MEAT & LIVESTOCK AUSTRALIA

on farm

Biological Control of Dock: Enhanced Distribution of the Dock Moth

Project number DAW.057
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ABSTRACT

The main aim of this project was to establish populations of the 'dock moth', *Synansphecia doryliformis*, in Western Australia, South Australia, Victoria and New South Wales, by enlisting the assistance of farmers and landholders to release the moth on their own properties. Moths were mass reared in an Agriculture Western Australia laboratory in South Perth, and distributed to project participants in the form of 'eggsticks' (toothpicks with moth eggs attached). The farmers inserted the eggsticks into the cut stems of approximately 1,000 mature dock plants in a prepared site on their properties. A second aim of the project was to assess the impact of the moth on the dock.

Surveys of the release sites in each State indicated an overall success rate of more than 70%, with the moth persisting in the field years after release. In Western Australia, surveys along transects extending from previously established sites showed that the moth is capable of dispersing at least four km in seven years and up to 1,000 m in a single generation. Assessments of dock density at these sites at the time of release and at various intervals subsequently, have shown marked reductions in the number of dock plants. A spectacular decrease in the abundance of dock elsewhere in the paddock has also been observed at some of the older sites.

These results indicate that the moth has established in Australian pastures, and is having a significant impact on the dock population. The moth is dispersing from the release sites and, in time, its distribution will be complete. Its effect in reducing dock to below economic thresholds will deliver benefits to producers in the form of improved pasture quality and utilisation, as well as reduced herbicide use. This project has served to hasten the delivery of these benefits.

EXECUTIVE SUMMARY

Docks (*Rumex* spp) have long been recognised as difficult weeds for producers to control throughout the high rainfall pasture areas of southern Australia. In 1982, biological control was identified as a possible means of economically controlling docks whilst minimising the use of herbicides on pastures, and improving pasture production and utilisation. Agriculture Western Australia, in a collaborative project with Meat & Livestock Australia (then Meat Research Corporation) and the CSIRO, identified and imported two clearwing moths, which are natural enemies of docks. One of these *Synansphecia* (formerly *Chamaesphecia*) *doryliformis* (Lepidoptera: Sesiidae) from Morocco, was re-synchronised to southern hemisphere conditions, and successfully reared on potted field collected dock plants.

The first releases of the 'dock moth' into pastures of south-west Western Australia were made in 1989. Assessment of these releases showed that although the moth was capable of surviving in the Australian environment, its one-year life cycle dictated that population numbers in the field would increase only gradually, and that dispersal from release sites would also be slow. Clearly, large numbers of moths would need to be released in many locations to establish the insect in pastures, and to gain maximum benefit from its introduction.

Further research funded by MLA between 1991 and 1994 resulted in the development and refinement of a semi-natural mass rearing system based on dock root pieces in a temperature controlled environment in the laboratory. This made possible the large scale production of dock moths required for release. Another important development was the 'eggstick machine', which enabled the robust moth eggs to be glued onto toothpicks. The eggsticks were then inserted into the cut stems of mature dock plants in the field. This technique greatly reduced the labour requirement of field releases and improved the efficiency of laboratory production by overcoming the critical constraints of using newly emerged larvae. The easily handled eggsticks also made possible the distribution and introduction of dock moth into affected pastures Australia wide.

Project aims

The two main aims of the project were:

- to establish 100-125 primary release sites of dock moth in each of WA, SA, Victoria and NSW, by involving producers in setting up sites and introducing the moth onto their own properties;

- to assess the impact of the dock moth on the control of dock in the field.

Two additional aims formulated during the course of the project were:

- to set up a number of benchmark sites in representative areas of Western Australia where the dock moth has established, as well as a number of control sites where it has not been released or has not yet reached;

- to assess the pasture composition in these sites, and the impact of the moth on dock abundance over time.

Project outcomes

The target number of releases of dock moth in each State was exceeded in Western Australia (352) and South Australia (101); was almost achieved in Victoria (96); but fell short of the target in New South Wales (77). However, the total number of dispatches over the five years of the project (626) exceeded what was required to effect 125 releases per State.

The extensive use of the print media, radio and television, Landcare and other community groups, as well as project collaborators, to recruit participants in each State ensured that as many producers as possible were aware of the availability of the dock moth and the potential benefits to be gained from its introduction into pastures. A workshop to train collaborators from each State, and field days to demonstrate release techniques to participants enabled farmers to confidently set up release sites on their own properties. Direct contact with the laboratory in South Perth via a Free-Call 1800 telephone line also facilitated the exchange of information between participants and project personnel.

In WA the moth was found at 73% of release sites set up by farmers and landholders during the course of the project. Whilst not all sites were surveyed in the other States, of those that were, 76% in NSW, 64% in SA, and 53% in Victoria showed evidence of the moth.

The impact of the dock moth on the abundance of dock was assessed at 26 monitoring sites established in Western Australia between 1989 and 1995. Counts of dock plants in these sites were made around the time of release and again one to six years later. The results showed a marked reduction in dock density in each site, from 37.4% two years after release, and up to 100% after five or six years.

Western Australian producers who released the moth on their properties were asked to report any changes in the abundance of dock in and around the release site, and in the surrounding paddocks since the release. A total of 53.4% of participants indicated a noticeable reduction in the amount of dock near the release site, with two sites showing complete absence of the weed. Over 30% also noted a significant decrease in the amount of dock in the paddock in the years following the introduction of the moth.

Fifteen benchmark and five control sites were set up in representative areas of Western Australia. **Pasture assessments were made at all twenty sites** during autumn and winter 2000. Assessments included pasture composition, and numbers of mature and seedling docks, in grazed and fenced ungrazed plots.

These data will provide a baseline against which future assessments will be compared to determine the impact of *S. doryliformis* on the dock.

Conclusions

Improved mass rearing techniques and a simple and efficient system to deliver the agent into the field, coupled with close collaboration with personnel in five States, enabled the successful distribution and release of the dock moth into over 600 sites across southern Australia. This was achieved with the assistance of producers recruited to the project, who set up sites and effected releases on their own properties.

Assessment of the releases to date has shown a success rate of over 70% and persistence of the moth years after release. This is strong evidence that the moth has established. Early

indications that the moth is having a significant impact on docks demonstrate the insect's potential to control the weed and thus benefit producers by reducing herbicide use and improving pasture production and utilisation.

