Benefit Cost Analysis of Mediterranean Fruit Fly Management Options in Western Australia

Report on the benefits, costs and probability of success of eradication and suppression options for control

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1. Introduction

1.1. The report

This report sets out a benefit/cost analysis (BCA) for the eradication or management of the Mediterranean fruit fly in Western Australia. It draws upon plans and experience within Agriculture Western Australia for an eradication based on sterile insect technique. The BCA has also drawn upon surveys and statistical collection within Western Australia and experience in international fruit fly management programmes. The BCA establishes a framework for the consideration of likely economic consequences of Medfly eradication over a twenty year period in both Western Australia and throughout Australia as a whole. The output of the analysis informs, but does not prescribe, decisions to be made about eradication or management of this pest.

Three spreadsheets accompany this report:

- Data report
- BCA framework
- Sensitivity report on CrystalBall output on uncertain variables within the model

The analysis indicates a just positive return of A$0.261 million over a 20 year period assuming a six year phased eradication programme across the state from the southwest, with no decline or increase in the horticultural area during this time. Several key variables make the result very sensitive to assumptions about both costs and benefits, some of which can be validated by field or grower surveys.

1.2. Background

The Mediterranean fruit fly (referred to throughout this report as Medfly), *Ceratitis capitata*, was introduced into Western Australia about 100 years ago and soon spread through out the country. With the spread of native Queensland fruit fly in the 1920s and 30s, the Medfly disappeared in the eastern states. It is now limited to Western Australia's towns and fruit growing areas, essentially the coastal zone, with occasional incursions into irrigated growing plots located in the extensive "buffer zone" of inhospitable land dividing the West from the East of Australia (Smith, 2000a). This buffer zone and the limited number of road and rail transport routes reduces the probability of spread to other parts of Australia, although casual fruit transport appears to be the cause of frequent outbreaks in South Australia. During 2000/2001 South Australia has been controlling six Medfly outbreaks, all thought to originate from Western Australian produce.

The Medfly currently is not established in any other location between Hawaii and Iraq. The presence of Medfly in the state of Western Australia (WA) causes some restrictions on exports of fruit fly hosts to other countries and to other states in Australia, costs of on -going control in production areas with greater infestations and losses in backyard garden fruit production. Environmental impacts from the current management are of increasing concern, as are pesticide residues on fruit exported to some key markets. Because of these costs and their strategic objectives to increase exports (AgWest 1997), Agriculture Western Australia sought an independent analysis of the benefits and costs of other management options, specifically of eradication of Medfly from WA. A committee of Western Australian government officials and growers was set up to evaluate the tender and review the report on the conclusion of the study. This analysis was conducted by a team from Imperial College, London, and the University of Western Australia, with support from various AgWest, Commonwealth and other State officials. A list of team members appears as Appendix IV.

This report provides an account of the Benefit Cost Analysis (BCA) of Medfly management options, including consideration of eradication or suppression in place of current management by individual growers and some towns. Key points are summarised in bullet form at the end of this report. Spreadsheets of data collected and various options accompany the report (Appendix I). The headings in the report relate to key areas of the terms of reference.

2. Experience from the pilot eradication programme at Broome

Prior to the contracting of a BCA, the AgWest conducted a small-scale pilot eradication programme to discover the technical and operational feasibility of a sterile insect technique[1] programme in the Western Australian context. The programme, which took place at Broome, was a qualified success and has proved invaluable in highlighting a number of issues that will need to be addressed should AgWest choose to implement a full-scale eradication programme. An assessment of the programme was made by two independent experts during May 2000 (Perepelicia and Smith, 2000) and should be referred to for further comments and information.

2.1 Preparation prior to SIT

Most Medfly sterile insect technique (SIT) programmes use an intensive chemical control operation prior to the fly release to reduce the Medfly population and provide a more favourable ratio of sterile/wild flies. The pilot programme was unusual in that no chemical control was used to make the sterile male release treatment more effective. However, results supplied by the manager, Bill Woods, suggest that eradication could have been achieved with the continued release of flies. The programme ended early due to lack of funds.

2.2 Production of sterile Medflies

The production facility appears to be well run and has easily been capable of supplying the 3 million male pupae per week required for the pilot program. The facility should be capable of producing 15 million fruit flies per week or possibly 20 million. It is very unlikely that a level of 50 million referred to in the report by Perepelicia and Smith (2000) could ever be reached using this facility. The facility is not large enough to produce sufficient flies to treat

[1] The sterile insect technique consists of the mass introduction of laboratory-reared males of the target species that have been sterilised using gamma radiation. The introduction of these sterile males into the infested area is for the purpose of mating with the "wild" insects which, because of the sterilisation, leads to population decreases until eradication is achieved.

the Perth Metropolitan area and would either need to be extended or additional flies could be sourced from other countries such as Guatemala.

During the course of the pilot programme the temperature sensitive lethal (TSL) strain[2] imported to start this colony showed increased levels of female survival but this was brought under control by the use of the filter kept for such purposes. This is an important point since in other parts of the world levels of female production routinely top 25-30% and the facility staff have been unable to regain the low levels of female production required for an efficient facility. In WA, the level of female production after the use of the filter was down to about 0.5%.

2.3 Transportation and distribution of pupae

The transportation of flies from Perth to Broome was by air and was done using insulated containers to prevent overheating of the pupae during transit. This proved to be successful. Distribution of the flies was by truck and therefore was a series of point releases. Because access to properties is required to get complete coverage, distribution presented some problems. The preferred release method would be by air, a technology already well developed and used in many other programmes. Any future programme should use aerial release in preference to ground releases since it gives better and faster distribution of the flies.

2.4 Trapping and monitoring

The trapping grid adopted in Broome and nearby towns (400m grid) and in the surrounding areas (1km grid) should have been adequate to detect and monitor the presence and relative abundance of Medfly in the programme area. There is no reason to believe that the information gathered from this network does not give a true picture on the dynamics of the fly populations throughout the pilot programme.

The cyclone in mid-April 2000 presented some problems with foliage being stripped from the trap trees and making the traps less efficient. Alternative trap sites had to be found whilst maintaining the integrity of the trapping grid. This is obviously something to be noted for any further operations. Trap sites should be selected with "cyclone resistance" in mind.

2.5 Overall conclusions

The pilot programme against Medfly in Broome indicates that the expertise currently exists to manage and operate an eradication campaign against this pest. The quality of facility management appears to be very good and, with sufficient increases in personnel, could produce 15-20 million good quality sterile flies per week. The management appears to be in

[2] Temperature sensitive lethal strain of Medfly has been developed as a way of eliminating female flies as early as possible in the rearing process, as they are useless in the SIT programme. In this strain, females are far more sensitive to increased temperatures which are lethal to them, thus leaving a predominately male colony. (Hendrichs *et al*, 1995).

place and capable of dealing with the day to day running of the programme along with unusual events such as the cyclone.

Should eradication of Medfly using SIT be pursued there is no reason to suppose that it could not be carried out successfully with the present personnel forming the core of an enlarged campaign group. Area wide schemes of similar scale have been implemented and met with success in the USA and Chile. The alternative approach adopted in South Africa of treating for suppression on an area basis would also be a suitable model for Western Australia in areas of high density fruit planting.

3. A Benefit/cost model

3.1. Model framework

The principle of the benefit/cost analysis is to provide a model framework in which all costs and benefits applicable to the project can be catalogued over a given time period. The model needs to be flexible so that various management scenarios can be tested. The uncertainties associated with the inputs should be taken into account in the output.

It is apparent that an eradication of Medfly in an area as large as Western Australia would take several years in a series of zones. The model is therefore based on a concept of summing the individual costs and benefits across each zone allowing for a phased extension of the eradication across the state with a rolling quarantine to protect the eradication frontier as it progresses. The key considerations within each zone affecting costs and benefits are the total areas to be treated and the values of losses that would be prevented with eradication. The zone boundaries have been selected based on:

- similarity of climate (which relates to Medfly threat)
- a phased increase in treated area to build up expertise and capacity
- a maximum annual area to treat of 1000 km^2
- a phased decrease in treated area as the programme winds down through lower risk areas to maintain capacity in the event of renewed outbreaks in any fly-free areas
- local government areas as a basis of both statistics and management

3.2. Estimating the base Medfly population and area for management

Potential area requiring treatment

The area that *could* contain Medflies is very large and has been estimated at about 1,104,000 km^2 (Fisher *et al*, 1994). However, a large proportion of this area is unsuitable for Medfly since it contains no known hosts, only native plants. No native plants have been observed to support Medfly. Before a major programme, confirmatory studies may be worthwhile for wild black berries or quandong (*Santalum spp*) but there is no reason to consider them hosts at this time.

Fisher *et al*, (1994) estimated the Northern area of 500,000 km^2 to have “only” perhaps 100,000 km^2 potentially containing Medfly. This seems to be a very large area considering that the entire area of susceptible commercial crops grown in WA is only about 7,000 ha. In Broome the treated area was about 30 km^2 (3,000 ha) where the entire agricultural area is about 6,300 ha and the area of susceptible fruit grown is about 67 ha. It is difficult to know the exact extent of the area to be treated but using Fisher *et al.* estimates, a total area of about 200,000 km^2 would be involved. The entire Perth to Bunbury metropolitan area, about 12000 km^2, would require treatment due to the high number of backyard trees and the suitability of the area for Medfly survival.

A new assessment of the area likely to require treatment has been made using several sources: AgWest statistics on areas of host crops; remotely sensed land-use data from 1992-3 at 1 km^2 spatial resolution for urban areas and crop/woodland mosaic; riparian zones along rivers (1 km either side) derived from maps of year round rivercourses where fruit fly hosts might fruit year round; and urban areas estimated by reference to the average density of dwellings in the urban areas of Perth, Bunbury and Geraldton and the total number of dwellings for each Local Government Area (LGA) determined from the WA Municipal Directory 1998/1999. The composition of this total is shown in Table 1. Some ground survey of riverine and urban areas will need to be done before embarking on a fruit fly control programme to ensure accurate measurement of the areas with continual host fruits sufficient to support a Medfly population throughout the year.

			Area in square kilometres									
Zone	Risk	Risk weight	Stone	Pome	Citrus	Grapes	Other	All crop	Urban	Crop/ Wood	Riverine	All other
Esperance	Med	0.5	0.0	0.0	0.0	0.0	0.0	0.0	47.7	32.8	0.0	80.5
Albany	Med	0.5	0.0	0.1	0.0	5.7	0.0	5.8	63.2	1.5	0.0	64.7
Manjimup-Nannup	Low	0.1	0.2	4.8	0.1	10.0	0.1	15.2	53.5	3.3	187.5	244.3
Bunbury-Donnybrook	Med	0.5	1.1	9.1	2.2	1.7	0.7	14.8	258.3	0.3	128.8	387.3
Perth	High	1.0	1.9	3.0	1.5	14.4	0.8	21.6	950.0	0.3	3.0	953.3
Perth East	High	1.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	39.8	42.4
Geraldton	High	1.0	0.1	0.0	1.9	4.2	0.1	6.3	56.8	8.5	0.0	65.3
Midwest	High	1.0	0.0	0.0	0.4	0.4	3.0	3.8	46.9	0.0	0.0	46.9
North	Med	0.5	0.0	0.0	0.0	0.0	0.4	0.4	16.7	0.0	0.0	16.7
Total		6.1	3.3	17.0	6.1	36.4	5.1	67.9	1495.7	46.5	359.0	1901.3

Table 1. Land use areas in Western Australia. The urban areas from Perth south to Bunbury are the most difficult to determine exactly for planning control operations.

Appendix I sheet 2 includes a list of local government areas (LGAs) covered by each of the zones referred to in Table 1.

There were substantial discrepancies in the urban areas determined by satellite images and from the Municipal Directory entries. This may be because of rapid suburban growth, particularly to the south of Perth in the late 1990s or due to the failure of satellite images to distinguish relatively sparse suburban areas as truly urban. Within the urban areas not all land is likely to harbour Medfly, for instance large industrial areas, railway yards, docks, etc, or much forest land or grassland. Where large contiguous non-host areas exist they can be bypassed during control operations, reducing costs. The true urban area likely to be included in a management programme therefore will depend on a close examination of the type and distribution of land use within the urban zones. A range of values between 1000 and 1400 km^2 are used in the analysis to reflect this uncertainty. All of this variability in areas is confined to the outskirts of Perth, particularly to the south.

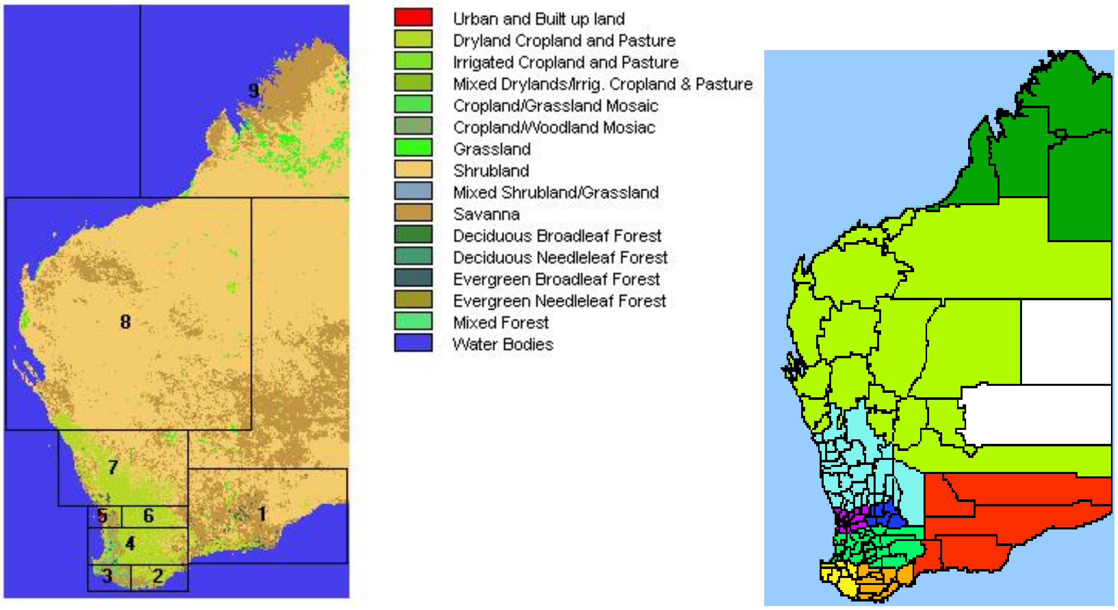
The Medfly risk ranking in Table 1 is based on altitude and latitude, in discussion with Bill Woods (AgWest Sr Entomologist).

