (LD_{50}'s) given in Table 1, that malathion is considerably less acutely toxic than some other insecticides. The ratio of malathion and chlorpyrifos LD_{50}'s is 20.7. This means that the amount of chlorpyrifos needed to kill a rat is twenty times lower than the amount of malathion needed to do the same thing. Malathion is much less toxic than chlorpyrifos to mammals.

If ingested by vertebrates, malathion is broken down by metabolic pathways similar to those that deal with other organophosphate insecticides. Malathion and its metabolite malaoxon are rapidly detoxified by esterases in the liver and in other organs. This rapid metabolism is the apparent reason for the lower toxicity of malathion compared with that of other organophosphate insecticides such as chlorpyrifos and diazinon.

Excretion of absorbed malathion is prompt. While it may appear in the urine within a few hours of ingestion, over 90% is eliminated from the body within 24 hours. Excretion is mainly via the urine and partly in the faeces and a little is exhaled as carbon dioxide.

Organochlorine insecticides, such as heptachlor, dieldrin, DDT and chlordane, have been banned for all external uses in Western Australia because of their toxicity, their ability to be stored and accumulate in fatty animal tissues, and their high environmental persistence. Malathion does not accumulate (it is non-bioaccumulative) in the body organs or fatty tissues of animals, and is readily hydrolysed to nontoxic compounds in the environment.

Table 1 The toxicity and common uses of the insecticide malathion. Data for chlorpyrifos and heptachlor are included for comparison.

Insecticide	Mammalian Acute toxicity LD_{50}[a] (mg/kg)	Mammalian Dermal toxicity LD_{50} (mg/kg)	Trade name	Use	Amount of chemical in typical application
Malathion (Maldison)	2800	4100	Malaban (200g/l)	Fleas and lice on dogs & cats	3g/l
			Maldison 500 (500g/l)	Vegetable insect control	1g/l
			Maldison grain control (20 g/kg)	Weevil control in stored grain	0.012 g/kg
			Deltawest headlice lotion	Headlice control on humans	5 g/l
			Hy-Mal (1150 g/l)	Male fruitfly lures Protein baits	1.6 g/block 1 g/tree (10 g/l)
Chlorpyrifos	135-163	2000	Chlorpyrifos 500 EC (500 g/l)	Insect control on vegetables	0.75 to 1 g/l
			Dursban PC (500 g/l)	Termite control	10 to 20 g/l
			Redlice cattle control (500 g/l)	Lice control on animals	1.5 g/kg body weight
			Chlorpyrifos 500 EC (500 g/l)	Fruitfly control (ground spray) Not currently proposed	0.9 g/l
Heptachlor	100-162	195-250	now banned	for external use	

LD_{50}[a] = The lethal dose of chemical required to kill 50% of the test rats, expressed as milligrams (mg) of chemical per kilogram (kg) of body weight.

LD_{50} data from The Pesticide Manual (1979)

4 Public review

Because of the urgency of the programme, the Minister for Environment, under Section 6 of the Environmental Protection Act, sought the approval of the Governor to waive certain appeals rights on the Authority's assessment report. Instead, the Authority directed that the Department of Agriculture hold a public information day on the 22nd of August, following wide advertisement of the event. A total of 148 people attended the information day, seeking further information and commenting on the proposed programme.

The majority of people were strongly in favour of the programme and many were concerned that it was not extensive enough. Two people expressed concern about the use of chemicals in the programme. Several expressed concern about access to backyards and the possibility of physical damage to plants and property from the programme, and several others were concerned that children, pets or bees might be accidentally poisoned. Table 2 summarises opinions in favour of the programme. Opinions against the programme are summarised in Table 3. Comments were sought from Department of Agriculture and Health Department officers to address the public concerns.

Table 2 Summary of opinions in favour of the proposed programme

Concern:	Householders outside the target area wish to be included in the proposed fruit fly eradication programme.
Comment:	The proposed programme is aimed at eradicating the current infestation of Queensland fruit fly. The programme will include comprehensive monitoring of Queensland fruit fly numbers and distribution. The programme will be modified if the geographic distribution of the population is wider than that currently identified.
Concern:	The programme should be extended to include eradication of Mediterranean fruit fly.
Comment:	The current programme aimed at eradicating Queensland fruit fly from 100 km^2 of the Perth metropolitan area will cost in excess of $5 million. The cost of eradicating Mediterranean fruit fly from the entire south west of the state would be prohibitive.
Concern:	Will the Government make subsidised pesticides available so that members of the public can assist the Department of Agriculture in the eradication programme?
Comment:	A coordinated programme by a single Government agency is considered to be the most environmentally acceptable means of eradication.
Concern:	What can householders do to assist the Department of Agriculture in the programme?
Comment:	Literature will be produced and made widely available by the Department of Agriculture to inform householders of the programme and how they can be of assistance.