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1. BACKGROUND

1.1 Project history

Concern about dock in Western Australia increased during the 1970s when surveys showed that the weed was a serious problem in high rainfall pastures. In a 1972/73 Agriculture Western Australia survey, John Allen (1974) reported that dock was in moderate to high densities in over 60,000 ha. The high rainfall area surveyed covered approximately 1 million hectares, 42% of which was sown to pastures. More alarming was a later report by Allen (1975), which estimated that dock had expanded its range to about 100,000 hectares. The reasons for the rapid expansion of dock spread were not clearly identified but it was widely accepted that the shift from sheep to cattle and dairy production was an important factor.

Cattle and dairy producers initiated a project in 1980 to investigate the prospects of controlling dock biologically. In 1982, Agriculture Western Australia and Meat & Livestock Australia (then Meat Research Corporation) commenced a long and successful partnership focussed on the biological control of dock in southern Australian pastures. The initial project involved collaboration with CSIRO to find candidate biological control agents in the weed's region of origin, southern Europe and northern Africa.

After three years of tests, conducted at the CSIRO research facility at Montpellier in France, two clearwing moths, *Synansphecia* (formerly *Chamaesphecia*) *doryliformis* (from Morocco) (Lepidoptera: Sesiidae) and *Bembecia chrysidiformis* (from France) (Lepidoptera: Sesiidae), were identified as the most prospective insects. They were found to be totally dependent on dock for survival and had the capacity to destroy the weed in the process of feeding on it. The life cycles of the moths were uniquely adapted to the dock plant with larvae feeding extensively within the taproot of the weed, a key to the weed's survival. These encouraging findings led to the two root boring moths being imported into quarantine facilities at Agriculture Western Australia's headquarters at South Perth in 1987 as project DAW.016.

Two more years were required to synchronise the moths' one-year life cycle from northern hemisphere to southern hemisphere conditions and to rear a generation of moths which could be safely taken from quarantine (DAW.031). *S. doryliformis*, with its wider ecological range, was successfully resynchronised, while *B. chrysidiformis* proved to have a different behaviour to seasonal cues and could not be resynchronised.

After quarantine clearance in 1989, *S. doryliformis* was introduced into 23 selected sites in the south-west of Western Australia, thus marking the initiation of the biological control of dock in southern Australia. In 1991, MLA continued its funding of this program with project DAW.045, aimed at developing ways of enhancing the dock moth's distribution and establishment, with a view to extending releases into all southern Australian States.

1.2 DAW.045 findings

Initial releases of the dock moth showed that although the insect could be established in the field, it was difficult to establish and slow to spread. These constraints would seriously limit the benefits to producers unless methods could be developed to greatly increase the production and distribution of the dock moth. Consequently project DAW.045 was initiated to:

- develop a mass rearing method for the dock moth that would enable its wide distribution throughout southern Australia;

- develop field release techniques that would provide a high rate of inoculation success.

Project DAW.045 was funded from 1991-1994 and developed the techniques necessary to enable the mass rearing and release of the dock moth. The key findings from the research were:

- large numbers of the dock moth could be produced in a semi-natural laboratory rearing system based on field collected dock roots;

- the dock moth life cycle could be manipulated by temperature control to enable mass production during the spring/summer release window;

- dock moth eggs were robust and the most suitable form of the insect to release in the field;

- approximately 1,000 dock plants required inoculation with dock moth eggs to ensure a high rate of establishment in the field.

1.3 The cost of dock to producers

A 20-year seed reserve in the soil and a complex seed dormancy makes short term dock control virtually impossible to achieve. Dock is a poor producer of early feed and serious economic losses begin at 30% of pasture composition. Docks develop rapidly from taproots early in the season and shade out germinating pasture species. Combined with low palatability to stock, the weed has a competitive advantage over pastures and can gradually dominate grazed paddocks. Work done in the late 1970s showed that a rye/clover pasture was capable of producing 2,300 kg/ha. When dock replaced either clover or rye, this could be reduced to 1,500 kg/ha.

The cost of dock control varies greatly depending on the enterprise affected and the chemical options available to the producer. For example, in a mixed farming enterprise the producer may have the opportunity to use selective broadleaf herbicides such as dicamba in cereal crops. Similarly a producer using only perennial grasses as a pasture could also utilise selective broadleaf herbicides to control dock. However, dock regeneration after spraying is common and is caused by the resilient taproot and seed dormancy of about 20 years. The following table illustrates the capacity of dock to dominate pasture after herbicide applications.

Table 1*: Densities of dock (plants/m^2) following spraying with dicamba

Years since spraying	Albany (700 mm average rainfall)	Witchcliffe (1200 mm average rainfall)
0	0.1	0.5
1	2	12
2	18	20
4	57	74
Many	93	70

* Data from 'Productive Pastures Pay', Bulletin 4302, Agriculture WA, 1995.

In addition, relatively cheap herbicide options such as dicamba, 2,4-D and other hormone herbicides are becoming restricted in their availability due to drift concerns to tomato and vineyard production. In these situations more expensive options must be used.

There are no herbicides that provide high levels of mature dock control without seriously affecting clover and other legume components of pasture.

In 1994, a comprehensive benefit-cost analysis of the economic impact of the dock biological project was performed by economists from Agriculture Western Australian and submitted to MLA. Using conservative estimates of both the insect's rate of spread and its impact on pasture production, the project still returned significant national benefits with an IRR of 22%. The research benefit is derived from a decrease in the cost of fighting the dock problem, together with increased pasture utilisation and an increase in animal production per hectare.

Current management practices for dock will become largely unnecessary in the long term. The carrying capacity of pastures, previously affected by dock, should increase by as much as 13%. In directly assessable terms this can be calculated to be as much as $3.6 million annually in WA alone, but indirectly there will be savings far in excess of this figure through savings on herbicides and other control costs.

2. OBJECTIVES

The main aim of the project was to physically increase the number of population epicentres of the dock moth in those States where it has already become established (WA, SA, Victoria, and NSW) in order to accelerate its impact on the weed, and hence increase the rate at which control might be achieved.

The initial project objectives were:

- to establish 200-250 primary release sites of dock moth in each of WA, SA, Victoria and NSW, by involving producers in setting up sites and introducing the moth onto their own properties;
- to assess the impact of the dock moth on the control of dock in the field.

However, after changes in project management in late 1994, and some initial problems with the eggstick machine, project objectives were reviewed and MLA agreed to reduce the number of release sites in each State to 100-125.