In order to estimate the base Medfly population in this area, a trapping grid would be deployed throughout zones with known hosts of this pest. In order to get reliable information on both the prevalence and distribution of the pest it will be necessary to have a trapping grid of approximately 7.5 km. The operation and maintenance of such a grid will provide valuable experience in preparation for the operation of the much denser grid necessary to monitor the effectiveness of any control programme and the subsequent annihilation. Although the area for treatment is calculated at less than 2,000 km^2 the area with traps will exceed this to ensure that all areas are sampled. Missing infestations of Medfly at this stage would be costly in the long term.

The cost of deploying and running such a trapping grid over 25,000 km^2 would be approximately A$400,000 per year.

Figure 1. Maps showing land use details and zones referred to.

Zones	**Year for eradication**
1 Esperance	4
2 Albany	4
3 Manjimup-Nannup	3
4 Bunbury-Donnybrook	4
5 Perth	5/6
6 Perth East	5/6
7 Geraldton	7
8 Midwest	8
9 North	8



3.3. General plan for an eradication programme

Eradication would be undertaken over a number of years in a series of zones. Two years of preparation would be required to build or organise a source of sterile flies, during which surveys of the Medfly and host abundance in the zones would be done. Costings are based on two scenarios, a project starting in the southwest (Manjimup and surrounding area – see Appendix I sheet 2) and working north and east, and one starting in Perth and progressing south and north. While the Perth start gives slightly greater returns, a project starting in the southwest gives a more gradual build-up and better spread of effort and would be more likely to succeed.

The maps in Figure 1 indicate the zones and areas proposed in the project plan. These are based on local government areas (LGAs).

Each eradication zone would take one year to complete, apart from the Perth zone, which is assumed to take two years, being a large and potentially difficult urban zone.

3.4. Establishing and maintaining an insect production and sterilization facility

Local Production

The current facility is capable of producing a maximum of 20 million flies per week -- sufficient to provide approximately 12 million quality flies for release each week. This is sufficient to treat an area of 100km^2. There will be a requirement to produce or import substantially larger numbers of flies when the program is underway. Current production costs using the existing facility are approximately 0.2 cents (A$) per pupae, which does not include the capital cost of the factory.

If production were to be local then there would be a requirement to extend the existing facility or build a new one. A facility that could produce 300 million flies per week would cost approximately A$12.6 million to build. This figure is derived from the figures produced in the Fisher *et al* (1994) report. An inflation figure of 5% has been used to adjust the costs to the present day. Compared to the cost of flies produced by the current facility, those from a larger scale factory are significantly lower and reflect the economies of scale that can be made.

Costs of local production of sterile Medfly (per one million flies)

	Fisher *et al*	Current facility
Production & Irradiation	A$128	A$1940
Shipping & Release	A$140	A$1600
Total	A$268	A$3540

Table 2. Comparison of Medfly production costs locally: current pilot facility and proposed large-scale factory according to Fisher et al, 1994.

The cost of flies is very important to the economic assessment, as they are the greatest input overall. Larger scale production would undoubtedly reduce costs, but a factory would only be running at full capacity of around 120 million male Medfly for release per week for around four years, with smaller runs in the two years before and after the main eradication effort. Current large-scale production facilities in Guatemala produce flies at a cost of around US$400/million sterile males for release. A new proposed factory planned in Slovakia expects to sell flies at a similar price (InSecta Ltd communication, 2001). Given a short run of production it is unlikely that local production costs could be brought to such low levels, however if buildings and materials were reused for other purposes subsequently costs could be kept down.

It is envisaged that the eradication will progress on a zone by zone basis starting in the southwest and eradicating moving toward Perth and the north. A barrier zone of flies will be established to prevent re-infestation of the cleared areas By operating in this way the capital cost of the program can be kept low in the early part of the programme since relatively low numbers of flies will need to be released each week to treat the relatively small areas. The benefits will also be recouped earlier in this way since most of the fruit production is in the south and around Perth.

Import of sterile flies

An alternative to the local production of flies is to import them from existing large-scale factories elsewhere in the world, such as Guatemala. Transport is obviously a problem here but it is possible to ship flies via Los Angeles and Singapore to Perth in about 24 hours. Sterile Medfly pupae may be transhipped through Singapore's international airport without any special permit, as long as the shipment transits in a reasonable time and remains within the free trade zone (Singapore AVA, 2001). This could also be accomplished from a European factory, with import to Perth via Singapore.

Import of live insects requires an application to Biosecurity Australia, which will carry out an assessment of the case and make a recommendation to the Australian Quarantine and Inspection Service (AQIS) on permitting or special restrictions. Environment Australia may also pose some restrictions. For the pilot programme in Broome, and for the foreseeable future, Biosecurity Australia processes a request for import of genetic stock to start a colony or for sterile pupae as biocontrol agents. This categorization is not strictly accurate, as sterile insects are not self-replicating and, for this and other reasons, do not fall under the International Standard on phytosanitary Measures regarding biocontrol agents. On-going import may warrant further discussions with Biosecurity Australia to better categorize the application.

The control programme in South Africa tried test shipments of flies from Guatemala. These had approximately 40% mortality of pupae during 36hrs transit via Amsterdam. Shipping was US$12/kg, with 12kg/million flies, including packaging. The estimated cost of the flies was US$450/million +US$144/million shipping +30 to 40% wastage in transit. Overall this gave a cost for viable flies to release of about US$900/million or approximately A$1,800/million flies.

3.5. Devising operational plans

The planning phase will require input from a number of different people in a range of government departments, institutions and organizations. Plans will have to be agreed with all participants and conform to existing legislation unless special dispensation can be obtained. It is likely that this phase could take up to one year and will certainly require the input of one senior individual full time and many days of effort from other high level individuals. An estimate of the cost to the programme of this phase of the operation is A$250,000.

3.6. The field campaign

The first eradication of Medfly took place in Florida in the 1950s using only baiting and fruit stripping. Since that time, a number of eradications of the species have been carried out, particularly in the USA, and the sterile insect technique was introduced leading to much greater efficiencies. The well established control methods employed in the Florida programmes are especially likely to be suitable for an eradication programme in Western Australia, since both the climatic conditions and the host crops under threat are very similar. Recent control of re-introduced flies in both Florida and California has also employed the chemical methods outlined in detail in Appendix II (CDFA 2001, FDACS 2001). Based on this and other country experience, the field campaign in WA will consist of baiting and release of sterile flies. Trapping to evaluate the progress of the release is another important component.

Baiting will require the treatment of all host trees (estimated at 2,000,000 in Fisher *et al* (1994)) in the release areas for a period of four months prior to the release of the flies to suppress the wild fly populations. In addition to the area of fruit trees it would be necessary to treat the urban areas which could be an area as large as 100,000 ha, making a total area of

107,000 ha. It is assumed that bait will be applied to all susceptible trees in orchards and backyards where possible. It may be possible to apply bait to surfaces other than trees where access is not possible but this will be less effective than placement on the host plants themselves. It may be possible and desirable to use fruit stripping in some areas to supplement the baiting or if necessary to replace it if chemicals cannot be used for some reason. It is envisaged that three sprays will be required and would be applied prior to the naturally low population period during the winter to reduce the fly populations as low as possible. A period after cessation of treatment will ensure that the bait was not effective against the sterile flies on their release. The total cost of this activity is likely to be about A$15 million (see Appendix I sheets on eradication scenarios).

The next phase will be the release of sterile males to suppress and eradicate the remaining populations of flies. The geography of the area dictates that the most sensible method for the release of flies is from adapted aircraft. This removes many of the problems of access to remote areas and the time required to travel to these places. The fact remains that it is still a huge area that will require treatment and much time will be spent merely moving the flies from the point of production to the release site. One problem that may occur is the problem of very small, widely distributed sites (such as backyard trees on farms) where the cost of over flying and releasing flies may be prohibitively expensive. It may be necessary to rely on fruit stripping and intensive baiting to remove flies at these places. The cost of releasing the flies over the area is estimated at A$3000/km^2. A total area of just under 2000 km^2 would require release. The peak year of the programme would involve release of flies over 1017 km^2, using just over 100 million flies per week.

A trapping campaign will need to be conducted during the release of flies to ensure that flies were being distributed as expected and to check on the decline of the wild flies. A trapping grid of 10 traps/km^2 will be required to monitor progress. The estimated annual cost of this trapping campaign is A$1300/km^2/year.

Once eradication has been achieved it will be necessary to maintain a trapping array for monitoring any introduced species. This has been estimated to cost A$250,000 per year.

3.7. Associated environmental impacts

A full environmental impact assessment is not included in this feasibility study. Impacts from the various Medfly management options will include those from use of pesticides, as detailed in Appendix II. Current practices imply a continuing exposure to pesticide in areas where the practice is employed, whereas eradication would require use of pesticides in the preparation phase but eliminate their use for Medfly subsequently.

Environmental impacts of current practice controlling Medfly in orchards

Current methods of control include sanitation (dry roasting of infected fruit), trapping (baited with a protein rich attractant), baiting (insecticide and protein bait combined) and cover spraying (crop treatment with dimethoate, trichlorfon or fenthion) (Anon., 2001). Since it is the environmental impacts of insecticide use that poses the greatest risk these are considered below. The pesticides currently used in cover spraying are fenthion, dimethoate or trichlorfon.

The information in Appendix II implies that significant environmental impacts occur from the current management practices and that these impacts will continue in infested farms from routine treatments and in other areas, including South Australia, with each outbreak of Medfly, increasing if the number or severity of outbreaks increases.

Environmental impacts of suppression of Medfly in Western Australia
Chemical methods employed in suppression of Medfly in Western Australia involve cover spraying of protein-baited malathion, exactly as laid out in the eradication programme. The environmental impacts of this treatment are discussed in the section below.

Possible environmental impacts of a Medfly eradication programme
The aerial spraying of malathion will have the greatest impact on non-target organisms (including humans) due to the unavoidable broad-scale application technique employed.

Impacts on humans will be greatest in exposed, sensitive individuals. Noise and vehicular emission pollution will be unavoidable, affecting humans and other organisms.

Impacts on biodiversity will be greatest for insects, whose diversity is likely to be substantially reduced. Beneficial organisms such as pollinators and honeybees will be significantly affected unless otherwise protected. Secondary poisonings and loss of food supply will affect vertebrate insectivores, particularly birds.

Inhabitants of shallow and stagnant water bodies (fish, amphibians and aquatic invertebrates) are likely to be affected, particularly following repeated aerial spraying.

Soil drenching will most likely significantly decrease soil fauna, resulting in chemical and physical changes to soil characteristics.

3.8. Direct costs incurred controlling Medfly (in the absence of an eradication campaign), projected over the next 20 years

The figures in Table 4 are derived from the figure provided in the accompanying spreadsheet. This includes more detailed information on the areas by shire and control costs. The control costs for Medfly may change over the next 20 years, as older cheap and effective products are likely to be withdrawn from the market. There is some pressure to remove some of the organophosphate products from use and it may be these will no longer be available for control purposes. It is difficult to predict what will happen with new agrochemicals over such a long period of time. Alternatives such as Spinosad™ are coming onto the market but appear to be less effective than the products they replace. In addition there is likely to be mounting pressure from consumers and importing countries to reduce pesticide use in food production. In the near future there are no major changes in pest control likely to impact the fruit industry.

The cost to backyard fruit production is estimated at A$100,000 per annum. This is calculated from information provided by Bill Woods on sales of pesticide for fruit fly control to the public.

Crop	Potential loss proportion	Residual loss proportion	Control million A$/sq km	Price A$/T	Yield T/ha	Value mill A$/sqkm	FVA mill A$/sqkm
Stone	0.400	0.040	0.100	1500	25.000	3.750	2.205
Pome	0.200	0.020	0.025	1667	18.000	3.000	0.943
Citrus	0.250	0.025	0.040	750	18.000	1.350	0.410
Grapes	0.050	0.005	0.005	1000	11.000	1.100	0.354
Other	0.200	0.020	0.025	2000	20.000	4.000	1.429

Table 4. Production areas and costs of control for Medfly susceptible produce grown in Western Australia. Figures are based on statistics collected and reported in the data spreadsheet accompanying the report, surveys and meetings with growers. FVA is farm value added. Apart from wine grapes, the non-farm value added for these crops is relatively small since they generally leave the farm ready for shipment and are consumed fresh and unprocessed. There is some uncertainty about the losses and residual losses (despite control), which is reflected in the BCA modelling. The losses indicated here are for areas designated as "high" risk for Medfly, and proportionally reduced for "medium" and "low" according to the risk weights shown in Table 1.