Table 3 Summary of opinions against the proposed programme

Concern:	People may be hypersensitive to malathion and may be exposed during the programme, especially if treated fruit trees are in close proximity to dwellings. Will any steps be taken to identify those people who may be hypersensitive to malathion prior to commencement of the programme?
Comment:	Malathion in the proposed bait formulations will not be particularly volatile. This means that airborne concentrations during the baiting programme are likely to be well below the limits of detection. The programme will rely on the use of sex attractants, protein hydrolysate preparation and ripening fruit to attract fruit flies to the localized areas of insecticide. There are no established links between possible hypersensitivity to malathion and other medical conditions. It would be extremely difficult to predict those in the population (if any) who are likely to be hypersensitive to malathion used in this manner.
Concern:	Two people expressed concern about the use of chemicals in the programme, and several people expressed concern about children or pets being affected following contact with the baits.
Comment:	The proposed programme is designed to ensure that there is little likelihood of accidental contact with the insecticide malathion contained in the baits. In addition, malathion has a low mammalian toxicity.
Concern:	Has there been any consideration of alternative chemicals or trapping mechanisms?
Comment:	The proposed programme is based on the latest knowledge of the biology of Queensland fruit fly and control techniques. There are no known cheap, effective, environmentally acceptable alternatives. There is not enough time available to fully assess possible alternative control measures brought to the attention of entomologists during the information day, as the programme must commence immediately if eradication is to be achieved.
Concern:	Will the programme be effective if inaccessibility of backyards means that full coverage of dwellings is not possible?
Comment:	Queensland fruit flies are mobile and able to cover several domestic backyards. This means that there is a high probability of contact between flies and baits even with a coverage slightly below 100%. The sterile males will actively seek out fertile wild females. However, there will need to be a high degree of public cooperation to ensure the success of the the programme.
Concern:	Will honey bees be attracted to the baits and killed?
Comment:	The cuelure baits are highly specific to male Queensland fruit flies and the protein hydrolysate baits are not likely to attract important beneficial insects, such as honey bees.
Concern:	Will the baiting programme attract Mediterranean fruit flies and house flies into the treated area?
Comment:	The protein hydrolysate bait will attract the Mediterranean fruit fly and some other species of flies and there is a strong possibility that these species will also be killed by the poisoned bait. It is unlikely that significant numbers of flies and fruit flies from outside the treated area will move into the area during the baiting programme. There may be some movement of Mediterranean fruit flies and other flies into the area subsequent to the eradication programme.
Concern:	Steps should be taken to ensure that there is minimal physical damage to property, pets and plants during the eradication programme.
Comment:	Staff carrying out the programme will be alerted to these concerns and due care will be exercised.

5 Environmental impacts

Because of the low environmental persistence and low mammalian toxicity of malathion and the inaccessibility of the baits to be used, there is little likelihood of adverse environmental impacts from the use of malathion in the proposed programme.

5.1 The male control programme

In the male annihilation programme, small caneite blocks will be impregnated with about 2 g of malathion and the cuelure male attractant. The bait blocks will be nailed into the upper canopy of selected trees, well out of reach of children. There may be some leaching of malathion out of the caneite blocks, but this will be minor. It is improbable that a child, bird or small pet could physically destroy and ingest the caneite block containing 2 g of malathion. There are many reports in the medical literature relating to children and adults surviving ingestion of similar doses of malathion after energetic medical intervention (Psaila-Savona *personal communication*). Because of the toughness and inaccessibility of the impregnated caneite block, accidental poisoning is highly unlikely, however.

Because the cuelure attractant is highly specific to male Queensland fruit flies, entomologists from the WA Department of Agriculture believe that is unlikely that other insects would be attracted to this bait. Cuelure is ineffective for attracting male Mediterranean fruit flies.

5.2 The protein baiting programme

Around 100 ml of protein hydrolysate / malathion bait (10 g malathion/litre) will be squirted into the foliage of fruiting trees at weekly intervals from September 1989 to early February 1989. This equates to one gram of malathion per fruiting tree per week. There may be some leaching of malathion from the foliage during rainfall, or watering, but this is not likely to be environmentally significant. Any malathion reaching the ground should be rapidly hydrolysed to non-toxic compounds. There is little chance of humans or pets coming in contact with malathion in the bait sprays. Domestic cats may be able to climb and lick treated foliage, but the bait mixture is not particularly palatable, and a damaging dose of malathion would be virtually impossible to pick up in this manner.

The protein hydrolysate bait is not as specific to Queensland fruit flies as the cuelure bait block. This means that other insect species may be attracted to the treated foliage and be killed. These species include Mediterranean fruit flies and other dipteran flies, of which blowflies are the most common.

Malathion is highly toxic to honey bees, but entomologists from the Department of Agriculture believe that bees and other beneficial insects, such as ladybirds and predatory mites, will not be attracted to the protein baits.

5.3 The sterile male release programme

The sterile males to be released during the programme do not contain radioactive substances, and because they are unable to reproduce, will simply die some time later. Significant environmental impacts will not occur from this part of the programme.

6 References

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7 Acknowledgements

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Members of the public who attended the Forum in Nedlands on Tuesday 22nd of August.