A second variation to the contract occurred when a small carryover of funds remained at the end of 1999 and afforded the opportunity to set up some benchmarking sites to study in more detail the long-term impact of *S. doryliformis* on dock weed infestations.

The aims of the benchmarking project were:

- to set up a number of benchmark sites in representative areas of Western Australia where the dock moth has established, as well as a number of control sites where it has not been released or has not yet reached;
- to assess the pasture composition in these sites, and the impact of the dock moth on dock abundance over time.

3. METHODOLOGY

3.1 Rearing the moth

The development rate of *S. doryliformis* can be manipulated by controlling the temperature at which it is reared. The moth's one-year life cycle can be shortened to a few months by exposure to constant 'springtime' conditions, thereby overcoming the winter dormancy which characterises its existence in the field. This finding enabled continuous year round rearing, and greatly facilitated the build-up of colony numbers to provide the millions of eggs required for the release season from October to March.

The moths were reared on mature dock plants collected weekly from infestations near Perth, using two rearing techniques.

3.1.1 Bulk rearing method

Tote boxes containing up to 120, 10 cm-long pieces of mature dock root in moist vermiculite were inoculated with two or three eggsticks (toothpicks with moth eggs attached) per root, and kept in two controlled temperature rooms. The rooms were held at 23-24°C during the release season, and 15°C for the other six months of the year. The low temperature regime slowed down larval development so that moth emergence was reduced during the winter months when the requirement for eggs was low. The relative humidity in the rooms was approximately 60% and the photoperiod was 14 hours light: 10 hours dark. Weekly watering ensured a minimum moisture level around the roots.

Collecting moths from the laboratory rearing facility

3.1.2 Tunnelhouse rearing

This system of rearing differed from the bulk method in that moth production was governed by outdoor conditions and was therefore seasonal, coinciding with the release season and the appearance of moths in the field.

Large field collected dock plants were potted into prepared soil mix (1/3 washed river sand, 1/3 top soil, 1/3 sawdust, 2% Osmocote® slow release fertiliser) in 20 cm plastic pots. Several plants were planted in each pot, and each was inoculated with eggsticks. Up to 600 pots were inoculated between March and July each year and held outdoors in a tunnelhouse covered with 70% shadecloth. Pots inoculated prior to June of each year were placed directly into the tunnelhouse after inoculation, whilst those inoculated later were held indoors for six to eight weeks to enable the larvae to develop to a stage where they could withstand low night-time temperatures. Automatic overhead sprinklers watered the pots daily.

In addition, naturally infested dock plants collected during monitoring of release sites were potted and placed in cages in the tunnelhouse. Eggs collected from these field reared moths were used to supplement the colony in the following season.

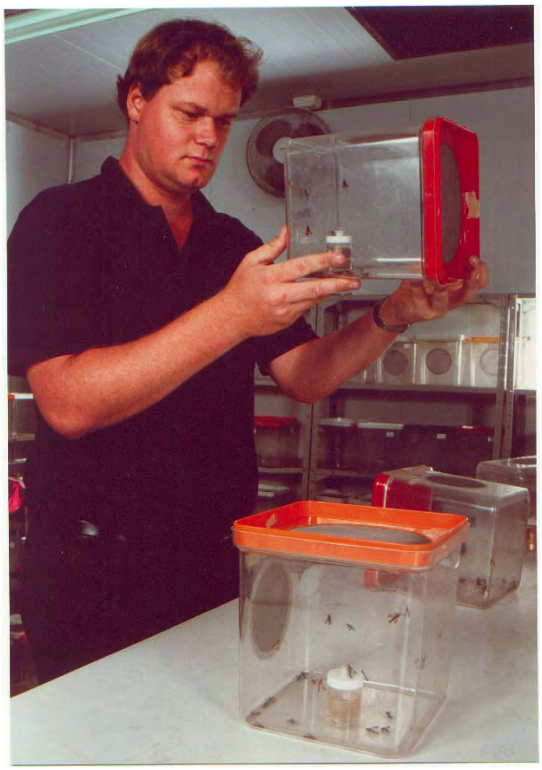
Tunnelhouse dock moth rearing facility

3.1.3 Moth handling and egg collection

Newly emerged moths were collected daily, sexed and counted, and placed into oviposition cages. These consisted of a clear plastic container (20x20x22 cm) with a ventilated lid. Food was provided in the form of a sugar-vitamin solution (30 g sucrose, 30 g dextrose, 3 g yeast hydrolysate, 1 L water, preservative and 2 mL/L of Accomin® vitamin mix) soaked onto cotton dental wicks.

The cages, each containing 15 pairs of moths, were placed in a glasshouse where the temperature was maintained between 18°C and 28°C. Two humidifier units delivering 70% relative humidity were installed when it was realised that the moths required a minimum level of humidity to successfully mate and lay eggs.

The moths were transferred to a new cage every third day for nine days, then discarded. The moth eggs, laid onto the walls, roof and floor of the oviposition cages, were loosened with a stiff-bristled paint brush and collected into a vial. The eggs were weighed to give an estimate of yield (15,000 eggs per gram), placed in ventilated 50 mL vials (0.2 g eggs per vial) and incubated at 24°C and 50% relative humidity until required.



Dock moth oviposition cages

3.1.4 Quality assessment

A quality profile was set up to monitor any changes in moth fecundity and egg hatch which might result from the rearing processes. Egg hatch was assessed from a sample of 200-300 eggs taken from the bulk collection each day. The eggs were placed in ventilated 50 mL vials and held in an incubator (25°C and 50-55% relative humidity). Egg hatch was determined by counting the number of empty eggshells once all the larvae had died.

Moth fecundity was assessed to monitor both production quality and any environmental problems affecting production. It was assessed from individual females as well as from the total daily egg production from all females. The fecundity of a sample of five females each week was assessed by placing pairs of newly emerged moths into 150 mL clear plastic containers with ventilated lids. The moths were provided with sugar-vitamin solution soaked onto dental wicks, and the containers were placed in the glasshouse under the same conditions as the oviposition cages. Females oviposited for the duration of their life, at the end of which the number of eggs produced by each female was counted. A sample of eggs from each female was assessed for egg hatch.

Bulk fecundity was determined by weighing the eggs collected each day, and this value was then used to calculate the average fecundity of moths each month.

Glasshouse oviposition facility.