Only three towns in Western Australia currently have town baiting schemes, although the number was much greater in earlier years. The cost of town baiting programmes in three towns where they are operated (Harvey, Kattaning and Carnarvon) is A$28k, A$15k and A$60k per year, respectively.

3.9. Estimate the indirect costs of controlling Medfly as currently practised

Periodical eradication required in South Australia as a result of infestation from WA

The indirect costs of Medfly come from many different sources. One of the most obvious is the cost to South Australia in maintaining quarantine posts to keep Medfly out and also the cost of eradication when the fly does breach the controls. The estimated average annual cost of Medfly to South Australia is given in table 5. The annual frequency of outbreaks is derived from the number of outbreaks suffered over the last 10 years (information from David Cartwright).

Average cost per year	A$
Trapping	500,000
Ceduna checkpoint	400,000
Eradication (assumes 1.5 outbreaks per year)	500,000
Total	**1,400,000**

Table 5. Average annual cost of Medfly to South Australia.

There appear to have been more outbreaks in the past few years so the figure of 1.5 outbreaks per annum may be conservative (there were a reported six outbreaks in 2001 to date). However, the cost of the quarantine checkpoint is not applied solely to Medfly since it also serves to reduce the movement of other pests and pathogens into South Australia. The estimated annual cost for continuing to eradicate occasional outbreaks is around A$1.4 million per year. There is no reason to believe this activity will become any cheaper over time, indeed if the trend toward more travel and more outbreaks continues the cost will increase.

Research costs

The industry-funded Horticulture Research and Development Corporation (HRDC) provides funding for research and pilot projects using WAQIS staff. Approximately A$300,000 to A$500,000 is spent on disinfestation research annually in Western Australia alone. Some of this may be eliminated with the eradication of the Medfly, but research probably would continue at a similar level on other pest and disease problems (the next most damaging ones) so that this cost would not actually be saved but rather redirected.

Federal funds (averaged out at around A$150,000 per year) are also spent on disinfestation research specifically against Medfly. Costs of this and other research may in fact be eliminated if eradication occurred.

Limitation on varieties planted

Fruit producers who experience Medfly damage are limited to planting early yield varieties, as late season ones are too vulnerable to the built up populations of Medfly.

Inspection fees

In the past, markets requiring phytosanitary certificates from AQIS cost the shipper A$38 per certificate. The system somewhat subsidised sea freight, which tended to be larger consignments, over air freight due to the smaller quantity per consignment. Rules governing federal inspection of exports are changing in July, 2001, however, so that exports going to countries that do not require phytosanitary certificates will also be charged an inspection fee and the cost per certificate will drop to A$20, according to current proposals.

While Medfly eradication will not have much impact on these costs, inspection fees by market country governments will continue to be an added burden to fruit exporters when treatments or area freedom is involved. No analysis was done to determine the amount these fees would be reduced if WA were recognised as Medfly free.

4. Alternative markets and regulations affecting exports

4.1 Regulatory status of Western Australia

The Medfly is considered one of the most serious pests for fruit. This is due only in part to the actual damage to fruits and costs of control. The impact of a Medfly outbreak on trade is possibly more serious, because many trade arrangements are based on the absence of this pest. The fact that WA has the only established population of Medfly between Hawaii and

Pakistan means that any spread of this species would have catastrophic consequences for the region's trade. (See discussion of the country's CBD responsibilities in Appendix III.)

Over 70 fruit fly species have been recorded in Australia, but the majority of control activities are against the Medfly and the Queensland fruit fly, *Bactrocera tryoni*. Fruit flies that are endemic but are generally not included in any trade regulations include *B. cucumis* (French), *B. neohumeralis* (Hardy), *B. jarvisi* (Tryon), *B. musae* (Tryon) *and B. frauenfeldi* (Schiner) (Smith, 2000a). Other species are intercepted in arriving cargo and the host material is treated or destroyed. The introduction (entry and establishment) of any other species of fruit fly, or change in regulatory status of those endemic species mentioned, could alter the results of this analysis. For example, if the single male melon fruit fly that was trapped in suburban Perth in 1996 had represented a breeding population, then fruits (or vegetable fruits such as green beans and squash) could have been added to the list of banned exports.

Although endemic to the country's rainforests, the Queensland fruit fly (or Q fly) has spread extensively through agricultural lands in the East and became established only once in Western Australia in 1989 in the Perth area, but was since eradicated (White and Elson-Harris, 1992; CABI/EPPO, 1997). Because Western Australia could experience outbreaks of Q fly, hosts of this fruit fly may also require treatment or are prohibited by some importers. The major fruits of interest in this report are all hosts of the Queensland fruit fly, except for strawberry (White and Elson-Harris, 1992) therefore any outbreak of this second species would eliminate the advantages of being free from Medfly. The Queensland fruit fly is quickly eradicated when found in the buffer zone (Smith, 2000a), making it is more likely that area free status would be successfully sought, if an importing country expressed concern about the Qfly on WA exports.

Pests other than fruit flies that affect fruit exports are mentioned below.

4.2 The Australian markets

Alternative markets include export markets of all types. Export statistics on fruit exports over the period analysed below are considered to underestimate the flow by 12% since they do not include exports to Eastern States of Australia (AWA, 1997). This figure would be even greater for certain fruits. Easily accessible statistics on interstate trade do not exist. A summary of traffic volumes on Eyre Highway, for example, appears fairly constant over the 12 years covered ending in 1995/96 does not distinguish commercial vehicles. Furthermore, producers that have qualified under the Interstate Certification Assurance (ICA) program issue their own certificates (for example for area freedom in Kununurra or for applying a treatment) and are not counted in the same system as AQIS certificates.

Many growers cited the Australian market as motivation for eradication or area freedom due to a perception of lost opportunity for the time that cold treatment is applied (around two weeks).

On the other hand, the Western Australian market for fruit has been virtually guaranteed for local producers due to quarantine restrictions on incoming fruit. This has lead to solid local prices that deter growers from exporting. Increasing pressure to regulate by risk assessment results may cause this market to open and prices to drop, thus forcing local producers to export or perish.

4.3. International markets

Fruit exports from WA were at a peak almost 25 years ago, dropping in quantity by about 60% until the mid-1990's when the industry expanded into new markets such as the UK, Taiwan and Indonesia (AWA, 1997). The Asian economic crisis had a devastating impact on the optimism from that initial resurgence. The state, however, continues to have some special advantages for fruit export, which would be further improved by Medfly eradication. One example is the production of Pink Lady apples, which are susceptible to apple scale (absent from WA) and have been planted in WA before other growing regions.

Based on five-year average value of exports from WA (shown in Appendix IV), the most important export of crops classed as Medfly hosts have been:

- apples,
- strawberries,
- pears,
- grapes,
- peaches and nectarines,
- oranges and
- mangoes.

Apples comprise the largest value and volume in fruit exports from Western Australia. A five year average (1/7/94-30/6/00) show apples of all varieties resulted in A$7.3 million, which is more than the total of the next three highest value in exports: strawberries, pears and grapes. Peaches averaged over A$1.5 million, while oranges and mangoes were below the million Australian dollar mark.

All of these fruits are considered Medfly hosts by at least one major market, and all but strawberry are considered hosts by all of the major importing countries. Since the time of these statistics, the area in table grapes, a marginal but regulated host, is reportedly decreasing as area in vineyards, unaffected by fresh fruit regulations, expands. New crops under development that did not rank in the top crops from the previous five years include avocado and olives, both of which are classed as Medfly hosts. Timber is also replacing some orchard production and is not a Medfly host.

The most important export markets by value for the historically most important crops by value (listed above) are:

- Singapore
- United Kingdom
- Malaysia

- Hong Kong
- Indonesia
- United Arab Emirates
- Brunei
- Thailand
- Netherlands
- USA

These countries allow entry of the key crops currently, either as harvested or with a fruit fly control treatment prior to shipping. Any changes in regulations would change the outlook, for better or worse, but no immediate tightening of restrictions is expected.

No phytosanitary certificate (or treatment) is required for fruit exports to Singapore, Malaysia or Hong Kong (Hong Kong, 2001). Singapore specifically requires an import permit for citrus and fruits from the American tropics (Singapore, 2000), but there is no treatment required for shipments of fruit from WA (Singapore AVA, 2001). Phytosanitary certificates are required for planting material entering Singapore. Infested fruits found in Malaysia may be treated or destroyed (Malaysia, 2000). Hong Kong imports will increase when China opens its markets as it remains an important port of entry.

Indonesia generally accepts sanitary, fumigation or other similar certificates for importation of fruits that would be prohibited otherwise. Cold treatment is applied to citrus, stone fruit and apples from WA. More stringent requirements apply to planting material. United Arab Emirates is in a region infested with Medfly. UAE is concerned about entry of mango seed weevil, however, and has required fruit cutting to demonstrate freedom from this pest. As WA does not have mango seed weevil, discussions are underway at the federal level to lift this requirement.

Brunei does not appear to have stringent regulations, but their requirements were never confirmed (Brunei, 2001). The country reportedly requires inspection on entry and a phytosanitary certificate. Everything from WA goes to Brunei by air freight. Thailand imports citrus from pest free areas and other fruits subject to inspection.

The United Kingdom and the Netherlands follow European Commission Directives on import from Australia. The EC Directives generally list organisms and sometimes host materials of concern. Although Medfly is not listed in the Annex I on harmful organisms whose introduction into and spread within all Member States shall be banned (77/93/EEC and amendments), other pests and planting material in particular are listed. Some protected zones within the EU are more restrictive on citrus imports than is the UK or the Netherlands, so individual country regulations should be checked as listed in the European Directives.

Although some opportunity may exist for expansion into these markets, other markets appearing lower on the list or not at all are likely to provide greater capacity for absorbing more fruit at premium prices (e.g. other EU countries, the USA, Japan). There is some discussion of Japanese regulations below because of its importance as a market and possibility of growth. China could be a considerable future market as well, although fruit is currently prohibited. This report does not provide the conclusions one could reach from a full market study, however, and no consideration is given to competing suppliers.

Specialty markets may carry a higher value in the market. This is the case for "organically-grown" produce in some markets. Producers wishing to export must comply with the National Standard for Organic and Bio-dynamic Produce; a domestic standard is not yet in force. This allows for baiting for fruit flies using what is statutorily required, if the bait is fully enclosed in traps. Cover spraying would negate the organic status for that period, but then sterile insect release would provide effective pest control over the years concurrent with the return to organic status (AQIS, 2001).

4.4 Regulatory options for increased trade

Host status for Medfly

Medfly has few hosts among native flora and probably over winters in citrus, returning to early stone fruits in the spring and attacking all of these plus apples and mangoes in the summer at their population peak. Hosts of the Medfly that are commercially grown for export in Western Australia include apples, pears, peaches, plums, mangoes and citrus. Ornamental and backyard trees will provide adequate hosts much of the year as well.

Strawberries generally are not considered to be a host of either the Medfly or the Q fly (White and Elson-Harris, 1992). This conclusion has held up to studies carried out in various regions. Some treatment of strawberries is still required for export to Japan, however. One approach to opening markets, therefore, is to convince the Japanese that strawberry is not in fact a host. Experience suggests that this would be a very costly and unproductive approach unless international pressure is already making headway on the issue.

The other fruits of interest are well established as hosts and, short of development of some variety proven not to be a host (as happened with an Israeli variety of tomatoes), proposals for change of host status are not feasible. This pessimism does not apply to early harvest or other measures taken to prevent infestation.

Treatment of Fruits

Treatments are already well established for most of the fruits of interest. Table 5 shows some of the options available. Additional treatments and alternatives to methyl bromide (MB) to apply in the future may increase market opportunities. Ethylene dibromide (EDB) was banned only in the last couple of years, so will have recently been replaced as a treatment. Verification research, infrastructure development and negotiation with countries to accept treatments already developed will probably have more impact on trade than developing completely new treatments.

Mango treatment with hot water or Vapour Heat Treatment (VHT), which was developed by the Japanese, is not feasible for WA but could be in the future. Although cost per unit of either treatment is not great, the initial cost of establishing a VHT facility, for example, is as much as A$2 million. The additional cost of treatment is exacerbated by the requirement for

Japanese inspectors to be on the premises at the time of treatment, which for one facility was estimated at A$140,000 per year.

Up until recently, the Japanese government required research that demonstrated effectiveness of treatments on each variety of fruit for quarantine pests. This requirement was challenged through the WTO dispute system and shown to be lacking in scientific basis. Now countries may negotiate treatment schedules with Japan by commodity, for example apples or tomatoes, rather than for each variety. The WTO Agreement on the Application of Sanitary and Phytosanitary Measures requires equivalency, so that any Member Countries that are trading partners with Australia are required to consider treatments that are proven to reach the same level of effectiveness as any other treatment accepted by that country.

Apples and pears from Australia (excluding Tasmania) must be cold treated to enter the US market. There is an additional cost of the preclearance inspectors. This programme is currently limited to Goulburn Valley production. Strawberry may enter the US without treatment. Some treatment is required for grapes prior to shipment, but little volume is being exported now. Mangoes, peaches and nectarines are not on the list of admissible products to the US from Australia. (This may be due to some pest of concern that cannot be treated, or because no importer has requested admission.)

Research is also underway on controlled atmosphere and systems approaches (such as with avocado mentioned below).