3.2 Field releases

3.2.1 Eggstick technology

In DAW.045, it was concluded that broad scale production and widespread distribution of the dock moth would be difficult to achieve without the development of new technology to facilitate distribution to landowners and to make releases simple, efficient and effective. Inoculation of plants with live larvae, whilst possible in a laboratory situation, was not suitable for field application, and the dispatch of live moths posed its own logistical problems. The most resilient stage of the moth's life cycle is the egg, which is easiest to collect and handle, transport and store for short periods of time.

As was reported in Milestone #13, a prototype 'eggstick machine' was developed in 1993-94. This enabled moth eggs to be mechanically glued onto toothpicks, which could then be dispatched to landholders to place in the field.

An improved version of the machine was built in the latter half of 1994, and was used to produce eggsticks for dispatch from December of that year. The machine consisted of a conveyor belt assembly with dispensers for dilute PVA (woodworking) glue and moth eggs. The toothpicks moving along the conveyor belt received a drop of glue, followed by a sprinkling of moth eggs, before being unloaded at the end of the conveyor and packaged ready for dispatch. The use of pre-prepared eggstick 'combs' (polystyrene strips with 25 evenly spaced toothpicks inserted along one edge) allowed for increased production efficiency. An experienced operator was able to turn out between 1,000 and 1,500 eggsticks per hour, which were enough to inoculate 1 to 1.5 release sites.

Experience in the laboratory determined that the commonly available flat sided birch toothpick was not strong enough to withstand being inserted into the crown of the dock root.

Much sturdier single-pointed bamboo toothpicks were initially purchased in bulk from a local supermarket, then sourced directly from a wholesaler.

To avoid storage problems, eggsticks were prepared as closely as possible to the time of dispatch, usually within 24 hours, and no more than five days prior to the anticipated hatch date, to allow enough time for them to be placed in the field. Where necessary, prepared eggsticks were stored in an incubator at 20°C before being packaged. Eggsticks to be used in the laboratory were generally prepared on the day they were required.

Dock moth eggstick machine.

3.2.2 Release sites and release methodology

The methodology for establishing a release site and releasing the dock moth was set out in detail in an information booklet for collaborators, produced in 1996, entitled 'Biological Control of Dock - Protocols for successful establishment of dock moth on farms'. A shorter version of the booklet was produced for farmers and landholders conducting releases on their properties (Appendix 1). A copy of the latter was forwarded to prospective participants when they first made inquiries about the project, and a second copy was included with the shipment of eggsticks. It was revised and updated periodically to include improvements and to clarify points raised by the users.

Briefly, release of dock moth eggsticks involved the following steps:

(a) Selection of a suitable site:

A suitable site contained approximately half a hectare of mature dock with a density of at least 10 plants/m^2, and a minimum crown diameter of 1 to 1.5 cm was required. The release

site needed to be safe from waterlogging during winter, and protected from herbicides and insecticides for two years following release.

(b) Pre-release preparation of the site:

The proposed release area, encompassing about 1,000 dock plants, was mown to give dock stems of 5 to 8 cm in length. The area could be in an already mown hay paddock or cut with a brush-cutter, lawn-mower, shears or secateurs, and lightly raked to expose the cut stems.

(c) Release procedure:

Combs with enough eggsticks to inoculate 950-1,000 dock plants per site were supplied to each participant, to be placed into the release area within two days of delivery. Early morning or late afternoon release was recommended.

Eggsticks were inserted securely into the central pith of the cut dock stem, at the rate of one eggstick per plant. It was important that inserted eggsticks were not dislodged in the process, so it was recommended that the release area be marked out with string or pickets, and that progress was in one direction only, backing away from the inoculated plants.

Every mature dock plant in the release area was inoculated until all the eggsticks were inserted. Eggsticks with fewer than three eggs attached, and those which 'lost' their eggs during the release procedure, were discarded.

(d) Post-release maintenance of the site:

Stock and vehicles were excluded from the release site for a minimum of one month after release to ensure the eggsticks were not disturbed before the larvae were able to establish in the root. It was recommended that the release site be fenced, and care taken to protect it from pesticide spray drift.

Typical dock moth release site.

To maximise the chances of establishment and build-up of a large population, consignments of eggsticks were required not to be split between paddocks or properties, nor inoculated plants, moths and eggs 'harvested' for re-distribution.

3.2.3 Releases in Western Australia

(a) Monitoring sites

The dock moth was released at 52 sites in the south-west of Western Australia between 1989 and early 1994. The early releases were made by 'painting' newly emerged larvae directly onto the bases of cut dock stems in the field; eggsticks were used for the later releases. Each site contained between 500 and 7,000 inoculated plants. The sites were surveyed on several occasions in the years following release to obtain data on insect establishment and dispersal, as well as information on impact on the dock population.

Project staff established four additional monitoring sites during the first year of the current project.

(b) Landholder / farmer releases

Participants were recruited to the project through the print media, radio and television interviews, agency publications, and a series of field days (see section on Communication). Inquiries to District Offices of Agriculture Western Australia were also directed to project staff at South Perth. Interested parties were asked to register directly with the laboratory for inclusion in the release program. A 'Free-Call 1800' telephone number was established to enable farmers and landholders from around Australia to speak directly with project staff. Callers were given details of the project and information on conducting releases, and were given the opportunity to ask questions. The interview was also used to establish the suitability of the caller's property as a release site for the dock moth, or whether alternative methods of control would be more appropriate.

Prospective participants were sent printed information including a colour Farmnote with photos of the dock moth, details of its life cycle and effect on the dock plant; and a protocol detailing the requirements for setting up a release site and step-by-step instructions for putting out the eggsticks. The farmers were asked to contact the laboratory again if they had any further queries, and to confirm their participation. Dispatch and delivery details were decided upon over the telephone, and re-confirmed with the participant three days prior to the eggsticks being sent.

Dispatches comprised of 950-1,000 prepared eggsticks (38-40 combs) packed in a polystyrene 'broccoli box'. Farmnotes on the dock moth and dock species identification, a protocol for releasing the eggsticks, and a questionnaire and reply paid envelope were also included in the box. The questionnaire requested details about the release, such as location of the release site, land-use in the area, soil type, dominant dock species, and weather conditions at the time of release. Participants were asked to return the completed questionnaire once the release had been made.

Boxes of eggsticks were dispatched by overnight courier, and were usually delivered by mid-morning on the following day to most towns in Western Australia. Farmers collected the boxes from the courier's agent in the nearest town. Participants resident or working in the

Perth metropolitan area had the option of collecting their box of eggsticks directly from Agriculture Western Australia.

3.2.4 Interstate distribution of S. doryliformis

Distribution of dock moth eggsticks outside Western Australia was either directly to the farmers themselves, or through collaboration with State agricultural agencies who coordinated requests for eggsticks and their distribution to participants. The principal collaborators were NSW Agriculture (NSW), Primary Industries South Australia and SARDI (SA), and Keith Turnbull Research Institute, DNRE (Victoria). A number of Landcare groups and shire weeds officers also acted as collaborators. Whilst Tasmania was not originally included in the project, having declined to become involved in 1989, the Tamar Valley Weeds Strategy Group requested eggsticks to set up two release sites during the 1997-98 season to determine whether the dock moth would survive in southern latitudes.

Boxes of eggsticks were airfreighted to the nearest airport then transferred to a courier for the remainder of the journey to the nearest town for collection. Apart from a few small rural towns in NSW and Victoria, most deliveries were made within 24-36 hours of departing Perth. Where it was known that the journey would take longer than one day, eggsticks were prepared using younger eggs to allow for possible delays in transit.

A workshop for interstate and Western Australian collaborators was held at South Perth in August 1996. The main aims were to demonstrate dock moth rearing, eggstick preparation and dispatch, and release techniques to the participants, and also to develop strategies to better coordinate the distribution of the dock moth to farmers in the various States. Participants were also shown a number of release sites in the south-west of the State to demonstrate techniques for monitoring the insect in the field, and to see the impact of the moth on the dock at close range.

Preparing eggsticks for dispatch.

3.3 Assessment of field releases

Assessment of field releases aimed to answer these basic questions:

- Was the release successful (are there larvae in the dock roots)?
- Did the larvae survive introduction into the field environment (did moths emerge in summer)?
- Are the moths spreading from the point of release (how far and how fast)?
- Is the moth population sustainable (how abundant are the struck dock plants)?
- What effect has the moth had on the dock population (is it working)?

Since *S. doryliformis* spends very little time above ground during its life cycle, monitoring its establishment and assessing its success is best achieved by measuring the disappearance of plants or by the destructive sampling of plants to locate the larvae.

The monitoring sites established by project staff were visited on numerous occasions to check larval survival and moth dispersal. Sites were first visited within six months of release (before moth emergence) to determine whether the release had been successful. The second visit was between one and two years later to determine whether the moths had begun to move out of the release site into the surrounding paddock. Later visits assessed the extent of moth dispersal. Dock density was estimated for some of the monitoring sites at the time of release and again during a subsequent visit (one to six years later). Density was estimated from dock plant counts in randomly thrown quadrats.

e.3.1 Questionnaires and assessment form

In anticipation of a large number of releases, it was originally envisaged that the farmers themselves would monitor the releases on their properties and report the information to project management. Four questionnaires were developed to facilitate data collection from the sites and to ensure that the data for all sites were comparable. The questionnaires were designed to be simple and quick to fill out, requiring the farmer to 'tick' a number of boxes to answer specific questions about the site and the insects found. They were to be sent out to farmers at the appropriate time to obtain information about the release site, to confirm that the release was successful and the insects were surviving, and finally to determine if the moths were dispersing from the site. In each instance the farmer was required to examine the release site for dead dock plants and empty pupal cases, dig up a number of dock plants and break open the roots to check for larvae or the frass-filled tunnels created by their feeding.

However, with an increasing number of properties changing ownership, management and land-use, it was decided that project staff should check all the sites at least once to determine insect survival, and to obtain a GPS reading for future reference. Monitoring was usually conducted during the autumn and winter months when the larvae were large and easily found in the hollowed out dock roots. During the final two years of the project, monitoring continued well into the summer months to ensure that all sites were visited. A two-page assessment form, a combination of the four questionnaires, was completed each

time a new release site was visited. It contained provision for owner and site details, as well as the results of monitoring the site for insect survival and moth dispersal.

The questionnaires and assessment form are included in Appendix 2.

e.3.2 Transects and destructive sampling methods

Moth dispersal was assessed by sampling dock plants along a straight line transect from the centre of the release site. Previous results showed that moths did not move preferentially in any one direction, therefore, a single transect was taken in a direction which presented the fewest obstacles to moth movement, and allowed easy access for sampling.

Between 20 and 60 dock plants were dug up at intervals along the transect. The intervals between samples depended on the age of the site and the abundance of struck plants. At the newer sites, samples were taken at 50 m intervals, whereas intervals of more than 200-500 m were common at the older established sites. The roots of each plant dug up were broken and quickly examined for evidence of dock moth larvae, then bagged for more thorough examination in the laboratory. The transect was extended until a sample failed to show evidence of larval activity in the roots.

In the laboratory, the roots were carefully dissected to reveal the larvae. The percentage of struck plants gave an indication of the abundance of dock moth in the field, whilst the increasing length of the transect over time provided an estimate of the extent and rate of moth dispersal. Live larvae extracted from the field collected roots were incorporated into the colony.

4. RESULTS AND DISCUSSION

4.1 Production

The total production of dock moth, *Synansphecia doryliformis,* for DAW.057, is shown in Table 2. Seventeen percent of the production came from potted plants in the tunnelhouse, which included field reared moths collected during monitoring trips. The total production of dock moth eggs for the five years of DAW.057 was almost 31 million with the maximum annual production occurring during the 1995-96 season, when almost 7 million eggs were collected. This was also the year with the highest moth production.

Table 2*: Summary of annual production of *S. doryliformis* from 1994 to 1999.