Pest Free Area

The concept of area freedom from a pest that is still established in other parts of the country is well established internationally. Australia's legislated Fruit Fly Exclusion Zone (FFEZ) is a good model for WA to consider.

Currently specified varieties of citrus may be shipped from Australia to the US from Riverina or Riverland with a phytosanitary certificate or from Sunraysia (all within the FFEZ) with a declaration of the origin from a pest free area, or if this is not the case with cold treatment. In this case, the certificates are issued by AQIS. Indonesia, Thailand, NZ and several other countries recognise these Pest Free Areas already. AQIS submitted a proposal to the Japanese in 2000 for recognition of these areas.

Japan recognises pest free areas for reduced or no restrictions on some quarantine pests. Tasmania has this status for fruit flies, thus allowing shipment of products such as tomatoes without treatment. Other areas are recognised by Japan which are continental (e.g. in China and the US), so there is no reason to believe this policy is restricted to islands.

Pest free areas and production areas free from pests are international standards under the International Plant Protection Convention, and therefore are binding through the WTO Agreement on the Application of Sanitary and Phytosanitary Measures. Although not all member countries have updated their legislation to match the SPS requirements, this is only a matter of time.

If Medfly were eradicated, WA would most likely need to establish the territory as a pest free area for Q fly to increase access to markets restricting fruits due to fruit flies. The advantage can be seen in the example of apples and pears from Tasmania which no longer need treatment prior to shipment (e.g. for the US only inspection at entry). Area freedom may be sought for coddling moth and other pests that limit trade with high value markets.

Table 5. Treatments Currently Available for Export of Western Australia Fruit to Control Medfly [or other quarantine pests].

Type of Treatment	Commodity Treated	Regulatory Status	Comments
Cold Treatment (14-16 days)	Citrus, Pome and Stone Fruit	Accepted for EA, Indonesia, Japan and USA (but not on citrus)	Delays shipment to EA. If closer Asian markets changed regs, would also cause delays.
Hard Harvest with Cold (within 48 hours)	Avocadoes	Used for EA interstate. Proposed to other countries (e.g. NZ)	Ready for submission to NZ, etc.
Vapour Heat	Mangoes (other than those from pest free areas)	Japan	No facility in WA, but a mobile one is available if volume warrants contracting.
Hot Water Dip	Mangoes (other than those from pest free areas)	USA	No facility in WA.
Insecticidal Dips	Tomato, Citrus	For trade with EA. [New Zealand for Q fly.].	Losing acceptability in import markets, limited by residue tolerances.
Methyl Bromide	All major crops	Accepted in most markets until MB eliminated. NZ would accept strawberries from WA but with MB treatment (never done due to quality issues after treatment.) Taiwan accepts MB with shorter cold treatment, as alternative to longer cold on apples so can be air freighted. [Japan as an alternative to treat apples from Tasmania when coddling is encountered. Etc.]	MB will not be available after the Montreal Protocol is fully implemented. Fruits often lose shelf life and quality after treatment.

EA refers to Eastern Australian states, other than Tasmania (i.e. NSW, QLD, VIC, ACT).

Although area freedom may be established under a suppression scheme for zones that have essentially eliminated the pest, it would be easier to gain area freedom for the entire state as quarantine measures would not be required. Medfly eradication would also reduce the requirements placed on the rest of Australia to show that they have area freedom from Medfly.

Restricted Permits

Phytosanitary certificates for fruit fly host material may be required for intrastate transport as well as international shipments. Conditions imposed for various production site/crop combinations include area freedom, time of harvest, fruit condition (eg. hard green, unbroken skin), and pre- or post-harvest chemical or physical treatments.

Research conducted in WA on avocado varieties Hass, Sharwill and Fuerte demonstrate that insecticidal dips is not necessary if the fruit is not tree ripened. This stipulation is complemented by a requirement to get the hard harvested fruit into cold within 48 hours of harvest. The fruit is held in cold until export. This research has been submitted to the US, NZ and others for market access. This approach is not, strictly speaking, to show that avocado is not a host but rather to show that these steps eliminate the risk of infestation by Medfly because the fruit could be a host.

Other pests of concern

Even if eradication of Medfly were achieved, some other restrictions will remain in place and can limit trade.

Codling moth (*Cydia pomonella*) occurs in Australia outside of WA and has occasional outbreaks in WA. Over the past century, there have been 20 outbreaks of codling moth, but only two occurred since the extensive1956 outbreak was eradicated (1993 and 1998). The most recent ones have taken around three years of control measures before WA regained its pest free status. Benefits of achieving Medfly free status would be essentially lost for apples during such a period of outbreak of coddling moth. Regulations (WA, 1989) require some prescribed immediate actions on the part of the grower when signs of codling moth occur, subject to penalty. Transport and other handlers are also required to comply with certain requirements. It remains unclear how the recent outbreaks were started.

Currently, because of codling moth, Japan bans apples, pears, peaches and other fruits from entry unless an approved treatment is applied. The value of Medfly eradication would be enhanced by negotiating pest free area status for WA for coddling moth. The US inspects a statistical sample of Australian (including Tasmanian) and New Zealand apples and pears for the family Tortricidae (fruit leaf roller complex). Methyl Bromide fumigation is required if this is found in the shipment (7 CFR 5:319.56-2j, January 2000 edition). MB is scheduled for phase out due to its status as an ozone depleting chemical. Unless an alternative treatment is developed, apples and pears with fruit leaf roller present will be destroyed upon entry to the US regardless of the fruit fly free status.

Grapes are currently shipped to the US with treatment for Medfly, Q fly and the light brown apple moth (*Epiphyas postvittana*). Eradication of the Medfly and pest free status for the Q fly would still not cover the need for treatment against the light brown apple moth for that market.

If fire blight became established in Australia, that would limit imports to Japan of plants of the family Rosaceae, but the fruit itself currently is not listed.

Other pests and disease may limit market access and should be considered carefully when projecting increases in export values to key market countries.

5. Environmental costs of Medfly treatments

Fruit producers and apple producers in particular in WA are in a unique position of having very few pests to deal with. The current use of chemical controls against Medfly undoubtedly has an impact on the remaining pests that could well be kept under control by natural enemies if the use of baits and cover sprays could be avoided. It is very difficult to be sure that this is the case or what the current costs to the industry are of controlling these other pests. It is considered likely that the figure would be relatively small and would not change the results significantly.

In the BCA modelling an environmental cost of A$1 per A$1 spent on pesticide is assumed, with some variance in the value in sensitivity analysis ranging from A$0.50 to A$1.50. This is based on an American study in which a value of 2:1 was used, for all American agriculture (Pimentel and Lehman, 1993). The reduced value is used in this case because current control programmes are either in limited areas or, in the case of area-wide schemes, would use baits that have less environmental impact than do the extensive use of herbicides, nematicides and the like. The value is relatively insignificant in this analysis since the values for the bait used in an eradication programme would approximately equal the cumulative value for continued current control.

6. Inputs and outputs of the BCA model

The inputs and outputs of the BCA model can be seen in Appendix I and through reference to the accompanying spreadsheets. Three scenarios are presented:

- Static fruit crop area, with eradication starting at Manjimup and moving north and east over six years (most likely scenario)
- Same, but starting in Perth and expanding south, then north
- Declining fruit crop (halving over 20 years), starting at Manjimup and progressing over six years

The model sets out a twenty year run of costs and benefits apportioned by category and summed for the zones applicable by that year.

Costs

- Demonstration: initial planning and demonstration SIT control in several town areas
- Survey: pre-eradication survey to delimit areas of bush that can be eliminated from treatment to reduce costs – estimated at 25% of area needing treatment (variable for sensitivity analysis)

- Bait: pre SIT baiting to reduce Medfly population
- Environment: cost to the environment of pesticide inputs only, at A$1/A$1 spent on pesticide (variable for sensitivity analysis)
- SIT: cost of flies and application (both variable for sensitivity analysis)
- Quarantine post eradication: in the first year the eradication frontier would require a rolling quarantine barrier, this is a function of area in the previous year and is determined by taking a percentage of the fly+application costs (variable for sensitivity analysis)
- Monitoring post-eradication: subsequently there would need to be monitoring in the fly free areas to ensure no new outbreak, eventually settling to a low level monitoring at A$250k/yr (variable for sensitivity analysis)
- Miscellaneous: includes publicity, administration and marketing costs (the latter to try to ensure benefits are derived)

Benefits

- Current control: with eradication the current costs of control would be saved from the year eradication starts in a zone
- Residual losses: with eradication there would be no residual losses (the loss that occurs despite current control) (variable for sensitivity analysis)
- Extra market local: there is some market lost at present in the eastern states for apples early in the season, which could be improved with eradication
- Extra export market, residue and residual loss: this is a function that assumes that with the withdrawal of current relatively cheap and effective control methods there might be increasing costs, residual losses and lost markets due to residues as growers attempt to control Medfly with other chemicals; this is simulated as a value based on the current level of residual loss and would grow steadily over 20 years, to a value of 2.5x the current level of residual loss; with eradication this would be prevented and so would be an additional benefit (variable for sensitivity analysis)
- Householders: costs saved in household fruit tree sprays (A$100k/yr) and town baiting (A$103k/yr); no value beyond that spent on pest control is assumed
- Environment: the environmental costs of current controls are calculated in the same way as for the costs of baiting (variable for sensitivity analysis)
- South Australia quarantine: variable costs of this are reduced on a pro rata basis as the area of fly freedom in WA increases; fixed costs are reduced after all of WA is fly free
- Kununurra fly free costs: reduce on a pro rata basis as the area of WA becomes fly free
- Disinfestation research: these costs stop after eradication is complete; five years of costs are included on the assumption that the research would not continue indefinitely

Overall result

The key output of the BCA model is a 20 year net present value (NPV) calculation of the stream of net benefits, calculated in Excel[3]. A more positive NPV is more favourable.

[3] Calculation of net present value (NPV) can be done in several ways depending on when during each year the benefits and costs are assumed to accrue, so mid-year or end of year accounting would give slightly different results, although spread over twenty years these are unlikely to affect decision making greatly. An argument for using mid-year or start of year accounting would be that funds are already earmarked at that stage.

In this case the NPV for the most likely option is A$0.261 million for the 20 year period. The Crystal Ball report indicates a substantial range of outcomes in a probability distribution around this mean figure, due to uncertainties in the inputs mentioned above.

Key sensitivity variables are indicated in detail in the Crystal Ball output accompanying the report. The most sensitive variables are:

- Extra loss due to changed chemical control options: this can not be tested empirically; so far there is no sign of resistance to pesticides in Medfly, but current controls are likely to be withdrawn; Spinosad is about 60% as effective and more expensive, more fruit would be rejected due to residual losses
- Perth metropolitan urban area needing treatment: this area has been calculated by satellite images and LGA dwelling data, but more detailed ground surveys will need to be conducted to determine if some industrial and other non-host areas can be left out)
- Bush areas near rivers: an assumption has been made that only about 25% of these areas would need treatment, but detailed surveys of Medfly populations and hosts should be made to determine a more precise value
- SIT fly costs: an estimate has been made of the likely large-scale cost per million male flies ready for release, based on experience elsewhere in the world; this will only be known when production is underway
- SIT application costs: a similar estimate has been made, but will be proven only when operations begin

If commercial horticulture declines over the next 20 years (for reasons other than Medfly, such as labour costs or water availability, etc) then the NPV is very much reduced. The same scenario, with a gradually reducing crop area (to half the current level) gives an NPV of *negative* A$9.165 million.

While the scenario starting at Perth gives a slightly higher NPV (since benefits accrue more quickly since it is a higher risk area than Manjimup) this option is not advised since it does not allow a gradual build-up of fly production and operational capacity, which the plans starting in the southwest have. Interim quarantine management would also be more difficult.

Given the sensitivity of the results to several variables which could be surveyed in the field it is strongly advised that these are investigated further prior to starting any significant control operations. A survey of the bush areas around rivers in the control zones would indicate the validity of assumptions about the area to be treated. An initial survey would give an indication of the likely overall reduction in area that a full survey would verify. More detailed mapping of the urban areas to control would also validate assumptions made about the areas to be treated. A survey to judge the likely growth or decline of the horticultural industry in general would help to indicate the likely level of benefit.

7. Distribution amongst potential beneficiaries of an eradication programme

The quantified benefits are apportioned to the various beneficiaries. The current distribution of costs are included in the estimate to reflect the minimum existing "willingness to pay" of each sector of the community.

Approximately 68% of the projected benefits of Medfly eradication would go to fruit growers in Western Australia, in reduced residual losses, reduced pest control expenditure, improved market access for some early season produce in the eastern states. The greatest part of this benefit is assumed to arise from increasingly damaging residual losses which would arise as effective current chemical control methods are withdrawn and replaced by more expensive and less effective alternative chemicals. This is assumed to occur gradually over the 20 year period, imposing an extra loss of 2.5x the present low level of residual losses.

The S Australian government would obtain approximately 17% of the benefit through reduced Medfly outbreak and monitoring costs. These reductions would be phased in pro rata as the eradication programme extended across the full area in Western Australia.

Environmental improvements make up most of the remaining 12% and depend on the detrimental value put on pesticide use in the environment. This has been estimated at A$1 per $ of insecticide applied. Some reduced costs to the state and federal governments are also included in these community benefits. Disinfestation and other research would be discontinued, but this is a very small amount compared to the other costs and losses prevented. Householders would receive about 3% of the overall benefit through reduced spraying and baiting costs.

8. Benefits of eradication and suppression

Eradication

In general terms, the benefits of eradication will be the removal of Medfly from Western Australia thereby removing a significant pest to the fruit production industry in the region. It would also result in the eradication of the fly from Australia as a whole.