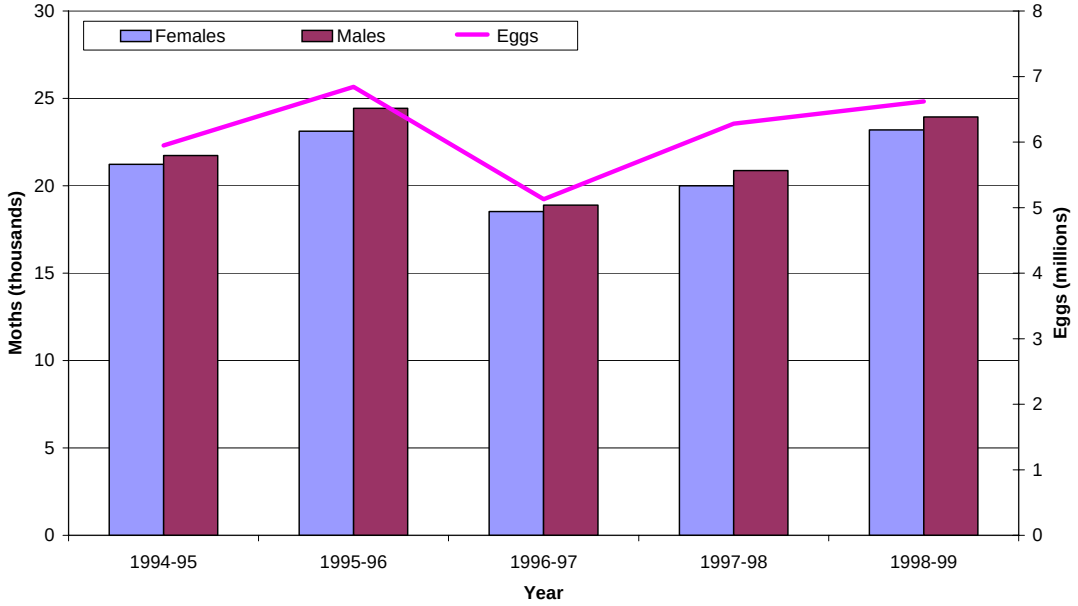
Year	Females	Males	Total	Laboratory	T'house	Eggs
1994-95	21,222	21,725	42,947	37,966	4,981	5,946,750
1995-96	23,1210	24,421	47,524	40,118	7,424	6,842,250
1996-97	18,520	18,890	37,410	29,225	8,185	5,126,700
1997-98	19,996	20,871	40,867	34,030	6,837	6,279,450
1998-99	23,189	23,932	47,121	37,226	9,895	6,619,050
Total	**106,048**	**109,839**	**215,887**	**178,565**	**37,322**	**30,814,200**

* Moths collected from laboratory tote boxes and tunnelhouse pots were combined for rearing purposes.

Annual production of *S. doryliformis* averaged just over 40,000 moths, which was the most that could be produced in the facility without compromising quality (Figure 1). The tunnelhouse and the two controlled temperature rearing rooms were filled with as many inoculated dock plants as the space allowed.

The sex ratio (male to female) was 1.04, which was consistent with that reported for *S. doryliformis* by Scott (1986). This was despite the intensive rearing, which was continuous since the moth's importation in 1987.

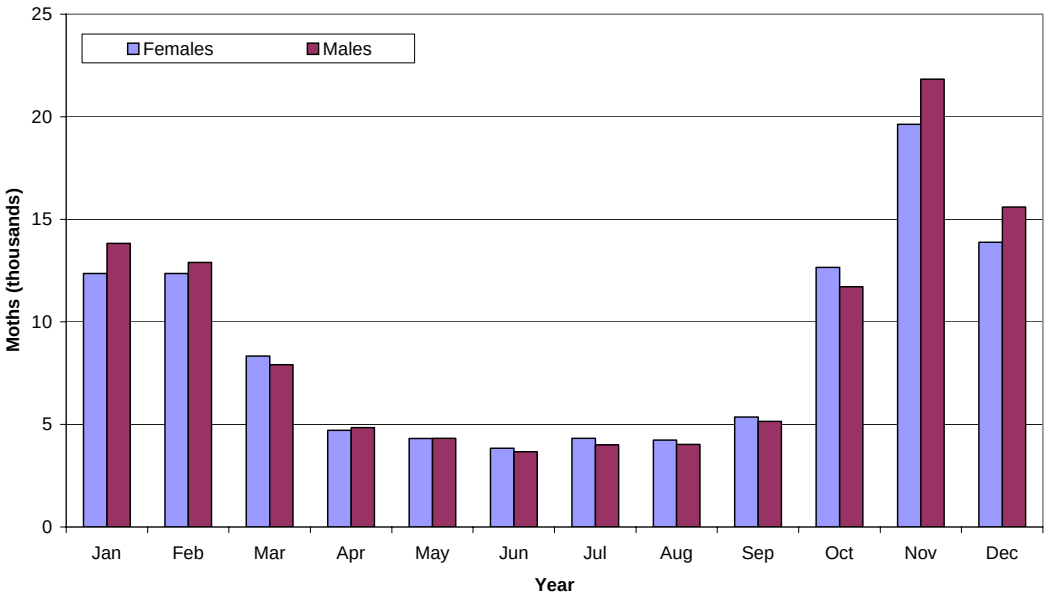
Figure 1: Annual production of female and male *S. doryliformis* and corresponding egg production from 1994 to 1999.



Moth emergence was seasonal, with the greatest number emerging between October and January each year (Figure 2). This seasonality was most marked for moths reared in pots outdoors in the tunnelhouse, as they were obliged to synchronise with the climate. The peak of emergence in November coincided with emergence of moths in the tunnelhouse.

The bulk rearing method under controlled temperatures ensured that moths and eggs were available year round, and the plasticity of the insect's developmental time allowed the larval stage to be completed in as little as two months. This meant that increasing the rearing temperature could artificially boost the number of emerging moths at any one time. This was especially useful in the latter half of the release season when tunnelhouse production had ceased.

Figure 2: Average monthly production of female and male *S. doryliformis* from 1994 to 1999.