The economic benefits will come from a number of different sources and can be quantified with a greater or lesser degree of certainty. They will include the following.

Within Western Australia

- The current expenditure for commercial control of Medfly in the field, including current expenditure on disinfestation treatments required for exports
- The current expenditure on maintaining controls around areas with fly free status e.g. Kununurra area
- The current expenditure on research into new methods of Medfly control and disinfestation
- The current expenditure by householders for the control of Medfly and losses due to Medfly infestation
- Increased fruit production resulting from the eradication of the fruit enabling greater volumes of exports

- Reduced pesticide use will result in reduced probabilities of harmful exposure for farm workers, risk of residues on fruits and impact of pesticides on the environment.

In the rest of Australia

- The current expenditure on disinfestation treatments required for exports (only for Medfly in WA)
- The current expenditure on quarantine controls around areas with fly free status e.g. Tristate area
- The current expenditure on eradication of outbreaks originating in WA
- The current expenditure on research on new methods of Medfly control and disinfestation

After eradication there is a need to prove that the fly is no longer present in the state and country, which is an expensive process because of the need for extensive trapping arrays. Once the fly is eradicated there is a requirement for an on going commitment to maintain a trapping network to detect any re-introductions of the fly.

Suppression

Suppression using SIT does not bring about the eradication of the fly but does provide some of the benefits. The major difference is that this approach does not have the high costs of trapping to prove that the fly has been eradicated and, in that sense, suppression has an advantage over eradication. However there is a recurrent cost for the continued release of flies over the years and the lack of the benefits that come from fly free status. In addition because it has to be done on an area wide basis it cannot be done successfully by individual farmers very easily and requires a government body to implement it. The problem then arises as to how this will be funded and how the money will be collected from the beneficiaries. Suppression does remove the need for chemical control and therefore has environmental benefits.

Suppression using SIT would be practical over several kilometres in which the density of commercial orchards is relatively high and where the risk from Medfly, and thus conventional control cost, is relatively high. In an area of 5 km^2 with 25% coverage of orchards in a high risk area conventional control costs are likely to range from A$30-100,000/yr. SIT would require 26 million flies for weekly treatment throughout the year for the whole area. At total costs of less than A$4000/million ***released in the field*** this could break even on high risk crops like stone fruit. Concentrating releases during the main season could reduce the annual cost considerably, although baiting costs at the start of the season would offset this.

Suppression does not eliminate the quarantine requirements (generally a treatment) for entry to market countries, however it may form part of a Systems Approach that could eliminate the treatment and rely on suppression, trapping and inspection. This approach is gaining recognition internationally and has already been used in a number of bilateral agreements.

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APPENDIX I. Benefit Cost Analysis spreadsheets

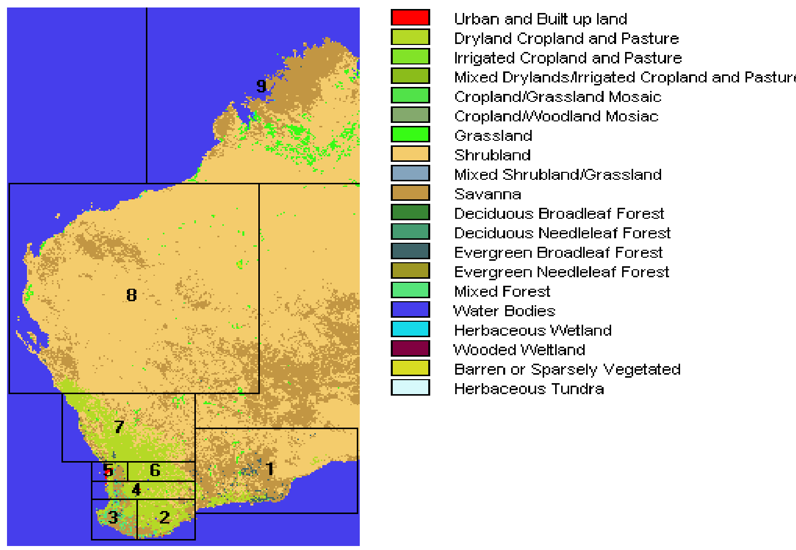
[These 8 sheets give a static indication of the dynamic spreadsheet, a Crystal Ball output report accompanies this report as an Excel file only]

Sheet 1: Maps

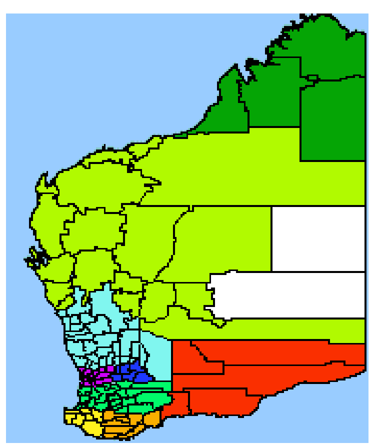
Medfly zones, land use and LGA areas by zone

These zones are based on similar agroclimatic conditions and are provide a basis for phased eradication of Medfly

Zone	Medfly Risk
1 Esperance	Med
2 Albany	Med
3 Manjimup-Nannup	Low
4 Bunbury-Donnybrook	Med
5 Perth	High
6 Perth East	High
7 Geraldton	High
8 Midwest	High
9 North	Med



Zones by Local Government Area corresponding to the map above



Sheet 2: LGA land areas

Western Australia LGA by Zone and Urban Area Estimates

Note that the area per dwelling means total area, including local amenities, roadways, shops and schools, etc

Zone	LGA	Area sq km	Dwellings	Sq km/Dwelling	Average sq km	l Dwelling	Scalar	Scaled sq km	"Urban " sq km	Comment
1	Coolgardie		1673			7.7	0.5	3.8		
1	Dundas		815			3.7	0.3	0.9		
1	Esperance		4788			22.0	0.5	11.0		
1	Kalgoorlie		9050			41.6	0.8	31.2		
1	Ravensthorpe		727			3.3	0.3	0.8	**47.7**	Based on average of Bunbury and Geraldton town density
2	Albany		11303			52.0	1.0	52.0		
2	Broomehill		226			1.0	0.0	0.0		
2	Cranbrook		509			2.3	0.3	0.6		
2	Denmark		2158			9.9	0.5	5.0		
2	Gnowangerup		784			3.6	0.3	0.9		
2	Jerramungup		320			1.5	0.0	0.0		
2	Kojonup		950			4.4	0.3	1.1		
2	Plantagenet		1685			7.8	0.5	3.9		
2	Tambellup		318			1.5	0.0	0.0	**63.2**	Based on average of Bunbury and Geraldton town density
3	Augusta		3752			17.3	0.5	8.6		
3	Boyup Brook		775			3.6	0.3	0.9		
3	Bridgetown		1723			7.9	0.5	4.0		
3	Busselton		8767			40.3	0.8	30.2		
3	Manjimup		4069			18.7	0.5	9.4		
3	Nannup		537			2.5	0.3	0.6	**53.5**	Based on average of Bunbury and Geraldton town density
4	Boddington		570			2.6	0.3	0.7		
4	Brookton		448			2.1	0.0	0.0		
4	Bunbury	61	11367	0.0054		61.0	1.0	61.0		
4	Capel		2278			10.5	0.5	5.2		
4	Collie		3536			16.3	0.5	8.1		
4	Corrigin		616			2.8	0.3	0.7		
4	Cuballing		304			1.4	0.0	0.0		
4	Dardanup		2399			11.0	0.5	5.5		
4	Donybroook		1600			7.4	0.5	3.7		
4	Dumbleyung		396			1.8	0.0	0.0		
4	Harvey		5992			27.6	0.8	20.7		
4	Katanning		1866			8.6	0.5	4.3		
4	Kent		335			1.5	0.0	0.0		
4	Kondinin		472			2.2	0.0	0.0		
4	Kulin		440			2.0	0.0	0.0		
4	Kwinana		7447			34.3	0.8	25.7		
4	Lake Grace		785			3.6	0.3	0.9		
4	Mandurah		17954			82.6	1.0	82.6		
4	Murray		4200			19.3	0.5	9.7		
4	Narrogin		295			1.4	0.0	0.0		
4	Narrogin Town		1751			8.1	0.5	4.0		
4	Pingelly		467			2.1	0.0	0.0		
4	Rockingham		24800			114.1	1.0	114.1		
4	Wagin		861			4.0	0.3	1.0		
4	Wandering		136			0.6	0.0	0.0		
4	Waroona		1470			6.8	0.5	3.4		
4	West Arthur		489			2.2	0.0	0.0		
4	Wickepin		405			1.9	0.0	0.0		
4	Williams		445			2.0	0.0	0.0		
4	Woodanilling		160		**0.0046**	0.7	0.0	0.0	**350.2**	Based on average of Bunbury and Geraldton town density

5	Armadale	545	18985			87.3	1.0	87.3	
5	Bassendea	11	5608	0.0020		11.0	0.8	8.3	
5	Bayswater	33	23040	0.0014		33.0	1.0	33.0	
5	Belmont	40	13261	0.0030		40.0	1.0	40.0	
5	Beverley	2310	674			3.1	0.3	0.8	
5	Cambridge	22	9533	0.0023		22.0	0.8	16.5	
5	Canning	65	25777	0.0025		65.0	1.0	65.0	
5	Claremont	5	4390	0.0011		5.0	0.5	2.5	
5	Cockburn	148	21400			98.4	1.0	98.4	
5	Cottesloe	4	3500	0.0011		4.0	0.5	2.0	
5	East Frema	3	3000	0.0010		3.0	0.5	1.5	
5	Fremantle	18	10300	0.0017		18.0	1.0	18.0	
5	Gosnells	127	25322			116.5	1.0	116.5	
5	Joondalup	97	49349	0.0020		97.0	1.0	97.0	
5	Kalamunda	349	16782			77.2	1.0	77.2	
5	Melville	53	34180	0.0016		53.0	1.0	53.0	
5	Mosman Pa	4	3422	0.0012		4.0	0.5	2.0	
5	Mundaring	644	11586			53.3	1.0	53.3	
5	Nedlands	21	7740	0.0027		21.0	0.8	15.8	
5	Northam	1400	1275			5.9	0.5	2.9	
5	Northam T	24	2600	0.0092		24.0	0.5	12.0	
5	Peppermin	2	586	0.0034		2.0	0.3	0.5	
5	Perth	9	6295	0.0014		9.0	0.8	6.8	
5	Serpentine	905	3397			15.6	0.5	7.8	
5	South Pertl	20	17530	0.0011		20.0	1.0	20.0	
5	Stirling	109	76682	0.0014		109.0	1.0	109.0	
5	Subiaco	7	6796	0.0010		7.0	0.8	5.3	
5	Swan	1029	29814			137.1	1.0	137.1	
5	Victoria Pa	18	12651	0.0014		18.0	1.0	18.0	
5	Vincent	10	12100	0.0008		10.0	1.0	10.0	
5	Wanneroo	688	23329			107.3	1.0	107.3	
5	York	2010	1180		**0.0021**	5.4	0.5	2.7	**852.2** Based on actual area plus calculated area for sparse parts
6	Bruce Rock		547			2.5	0.3	0.6	
6	Cunderdin		575			2.6	0.3	0.7	
6	Kellerberrin		612			2.8	0.3	0.7	
6	Narembeen		445			2.0	0.0	0.0	
6	Quairading		514			2.4	0.3	0.6	
6	Tammin		301			1.4	0.0	0.0	**2.6** Based on average of Bunbury and Geraldton town density
7	Carnamah		441			2.0	0.0	0.0	
7	Chittering		1120			5.2	0.5	2.6	
7	Coorow		812			3.7	0.3	0.9	
7	Dalwallinu		637			2.9	0.3	0.7	
7	Dandaragan		1699			7.8	0.5	3.9	
7	Dowerin		405			1.9	0.0	0.0	
7	Geraldton	28	8050	0.0035		28.0	0.8	21.0	
7	Gingin		2563			11.8	0.5	5.9	
7	Goomalling		428			2.0	0.0	0.0	
7	Greenough		3775			17.4	0.5	8.7	
7	Irwin		1150			5.3	0.5	2.6	
7	Koorda		296			1.4	0.0	0.0	
7	Merredin		1300			6.0	0.5	3.0	
7	Mingenew		222			1.0	0.0	0.0	
7	Moora		1080			5.0	0.5	2.5	
7	Morawa		378			1.7	0.0	0.0	
7	Mt Marshall		399			1.8	0.0	0.0	
7	Mukinnbudin		311			1.4	0.0	0.0	
7	Mullewa		448			2.1	0.0	0.0	
7	Nungarin		134			0.6	0.0	0.0	
7	Perenjori		305			1.4	0.0	0.0	
7	Three Springs		373			1.7	0.0	0.0	
7	Toodyay		1392			6.4	0.5	3.2	
7	Trayning		248			1.1	0.0	0.0	
7	Victoria Plains		450			2.1	0.0	0.0	
7	Westonia		144			0.7	0.0	0.0	
7	Wongan		703			3.2	0.3	0.8	
7	Wyalkatchem		323			1.5	0.0	0.0	
7	Yalgoo		97			0.4	0.0	0.0	
7	Yilgarn		900		**0.0046**	4.1	0.3	1.0	**56.8** Based on average of Bunbury and Geraldton town density
8	Ashburton		2700			12.4	0.5	6.2	
8	Carnarvon		3319			15.3	0.5	7.6	
8	Chapman Valley		325			1.5	0.0	0.0	

Sheet 3: Inputs

SIT eradication inputs

Values in green are subject to sensitivity analysis

Eradication would be based on a phased scheme of eradication by zones

Proportion of Wood and Riverine areas with Medfly/host >>> 0.25

Zone	Risk	Risk weight	Area in square kilometres Stone	Pome	Citrus	Grapes	Other	**All crop**	Urban	Crop/ Wood	Riverine	**All other**
Esperance	Med	0.5	0.0	0.0	0.0	0.0	0.0	**0.0**	47.7	32.8	0.0	**80.5**
Albany	Med	0.5	0.0	0.1	0.0	5.7	0.0	**5.8**	63.2	1.5	0.0	**64.7**
Manjimup-Nannup	Low	0.1	0.2	4.8	0.1	10.0	0.1	**15.2**	53.5	3.3	187.5	**244.3**
Bunbury-Donnybrook	Med	0.5	1.1	9.1	2.2	1.7	0.7	**14.8**	258.3	0.3	128.8	**387.3**
Perth	High	1.0	1.9	3.0	1.5	14.4	0.8	**21.6**	950.0	0.3	3.0	**953.3**
Perth East	High	1.0	0.0	0.0	0.0	0.0	0.0	**0.0**	2.6	0.0	39.8	**42.4**
Geraldton	High	1.0	0.1	0.0	1.9	4.2	0.1	**6.3**	56.8	8.5	0.0	**65.3**
Midwest	High	1.0	0.0	0.0	0.4	0.4	3.0	**3.8**	46.9	0.0	0.0	**46.9**
North	Med	0.5	0.0	0.0	0.0	0.0	0.4	**0.4**	16.7	0.0	0.0	**16.7**
Total		6.1	3.3	17.0	6.1	36.4	5.1	**67.9**	1495.7	46.5	359.0	**1901.3**

Standard values for Medfly loss and control are used. These are modified on the basis of the risk weight.