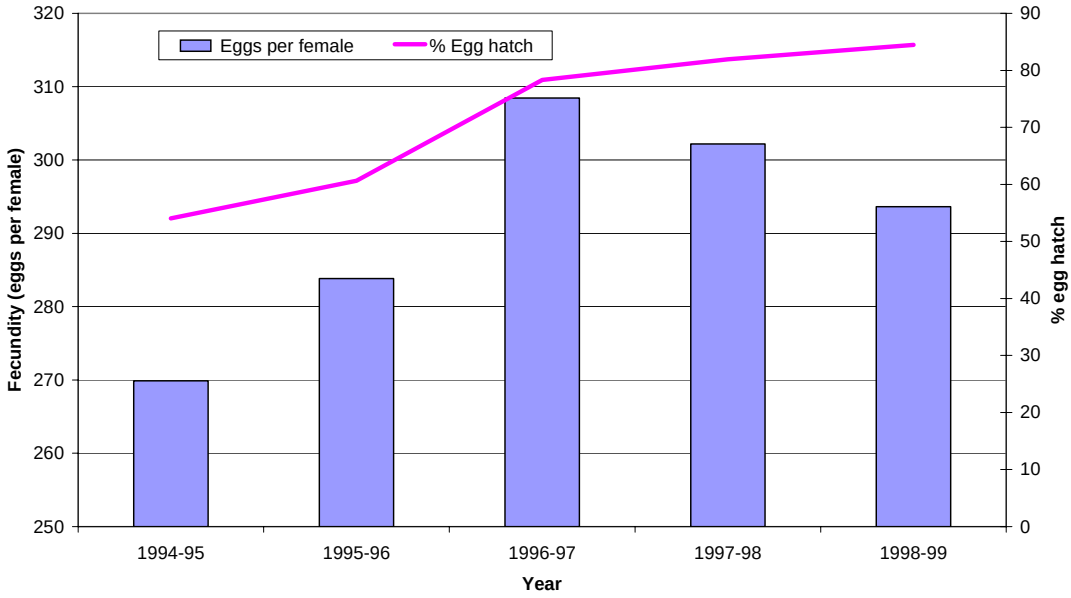
The bulk rearing method using dock root pieces in tote boxes in controlled temperature rooms was more efficient than rearing in pots. A greater number of moths could be produced per unit area, with greater reliability than the pot method. An examination of 50 tote boxes showed that it was possible to maintain an average production of more that one moth per root piece using the tote box method. Emergence from tote boxes began 65 to 70 days after inoculation, and continued for up to a year. In contrast, moths emerged from the pots for a period of two or three months during late spring and summer.

Fecundity is an important part of the insect rearing quality profile as it is sensitive to aspects of the rearing process as well as environmental conditions necessary for good oviposition. Inherited decreases in fecundity and egg hatch, due to rearing methodology, are undesirable for insects being released into the field.

The average fecundity of female *S. doryliformis* for each year is shown in Figure 3. Females laid an average 291.6 eggs throughout their lifetime, with most being oviposited within the first two or three days after emergence. Poor environmental conditions in the glasshouse contributed to the lower than average values in the first two seasons of the project. These were overcome in later years by the installation of humidifiers and fans. Heaters were added during the winter months, as well as additional artificial lighting provided in the form of timer-controlled floodlights. The amount of natural light entering the glasshouse was also increased by the removal of a number of trees near the glasshouse.

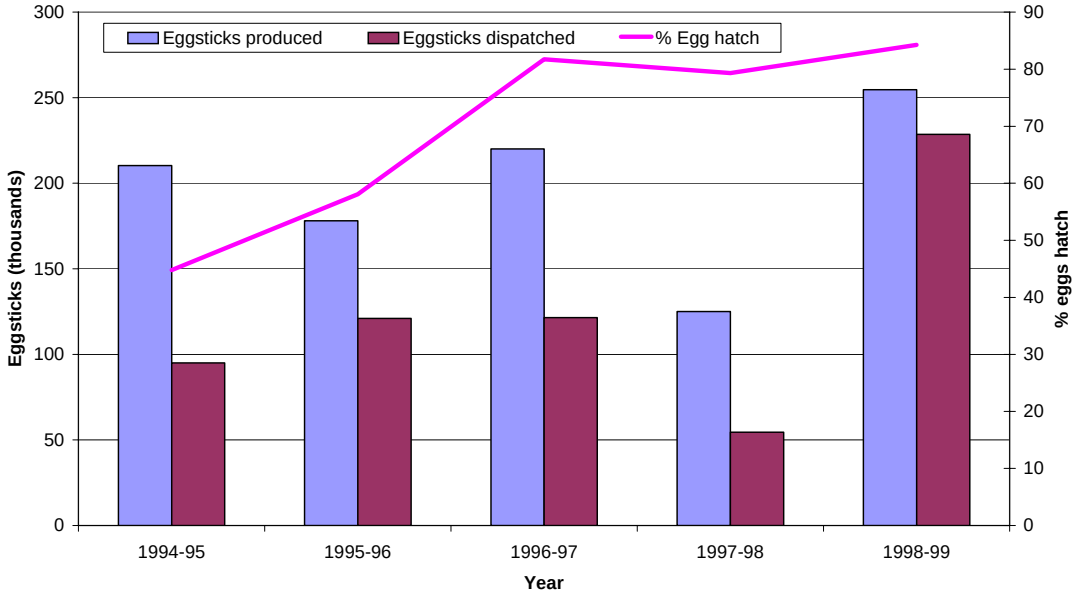
The average fertility of the eggs produced increased steadily throughout the project as conditions improved. The average percentage egg hatch was 71.9%. The high levels of fertility in the last two years of production compensated for the slight decline in fecundity observed at this time.

Figure 3: Average fecundity (eggs/female) and average fertility (percentage egg hatch) for *S. doryliformis* females reared from 1994 to 1999.



The high level of egg fertility in the colony meant potentially high levels of egg hatch from eggsticks placed in the field at release sites. Fertility of the prepared eggsticks was assessed from samples of 25 eggsticks taken randomly from each batch produced. The average fertility of eggsticks dispatched for release was 70.9%, and well above that average for the last three release seasons (Figure 4). The total number of eggsticks dispatched was 620,795, or 63% of the total number produced. Almost all of the eggsticks produced in the last season were available for dispatch as they were not required in the colony.

Figure 4: Annual production and dispatch of eggsticks, and average fertility (percentage egg hatch) of eggsticks.



4.1.1 Discussion

Annual production of *S. doryliformis* reached a maximum and steady level of about 40,000 moths, due mainly to the space restrictions imposed by the size of the rearing rooms and the tunnelhouse. Another limiting factor was the number of dock roots available for inoculation each week. Roots were collected two or three times per week from infested properties located up to two hours drive from Perth. In the early years of the project, this was relatively easy to do but later became more difficult as large rooted docks became harder to find close to Perth, or properties became release sites for the moth. An initiative to grow docks from seed on an Agriculture WA field research station in 1994 proved of limited use as the docks took more than two years to grow to the required size and only a limited number of plants could be grown at any one time.

Improvements in the rearing techniques and, particularly, the environmental conditions provided for the moths from 1996 onwards, resulted in a significant increase in the number of eggs available for dispatch. This was due to increases in the fecundity of the moths and the fertility of the eggs they produced.