Crop	**Potential loss**	**Residual loss**	**Control nill $/sqkm**	**Price $/T**	**Yield T/ha**	**Value mill $/sqkm**	**FVA mill $/sqkm**
Stone	0.400	0.040	0.100	1500	25.000	3.750	2.205
Pome	0.200	0.020	0.025	1667	18.000	3.000	0.943
Citrus	0.250	0.025	0.040	750	18.000	1.350	0.410
Grapes	0.050	0.005	0.005	1000	11.000	1.100	0.354
Other	0.200	0.020	0.025	2000	20.000	4.000	1.429

Costs and losses are calculated by zone in phased eradication scheme

Costs and losses

Zone	Fruit type / Loss type	**Stone (million $/yr)** Chemical	**Res. Loss**	**Env cost**	**Mkt loss**	**Pome (million $/yr)** Chemical	**Res. Loss**	**Env cost**	**Mkt loss**	**Citrus (million $/yr)** Chemical	**Res. Loss**	**Env cost**	**Mkt loss**
Esperance		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Albany		0.000	0.000	0.000	0.000	0.001	0.002	0.000	0.002	0.000	0.000	0.000	0.000
Manjimup-Nannup		0.002	0.003	0.001	0.000	0.012	0.029	0.007	0.144	0.000	0.000	0.000	0.000
Bunbury-Donnybrook		0.055	0.083	0.033	0.000	0.114	0.273	0.068	0.273	0.044	0.037	0.026	0.000
Perth		0.190	0.285	0.114	0.000	0.075	0.180	0.045	0.090	0.060	0.051	0.036	0.000
Perth East		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Geraldton		0.010	0.015	0.006	0.000	0.001	0.001	0.000	0.001	0.076	0.064	0.046	0.000
Midwest		0.001	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.016	0.014	0.010	0.000
North		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Itemised costs are calculated for the components of eradication

SIT Costs	**mill $/km**	**mill $/km**	**mill $/yr**	**proportion flies**	**proportion flies**	**Notes**		
Fly source Local								
Flies	0.006					1133.333 AUS$million flies ready at Perth - local or foreign source >>	1800	**$1800/milli**
Application	0.003					release costs at $3000/km/yr	1133	**$1200/milli**
Q post-erad first year					0.04	function for roadblocks, preventative releases, mop-up operations	800	**$800/millic**
Publicity				0.05				
Administration				0.15				
Marketing				0.02		function to make sure that any premium prices are obtained for produce		
Monitoring eradication		0.001				10/km certification grid, fortnightly, $5/inspection		
Demonstration of SIT			0.625			project planning @$125k/yr, 3 towns for control projects @$500k/yr		
Pre-eradication surveys			0.700			Surveys of alternate host areas to reduce overall control area needing treatment, and fly population at baitir		
Bait pre-eradication	0.006					$20/ha 3x		
Q post-eradication			0.250			$250k, for 800 km this comes to 160 traps, * 52 checks		
Total	0.015	0.001	1.575	0.220	0.040			

Itemised values for costs that would be saved by eradicating Medfly

Other costs/benefits

	per year	units as noted	
Environment		1.000	$/$ chemical control
SA Q Monitoring	0.500		million $/yr, would decline to $100k/yr after eradication
SA Q Control		1.000	million $/yr (proportional to area infested in WA)
Kununurra Fly-free		0.100	million $/yr (proportional to area infested in WA)
Market access premiums		0.010	proportional extra value for pome to Eastern States
Disinfestation research	0.250		Figure from Canberra, to run for 5 years once eradication is complete, split 50:50 WA:Fed

Grapes (million $/yr)				Other (million $/yr)						Total (million $/yr)					Total
Chemical	Res. Loss	Env cost	Mkt loss	Chemical	Res. Loss	Env cost	Mkt loss	Town bait Backyard		Chemical	Res. Loss	Env cost	Mkt loss	Town bait Backyard	Mill $/yr
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.001
0.014	0.016	0.009	0.000	0.000	0.000	0.003	0.000	0.005		0.015	0.017	0.012	0.002	0.005	0.050
0.005	0.006	0.003	0.000	0.000	0.001	0.017	0.000	0.028		0.020	0.038	0.029	0.144	0.028	0.259
0.004	0.005	0.003	0.000	0.009	0.028	0.032	0.000	0.045		0.226	0.425	0.162	0.273	0.045	1.132
0.072	0.079	0.043	0.000	0.020	0.064	0.042	0.000	0.050		0.417	0.659	0.280	0.090	0.050	1.496
0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.005		0.000	0.000	0.003	0.000	0.005	0.008
0.021	0.023	0.013	0.000	0.003	0.008	0.008	0.000	0.010		0.110	0.111	0.072	0.001	0.010	0.304
0.002	0.002	0.001	0.000	0.075	0.240	0.081	0.000	0.060		0.094	0.257	0.092	0.000	0.060	0.504
0.000	0.000	0.000	0.000	0.005	0.016	0.003	0.000	0.000		0.005	0.016	0.003	0.000	0.000	0.024
									Total	**0.886**	**1.525**	**0.654**	**0.509**		**3.777**

ion male flies ready for release, foreign source
ion local source
ɔn cheapest possible local source

ɲg

Sheet 4: Scenario 1 – Static crop area, starting from Manjimup

Eradication scenario - static orchard area, from Manjimup

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Eradication zone/phase	Pre-erad	Pre-erad	Manjimup	Esperance Albany Bunbury	Perth Perth East	Perth	Geraldton	Midwest North	Post-erad	Post-erad	Post-erad	Post-erad	Post-erad	Post-erad	Post-erad
Risk weight			Low	Med	High	High	High	High/Med							
km			259.5	553.1	1017.2	974.9	71.6	67.8							
Costs ($ million)															
Demonstration	0.625	0.625													
Survey	0.700	0.700													
Bait Orchard+Urban			0.412	2.339	5.845	5.830	0.379	0.407							
Environment			0.247	1.403	3.507	3.498	0.227	0.244							
SIT All host areas			2.443	5.101	9.239	8.862	0.693	0.640							
Quarantine Post-erad first year				0.098	0.204	0.370	0.354	0.028	0.026						
Monitoring Post-erad					0.311	0.664	1.221	1.170	0.086	0.081					
Misc			0.537	1.122	2.032	1.950	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
Total	**1.325**	**1.325**	**3.639**	**10.064**	**21.139**	**21.172**	**3.124**	**2.739**	**0.362**	**0.331**	**0.250**	**0.250**	**0.250**	**0.250**	**0.250**
							Total to eradication		64.889						
Benefits ($ million)															
Current control			0.020	0.260	0.677	0.677	0.787	0.886	0.886	0.886	0.886	0.886	0.886	0.886	0.886
Residual loss			0.038	0.481	1.140	1.140	1.252	1.525	1.525	1.525	1.525	1.525	1.525	1.525	1.525
Extra market local			0.144	0.419	0.419	0.509	0.509	0.509	0.509	0.509	0.509	0.509	0.509	0.509	0.509
Extra export market/residue loss			0.000	0.060	0.285	0.428	0.626	0.953	1.144	1.334	1.525	1.715	1.906	2.097	2.287
Householders			0.028	0.078	0.133	0.188	0.143	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203
Environment			0.029	0.203	0.486	0.486	0.558	0.654	0.654	0.654	0.654	0.654	0.654	0.654	0.654
SA Q			0.000	0.132	0.413	0.413	0.929	0.966	1.000	1.400	1.400	1.400	1.400	1.400	1.400
Kununurra Fly-free			0.000	0.013	0.041	0.041	0.093	0.097	0.100	0.100	0.100	0.100	0.100	0.100	0.100
Disinfestation research								0.250	0.250	0.250	0.250	0.250			
Total	**0.000**	**0.000**	**0.259**	**1.646**	**3.594**	**3.882**	**4.897**	**6.042**	**6.271**	**6.861**	**7.052**	**7.242**	**7.183**	**7.374**	**7.564**
Net (Benefit-Cost) ($ million)															
Total	-1.325	-1.325	-3.381	-8.417	-17.545	-17.290	1.773	3.303	5.909	6.530	6.802	6.992	6.933	7.124	7.314
Cumulative	-1.325	-2.650	-6.031	-14.448	-31.992	-49.283	-47.510	-44.207	-38.298	-31.768	-24.966	-17.974	-11.041	-3.917	3.397
NPV 20 yr	**0.261**														

Proportional benefits	**% of total**	
Growers	68%	
Householders	3%	
Community Benefits	12%	Environment, WA, Commonwealth governments
Government - SA	17%	
	100%	

Sheet 5: Scenario 2 – Static crop area, starting form Perth

Eradication scenario - static orchard area, from Perth

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Eradication zone/phase	Pre-erad	Pre-erad	Perth Perth East	Perth	Esperance Albany Bunbury	Manjimup	Geraldton	Midwest North	Post-erad	Post-erad	Post-erad	Post-erad	Post-erad	Post-erad	Post-erad
Risk weight			High	High	Med	Low	High	High/Med							
km			1017.2	974.9	553.1	259.5	71.6	67.8							
Costs ($ million)															
Demonstration	0.625	0.625													
Surveys	0.700	0.700													
Bait Orchard+Urban			5.845	5.830	2.339	0.412	0.379	0.407							
Environment			3.507	3.498	1.403	0.247	0.227	0.244							
SIT All host areas			9.239	8.862	5.101	2.443	0.693	0.640							
Quarantine Post-erad first year				0.370	0.354	0.204	0.098	0.028	0.026						
Monitoring Post-erad					1.221	1.170	0.664	1.221	0.086	0.081					
Misc			2.032	1.950	1.122	0.537	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
Total	**1.325**	**1.325**	**20.623**	**20.509**	**11.541**	**5.013**	**2.310**	**2.790**	**0.362**	**0.331**	**0.250**	**0.250**	**0.250**	**0.250**	**0.250**
							Total to eradication		65.798						
Benefits ($ million)															
Current control			0.417	0.417	0.658	0.677	0.787	0.886	0.886	0.886	0.886	0.886	0.886	0.886	0.886
Residual loss			0.659	0.659	1.102	1.140	1.252	1.525	1.525	1.525	1.525	1.525	1.525	1.525	1.525
Extra market local			0.000	0.090	0.365	0.509	0.509	0.509	0.509	0.509	0.509	0.509	0.509	0.509	0.509
Extra export market/residue loss			0.000	0.082	0.275	0.428	0.626	0.953	1.144	1.334	1.525	1.715	1.906	2.097	2.287
Householders			0.055	0.055	0.105	0.133	0.143	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203
Environment			0.283	0.283	0.458	0.486	0.558	0.654	0.654	0.654	0.654	0.654	0.654	0.654	0.654
SA Q			0.000	0.517	0.517	0.797	0.929	0.966	1.000	1.400	1.400	1.400	1.400	1.400	1.400
Kununurra Fly-free			0.150	0.150	0.150	0.000	0.052	0.097	0.100	0.100	0.100	0.100	0.100	0.100	0.100
Disinfestation research								0.250	0.250	0.250	0.250	0.250			
Total	**0.000**	**0.000**	**1.564**	**2.252**	**3.628**	**4.170**	**4.856**	**6.042**	**6.271**	**6.861**	**7.052**	**7.242**	**7.183**	**7.374**	**7.564**
Net (Benefit-Cost) ($ million)															
Total	-1.325	-1.325	-0.843	-7.913	-19.060	-18.256	2.546	3.252	5.909	6.530	6.802	6.992	6.933	7.124	7.314
Cumulative	-1.325	-2.650	-3.493	-11.406	-30.466	-48.722	-46.176	-42.924	-37.015	-30.485	-23.683	-16.691	-9.758	-2.635	4.680
NPV 20 yr	**1.445**														

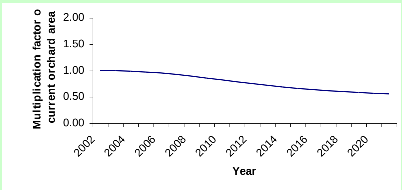
Proportional benefits	**% of total**	
Growers	67%	
Householders	3%	
Community Benefits	12%	Environment, WA, Commonwealth governments
Government - SA	18%	
	100%	

Sheet 6: - Scenario 1: Crop area reduced by half over 20 yrs, starting at Manjimup

Eradication scenario with variable orchard growth/decline - from Manjimup

			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	Year		**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
	Eradication zone/phase		Pre-erad	Pre-erad	Manjimup	Esperance Albany Bunbury	Perth Perth East	Perth	Geraldton	Midwest North	Post-erad	Post-erad
	Risk weight				Low	Med	High	High	High	High/Med		
!					259.2	552.4	1016.1	19.9	70.9	67.8		
	Costs ($ million)											
	Demonstration		0.625	0.625								
	Survey		0.700	0.700								
!	Bait	Orchard+Urban			0.411	2.335	5.838	5.819	0.374	0.362		
	Environment				0.246	1.401	3.503	3.491	0.225	0.217		
!	SIT	All host areas			2.438	5.089	9.218	8.831	0.681	0.639		
!	Quarantine Post-erad first year					0.098	0.204	0.369	0.353	0.027	0.026	
	Monitoring	Post-erad					0.311	0.662	1.219	1.166	0.085	0.080
!	Misc				0.536	1.120	2.028	1.943	0.250	0.250	0.250	0.250
	Total		**1.325**	**1.325**	**3.631**	**10.042**	**21.101**	**21.115**	**3.101**	**2.662**	**0.360**	**0.330**
									Total to eradication		64.663	
	Change in Orchard area (p of current area)		1.00	0.99	0.98	0.97	0.95	0.92	0.89	0.85	0.82	0.78

Anticipated change in area	**Halved**
Rate of change	**0.2**
Year of maximum change	**2010**



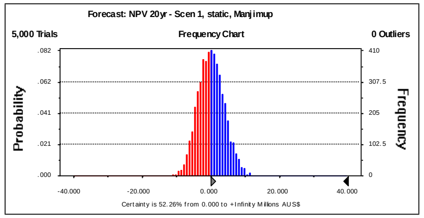
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Benefits ($ million)										
Current control			0.019	0.252	0.641	0.623	0.699	0.756	0.723	0.691
Residual loss			0.038	0.465	1.079	1.048	1.111	1.300	1.244	1.189
Extra market local			0.141	0.405	0.396	0.467	0.452	0.434	0.415	0.397
Extra export market/residue loss			0.000	0.058	0.270	0.393	0.555	0.813	0.933	1.040
Householders			0.028	0.078	0.133	0.188	0.143	0.203	0.203	0.203
Environment			0.028	0.196	0.460	0.447	0.495	0.557	0.533	0.510
SA Q			0.000	0.132	0.413	0.413	0.929	0.966	1.000	1.400
Kununurra Fly-free			0.000	0.013	0.041	0.041	0.093	0.097	0.100	0.100
Disinfestation research								0.250	0.250	0.250
Total	**0.000**	**0.000**	**0.255**	**1.600**	**3.432**	**3.620**	**4.478**	**5.375**	**5.403**	**5.779**
Net (Benefit-Cost) ($ million)										
Total	-1.325	-1.325	-3.376	-8.443	-17.669	-17.495	1.376	2.713	5.043	5.449
Cumulative	-1.325	-2.650	-6.026	-14.469	-32.138	-49.634	-48.257	-45.544	-40.502	-35.053
NPV 20yr at discount rate	**-9.165**									

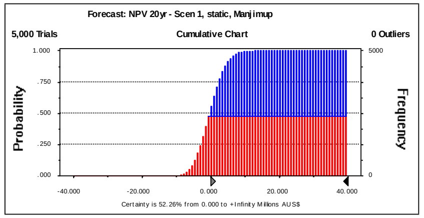
Proportional benefits		**% of total**	
	Growers	62%	
	Householders	4%	
	Community Benefits	12%	Environment, WA, Commonwealth governments
	Government - SA	23%	
		100%	

Sheet 7: Crystal Ball output on best bet scenarios using local flies

Best bet values on all inputs

Eradication scenario - static orchard area, from Manjimup





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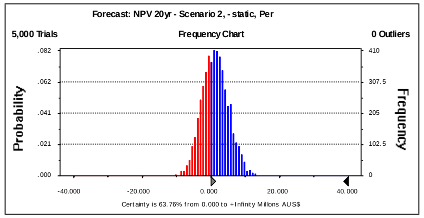
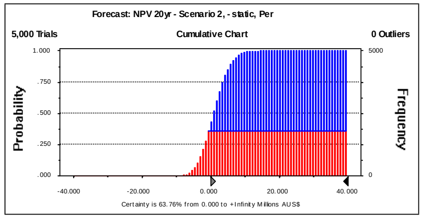
Eradication scenario - static orchard area, from Perth





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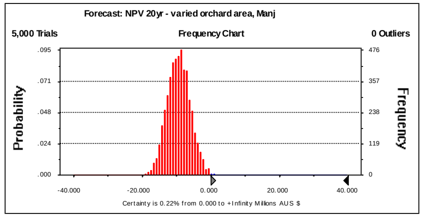
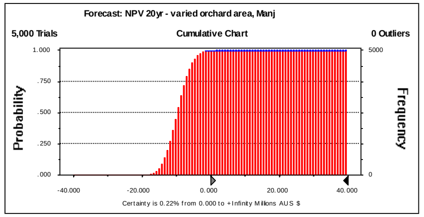
Eradication scenario with orchard decline to half current area - from Manjimup





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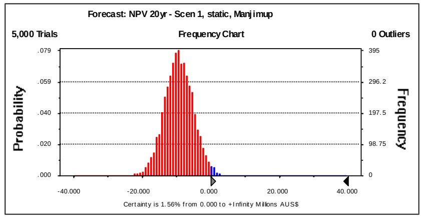
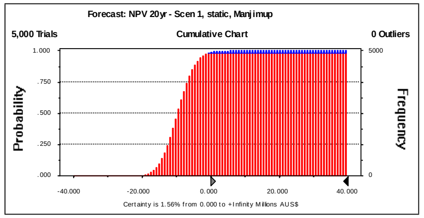
Sheet 8: Crystal Ball output on best bet scenarios using imported flies

Likely case values on all inputs other than fly costs

Foreign flies/full treatment areas/horticultural area halves over 20 years

Eradication scenario - static orchard area, from Manjimup





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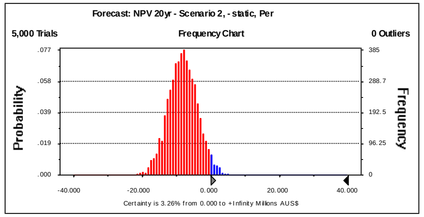
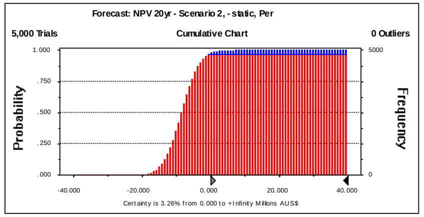
Eradication scenario - static orchard area, from Perth





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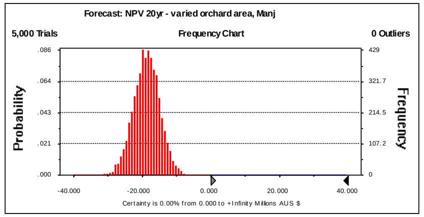
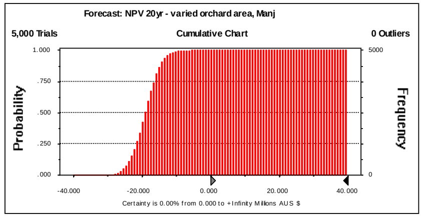
Eradication scenario with orchard decline to half current area - from Manjimup





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APPENDIX II. Pesticide Treatment Options

Details on pesticides used for Medfly control

The pesticides currently used in cover spraying are fenthion, dimethoate or trichlorfon.

Table A2.1. Currently employed insecticides for control of Medfly in Western Australia.

Chemicals	Proprietary Name	Poison Schedule (Australia)	Rate of Application	Frequency of Application	Comments
Fenthion (contact)	Lebaycid	S6	**Stonefruit**: 8mL in 10L water **Citrus, apples, pears**: 16mL in 10L water	every fortnight	toxic to birds 1 week withholding period
Dimethoate (systemic)	Rogor Dimethoate Sabateur	S6	10mL in 10L water	every fortnight	not suitable on some citrus, stonefruits, figs and loquats 1 week withholding period
Trichlorfon	Dipterex	S5		weekly	not suitable on any citrus 2 day withholding period

Soil half-life of fenthion (an acetylcholinesterase organophosphate) is estimated to be 24 hours (USDA 1993). Though this pesticide does not leach easily, widespread broadcast will mean that there is a significant risk of the chemical entering streams and ponds. Acute oral and dermal toxicity fenthion is moderate to severe for humans and considered moderate for other animals (USDA 1993, EPA 2001c). Chronic toxicity to humans of fenthion is considered extremely high, and it may be a neurotoxin (USDA 1993). Table A2.2 reports the Non-Observable Effects Level (NOEL) for rats and the Acceptable Daily Intake (ADI) for humans of these chemicals.

Fenthion is slightly to moderately toxic for mammals, reptiles and terrestrial amphibians but is severely toxic to birds, fish, prawns and both terrestrial and aquatic invertebrates (including honeybees). Since widespread cover spraying of this chemical will include broadcasting into rivers and ponds, there is a significant risk to fish and other aquatic organisms, including shrimp and prawns. Likewise there is a considerable risk to frugivorous birds consuming treated fruit.

The half-life of dimethoate in soil generally varies between 4 and 16 days and depends on moisture and the soil fauna present. It is rapidly broken down by microorganisms, particularly in damp conditions (EXTOXNET 2001a). Because this chemical is highly soluble in water it may leach quickly to groundwater. Dimethoate shows no phytotoxicity (EXTOXNET 2001a). Dimethoate (another acetylcholinesterase organophosphate) acute and chronic toxicity to humans is considered moderate. Carcinogenic effects are unlikely (EXTOXNET 2001a). When applied at maximum label rates to affected crops, risks to humans are considered minimal (EPA 2001a).

Dimethoate is moderately toxic to small mammals and fish, very highly toxic to birds and both terrestrial and aquatic invertebrates, including honeybees (EPA 2001a). When applied at maximum label rates there is a significant risk to beehives unless otherwise protected. Several studies have found bird populations significantly depressed in crop areas treated with high doses (EPA 2001a).

Table A2.2. Registration status and environmental fate of insecticides potentially employed in current Medfly control (British Crop Protection Council 1997, Agriculture Fisheries and Forestry Australia 2001).

Chemical	Registration status in WA	Mammalian toxicology:			Ecotoxicology	Environmental fate
		NOEL 2y for rats (mg/kg b.w.)	ADI for humans(mg/kg b.w.)	Toxicity class (WHO)		
Fenthion	Fruit fly control	<5	0.007	II	Toxic to bees, harmful to worms, daphnia, algae	Hydrolysed in mammals, excreted in urine. Rapid degradation in soil under aerobic conditions forming fenthion sulfoxide, fenthion sulfone and phenol compounds.
Dimethoate	Medfly control	0.2	0.002	II	Toxic to bees	Low risk to farm animals, moderate risk to aquatic animals.
Trichlorfon	Fruit fly control	100	0.01	II	Low toxicity to bees and other beneficial organisms	Excretion in animal urine within 6 hours, moderate risk to aquatic animals- should not be sprayed over water.

ADI: Acceptable Daily Intake (the maximum dose of a substance that is anticipated to be without lifetime risk to humans when taken daily)

NOEL: No Observed Effect Level (the highest dose at which there are no observable differences between test and control populations)

Trichlorfon (a selective acetylcholinesterase organophosphate) has a half-life of between 3 and 27 days and exhibits low persistence in soil. In water the degradation of this chemical depends primarily on pH; it will break down within 2 hours in an alkaline pond, but may persist for up to a year in an acidic pond (EXTOXNET 2001b).

Acute and chronic toxicity of trichlorfon is moderate in humans. Studies of carcinogenic effects are inconclusive (EXTOXNET 2001b). Risks are of concern to residents in treated areas and advice is for treatments to be as topical as possible (EPA 2001b).

Trichlorfon is moderately to highly toxic to birds and very highly toxic to aquatic organisms (EXTOXNET 2001b). There is some concern over risk levels to birds and fish in treated areas. Trichlorfon has only a low toxicity to honey bees, and in treatment areas containing commercial hives this chemical may be therefore preferable over dimethoate or fenthion.

Chemical methods of treatments

Chemical methods combine control of adult Medflies by Malathion at the same time as targeting larval stages with applications of soil insecticides (e.g. Diazinon, Chlorpyrifos or Fenthion). A possible alternative to Malathion in Australia might be Trichlorfon or Dimethoate. Whilst stripping of infested fruit trees and introduction of sterile male flies into infested areas can complement these chemical treatments, the major environmental impacts of an eradication programme will most likely result from these insecticides. The registration status and toxicity of these five organophosphate insecticides are listed in Table A2.3 in the text. All Australian registered pesticides are valid until 30/06/2001, when registration of individual products will be reviewed.

Ground application of Malathion-bait mixture
Backpack sprayers and tractors are employed to target infested crop areas. A mixture of bait (protein hyrolysate) and Malathion is sprayed at a dose of 0.171 kg/ha a.i. Malathion, starting at the centre of the identified outbreak and working outwards until the whole area of host crop has been sprayed. These applications should be repeated at intervals of 5-21 days. In addition, spot foliar baits may be laid, but this approach is labour intensive and the efficacy of this method is unknown. In general terms, ground spraying may be more focussed than aerial spraying, resulting in impacts on fewer non-target areas (such as areas around human habitation or that would result in drift into water bodies). However, this method is much more labour intensive and may not be able to cover all areas.

Aerial spraying of Malathion-bait mixture
The same mixture and dosage (0.171 kg/ha a.i.) of Malathion and protein bait as used in ground applications can effectively be applied from the air. Typically an area of ca. 9 square miles from the epicentre of the infestation might be sprayed at intervals of 5-21 days.

Ground application of soil pesticide
Soil drenching is typically carried out to eradicate Medfly larvae and emerging adults from the soil under infested crops. Application of Diazinon is usually at a dose of 4.87 kg/ha a.i., Chlorpyrifos at .07-3.9 kg/ha a.i. or Fenthion at 3.9 – 7.8 kg/ha a.i., and treatments are repeated at fortnightly intervals.

Ground and aerial application of malathion bait mixture

The half-life of malathion (an acetylcholinesterase inhibiting organophosphate) in the soil is dependent on soil type, microbial activity and pH, but generally varies between 1-6 days. Products of degradation (e.g. malaoxon) also have short half-lives. Several studies have reported no effects on growth and performance of decomposing fungi (Giles 1970, Anderson 1981, both cited in USDA 1993). Leaching to groundwater is unlikely due to adsorption by organic material and rapid degradation. In drier and more alkaline soils inorganic degradation via hydrolysis may become more important than organic degradation, and in these areas small background residues of malathion may occur.

The oral and dermal acute toxicity of malathion is minimal to humans (USDHSS, NIOSH, OSHA 1978, and EPA, OPP 1989, both cited USDA 1993). Studies also show low chronic toxicity to humans, though carcinogenicity tests show that it may cause chromosomal damage in mammals (WHO, IARC 1983, cited USDA 1993). Table A2.2 reports the NOEL for rats and the ADI for humans. Exposure risks include dermal contact with newly sprayed vegetation, or direct contact with spray. Oral exposure is most likely from ingestion of treated crops before bait has dried or of swimming pool water (under aerial treatment). The likelihood of exposure form inhalation of sprayed air was found to be insignificant (USDA 1993). The hazard quotient calculated by USDA under various scenarios of public interaction with treated crops, air, soil and water was found to be less than 1, therefore posing an acceptable risk (USDA 1993).

The hazard resulting from the aerial spraying of water bodies is greatest in non-flowing shallow water, where EPA (Environmental Protection Agency, USA) and CDFG (California Department of Fish and Game, USA) criteria may be exceeded immediately following spraying, but chronic exposure is unlikely because of chemical and biological degradation of malathion (USDA 1993).

Table A2.3. Registration status and environmental fate of insecticides potentially employed in Medfly eradication programme (British Crop Protection Council 1997, Agriculture Fisheries and Forestry Australia 2001).

Chemical	Registration status in WA	Mammalian toxicology:			Ecotoxicology	Environmental fate
		NOEL 2y for rats (mg/kg b.w.)	ADI for humans(mg/ kg b.w.)	Toxicity class (WHO)		
Malathion	Medfly control	100	0.02	III	Toxic to bees	Excreted in 24 hours.
Dimethoate	Medfly control	0.2	0.002	II	Toxic to bees	Low risk to farm animals, moderate risk to aquatic animals.
Trichlorfon	Fruit fly control	100	0.01	II	Low toxicity to bees and other beneficial organisms	Excretion in animal urine within 6 hours, moderate risk to aquatic animals- should not be sprayed over water.
Chlorpyrifos	Fruit fly control	0.03	0.01	II	Toxic to bees, collembola, daphnia	Rapid metabolism in animals, excretion via urine. Slow soil degradation to organochlorine compounds and CO_2.
Fenthion	Fruit fly control	<5	0.007	II	Toxic to bees, harmful to worms, daphnia, algae	Hydrolysed in mammals excreted in urine. Rapid degradation in soil under aerobic conditions forming fenthion sulfoxide, fenthion sulfone and phenol compounds.
Diazinon	Not for fruit fly	0.02	0.002	II	Highly toxic to bees	Metabolised in animals as diethyl thiophosphate and diethylphosphate. Strongly absorbed into soil, low mobility. Degradation involves oxidation to dioxon and hydrolysis.

ADI: Acceptable Daily Intake (the maximum dose of a substance that is anticipated to be without lifetime risk to humans when taken daily)

NOEL: No Observed Effect Level (the highest dose at which there are no observable differences between test and control populations)

The toxicity of malathion to mammals and birds is slight to moderate, moderately severe for terrestrial invertebrates, and is of low phytotoxicity to most plants (USDA 1993). Toxicity to aquatic organisms is much more severe, being highly toxic to fish, juvenile reptiles and amphibians and aquatic invertebrates. Exposure risks are highest to both terrestrial and aquatic invertebrates, particularly for predatory invertebrates (e.g. spiders), invertebrates with high metabolic rates (e.g. caterpillars) and nectar feeders (ants and bees). Risks are therefore greatest to terrestrial invertebrates, and studies have shown significant and long term residual effects on non-target invertebrates (Dahlsten 1985 cited in USDA 1993). Since predatory and parasitic invertebrates are more susceptible to malathion than pest species a significant risk of post treatment pest outbreaks arises (USDA 1993). Significant decrease in soil invertebrate numbers may result in changes in the physical properties of the soil. Experience in the USA has shown that unprotected honeybee hives can be devastated by malathion bait spraying (USDA 1993). Whilst direct risks to vertebrates from aerial or ground spraying of malathion is considered insignificant, indirect loss of prey may affect population levels. Likewise plants may be indirectly affected by loss of pollinators etc. Risks to sensitive fish and aquatic invertebrates are reduced if spraying regimes are altered to reduce likelihood of runoff (e.g. no spraying before storm weather forecast). Ground spraying poses fewer risks than aerial spraying as spraying is focussed on target areas only.

Soil drench treatment (with diazinon, chlorpyrifos or fenthion)

The half-life of diazinon (an acetylcholinesterase organophosphate) depends on soil moisture, organic content and pH, and may be as long as 10 weeks in a dry, organic-rich and alkaline soil. Likewise, degradation of chlorpyrifos is slowest in organic rich soils. Half-life of chlorpyrifos (also an acetylcholinesterase organophosphate) in most soils is estimated as one month (USDA 1993). Leaching to groundwater is unlikely for either diazinon or chlorpyrifos as these chemicals leach very slowly (USDA 1993), tending instead to remain in the soil surface. Due to this tendency to remain near the soil surface, runoff to surface water following major storms is a likely source of contamination. Breakdown of diazinon is significantly speeded up by increasing irrigation (USDA 1993). Neither diazinon nor chlorpyrifos volatilise readily and pose little risk to air quality in treated areas.

Less information is available on the environmental fate of fenthion (another acetylcholinesterase organophosphate), but soil half-life is estimated to be just 24 hours (USDA 1993). Again, this pesticide does not leach easily, and the greatest threat of contamination is from storm run-off to surface water. However, fenthion is quickly adsorbed by sediment, reducing the possible impact on aquatic organisms.

Acute oral and dermal toxicity of diazinon is low to moderate for humans. Acute oral and dermal toxicity of both chlorpyrifos and fenthion is moderate to severe for humans and considered moderate for other animals (USDA 1993). Chronic toxicity of both diazinon and chlorpyrifos is moderate to high for most animals. Chronic toxicity to humans of fenthion is considered extremely high, and may be a neurotoxin (USDA 1993). No evidence of carcinogenicity has been observed for diazinon, but studies are still lacking for fenthion. Whilst several studies suggest that chlorpyrifos is a non-carcinogen, some results indicate the possibility that the chemical may cause chromosomal aberrations (USDA 1993). Table 1 reports the NOEL for rats and the ADI for humans of these chemicals.

Exposure risks of these soil drenching chemicals to the general public are low, the greatest threat being to small children consuming soil, and adequately avoided by cautioning parents to prevent children from entering sprayed areas until the soil drench has dried. Extreme scenarios of exposure to workers (major dermal contact through spillage) should not raise concern (USDA 1993).

Diazinon, chlorpyrifos and fenthion are generally slightly to moderately toxic for mammals, reptiles, terrestrial amphibians and fish, but are severely toxic to birds and both terrestrial and aquatic invertebrates (including honeybees). Since the exposure is likely to be minimal for aquatic organisms when these chemicals are used as a soil drench, the risk posed to this group is also small. All three chemicals pose some risk to terrestrial vertebrates, and particularly to birds. Fenthion may pose a greater risk than either diazinon or chlorpyrifos to birds. The greatest risk to non-target organisms is to soil fauna, which may result in changed physical and chemical properties of the soil (USDA 1993).

Table A2.4. **Rates of application of chemicals required in eradication or suppression of Medfly**

	Chemical	**Amount active ingredient per hectare**	**Rate of application**
Eradication or suppression of Medfly	Malathion bait spray	0.171 kg/ha	5-21 days
	Diazinon soil drench	4.87 kg /ha	Fortnightly
	Fenthion soil drench	3.9-7.8 kg/ha	Fortnightly
	Chlorpyrifos soil drench	0.07-3.9 kg/ha	Fortnightly
Current control methods	Trichlorfon cover spray	?	Weekly
	Fenthion cover spray	?	Fortnightly
	Dimethoate cover spray	?	Fortnightly

Ref: USDA (1993)

APPENDIX III. Responsibility for Medfly Control under International Conventions

Whose Cost and Benefit?

For plant health Benefit Cost Analysis, factors of benefit and cost are generally limited to the area under management. In the case of Western Australia, this follows the most common situation of all beneficiaries from a control programme being identified within that country. Other models may need consideration under current international agreements, however. Taking a regional perspective would greatly alter the benefit and cost as the territory considered would change.

Current Practices and the World Trade Organization

The World Trade Organization's Agreement on the Application of Sanitary and Phytosanitary Measures (WTO/SPS) embodies the practice of each country determining their own level of risk and appropriate protection. In practical terms, this indicates that a country elaborates measures related to the risk to their own territory, and that other countries maintain their own sovereignty in determining their concept of risk. As risk is based on both the probability of an introduction and spread of an exotic pest and the magnitude of the consequences, the level of risk from the same organism can easily vary among neighbouring countries.

This interpretation of rights and responsibilities has been borne out in examples with fruit fly species of economic significance. Canada is not concerned about these fruit flies because the climate would not allow for establishment over time. The United States of America, however, suffers repeated introductions of fruit fly host material entering Canada and then moving on in transport to the climatically vulnerable USA. This is a particular problem for California where the consequences of such an introduction will be great due to the type of production in that state (National Plant Board, 1999, Section 2.13). Under the WTO/SPS model, most countries consider the spread of fruit fly host material from Canada as beyond its rights to regulate.

Another example is the anxiety of countries over the establishment of the Carambola Fruit Fly (*Bactrocera carambolae*) in Suriname, in Northern South America. Suriname did not have a significant fruit export market. The market that did exist was almost entirely European due to historic trade relationships. At that time Europe was not concerned about the potential entry of this fruit fly into the region. Therefore the Government of Suriname placed far less priority on controlling this pest than did the Governments of neighbouring Guyana, French Guiana, and Brazil. As this was the only establishment of this species in the Americas, in fact Governments Venezuela, Colombia, Chile and all of the Central American countries, as well as the USA felt the risk presented to their countries was unacceptable (Quinlan, pers comm 2001). Eventually (after the species spread to Guyana, French Guiana and Brazil) their pressure changed the attitude of the Government of Suriname so that a regional control programme could begin (see www.carambolafly.com).

International Plant Protection Convention

Some argue that the International Plant Protection Convention (IPPC, 1997) text itself indicates in the preamble that Contracting Parties, which includes Australia, are to prevent the "international spread" of pests into endangered areas (where they could establish and cause economic damage). This obligation may also be supported by Article VII on Requirements in relation to imports, since the location of economic damage is not specified:

"A contracting party may apply measures specified in this Article to pests which may not be capable of establishment in its territories but, if they gained entry, cause economic damage. Measures taken against these pests must be technically justified."

The same Article goes on to note this principle for transiting cargo as well. Yet, countries have consistently applied the IPPC using the trade-related model of the later WTO/SPS.

Convention on Biological Diversity

Regardless of the interpretation of the rights and responsibilities under the IPPC, or the WTO/SPS, a new convention has now altered the legal stand on this issue. The Convention on Biological Diversity (CBD), of which Australia is a Signatory, is quite clear about the obligation to prevent the movement of alien invasive species (which include quarantine pest species) into a neighbour's territories as well as one's own (Article 4, b on jurisdictional scope regardless of where the effects occur and Article 8, h on prevention of introduction of alien invasive species). The CBD goes even further to propose the development of mechanisms for determining international liability and redress in an attitude taken from "polluter pays" legislation.

Although this aspect of the CBD has not yet been implemented, it gives reason to consider whether the biological consequences of the spread of the Medfly from Western Australia to other countries in a region otherwise free from this pest should be considered in a Benefit Cost Analysis. Unfortunately, identifying these other beneficiaries does little to establish "willingness to pay".

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