There was a 31% reduction in the number of *S. doryliformis* produced between October and December 1997, compared to the same time the previous year, due to a small moth, *Opogona omoscopa* (Lepidoptera: Tineidae), feeding on the dock roots. The moth was found mostly in the tote boxes in the controlled temperature rooms and, to a lesser degree, in the potted dock plants in the tunnelhouse. Its presence was easily noted by mounds of dry granular grey-black frass around the dock root, and its feeding activities quickly reduced the root to an outer epidermis full of frass. Much smaller than *S. doryliformis*, several *O. omoscopa* larvae were able to feed in each dock root, and even the smallest root pieces contained larvae. The moth was also reported from the CSIRO glasshouses in Floreat, WA, where it was infesting potted *Emex australis* plants. At Keith Turnbull Research Institute in Frankston, Victoria, the moth was found in potted horehound plants being grown to rear *Chamaesphecia mysiniformis*. In both cases it destroyed the roots and killed the plants.

O. omoscopa is native to Australia, and quite common, having originally been reported by Meyrick in 1893 (cited in Davis, 1978). It feeds mainly on dead and/or rotting plant material, but has been known to feed on live plant tissue where this is in contact with decaying plant debris. It is of little economic importance, although it has been reported to cause damage to flower bulbs and sugarcane buds, particularly where the tissue has been previously damaged by another agent (Robinson and Nielsen, 1993). It has a shorter life cycle than *S. doryliformis*, preferring conditions of high humidity and temperature, and low light.

It is not known for certain how the insect came to be introduced into the dock moth colony. Two possible sources are infested plants collected from the field or, more likely, infested jarrah woodchips used in the bases of the pots. The tote boxes may have become infested via the potted dock plants being held in the same room.

As insecticides could not be used to eliminate the moth, and to discard the infested boxes would severely set back the rearing schedule, a number of other control options were explored.

Yellow and white sticky traps and a number of different pheromone traps for moth pests of fruit, placed on the walls and hung from the ceiling in one of the rearing rooms, proved totally

ineffective in attracting the moths. This was not an unexpected result as the species is not considered a pest and consequently there are no specific traps available.

Some moths were attracted to the UV light of insect electrocution units when the room lights were turned off, but most were attracted to the UV light reflecting off the white walls. Many pairs of moths congregated on the walls within minutes of the lights being extinguished, and it is thought that the species possibly mates at night. The moths were swatted (with a fly swat) as they rested on the wall.

Swatting was replaced by twice daily vacuuming with a domestic vacuum cleaner, after the dock moths had been collected. The moths were vacuumed from their resting places on the dock roots, the undersides of the boxes and benches and the walls and floors of the room. The number of *O. omoscopa* moths began to decline after two months of intensive vacuuming, which was continued until the moth was eliminated.

Insect-proof screening was installed in the rearing rooms to confine the *O. omoscopa* and to prevent re-infestation once a room was cleaned. Tote boxes of roots were discarded as soon as the peak of dock moth emergence had passed, and the remaining infested boxes were moved to a single room. In addition, newly prepared boxes of roots were dipped in a weak pyrethrum solution before being introduced into the clean rearing room for inoculation with dock moth eggs.

4.2 Releases

Releases of dock moth eggsticks were made in all of the southern Australian States during the five years of the project. The seasonal distribution of dispatches to each State is shown in Table 3. The greatest number of dispatches was to farmers in Western Australia (56.0%), followed by SA (16.1%), Victoria (15.3%), NSW (12.3%) and Tasmania (0.3%). The total number of dispatches between 1989 and 1999 was 716.

Table 3*: Dispatches of eggsticks made to each State each release season, 1994-95 to 1998-99

Release season	Western Australia	Victoria	New South Wales	South Australia	Tasmania	Season totals
1994-95	95	6	0	0	0	101
1995-96	104	5	0	15	0	124
1996-97	27	35	13	49	0	124
1997-98	9	17	22	4	2	54
1998-99	119	34	42	33	0	228
1994-99	**352**	**96**	**77**	**101**	**2**	**628**
Pre-1994	57	9	8	14	0	88
Total	**409**	**105**	**85**	**115**	**2**	**716**

* Each dispatch comprised enough eggsticks to establish one release site (950 eggsticks). Dispatches prior to 1994 comprised moth eggs; the newly hatched larvae were 'painted' directly onto the prepared dock plants. Releases of larvae were conducted by project staff in WA and agency collaborators interstate.

The number of dispatches is generally indicative of the number of release sites set up in each State. The exact number of release sites, and therefore potential epicentres for new populations of dock moth in Australia, depends on the fate of the individual dispatches. Some were used to re-inoculate previous release sites which, on inspection, appeared not to have been successful. Some dispatches were divided between release sites in the same paddock, or different paddocks on the same property, or even between different properties, a practice that was actively discouraged. Dividing the dispatch between sites may have contributed to some of the releases not being successful or not persisting beyond the first year due to the small number of moths emerging from a restricted number of inoculated plants in the site.

For a variety of reasons, a small number of dispatches were not used at all. In Western Australia, three release sites were ploughed under before they were checked because the farmer thought that the moth hadn't survived. In addition, a small number of dispatches were sent to farmers resident in one State who made the release on property in an adjacent State (eg. between SA and Victoria).

In the 1996-97 release season, the number of requests for eggsticks far exceeded the number available for dispatch. This was mainly due to the interest generated by the coverage on the Cross Country news program, which was broadcast on national television on the last Saturday of November 1996. Interested farmers and landholders from both Western Australia and interstate began phoning the Free Call telephone number within hours of the program being shown, and necessitated the use of an answering machine to take calls outside normal working hours.

The number of plants inoculated for the following year was increased to enable supply of eggsticks to those farmers who missed out in 1996-97. However, production during the peak emergence and release period of the 1997-98 season suffered due to the *O. omoscopa* infestation. In addition to this, the effects of the El Nino were being felt in most States. Farmers reported that the docks had dried off earlier than usual due to the dry conditions, and that the stems were too brittle to insert the eggsticks. Consequently, there were far fewer participants during that season, even though many had indicated a willingness to conduct releases when contacted earlier in the year.

The large number of dispatches in the final year of the project was possible because nearly all the eggs produced were available for dispatch. Farmers and landholders were also made aware of the fact that the eggsticks would no longer be available after March 1999, and many participants from previous years requested additional dispatches, based on promising indications of success in their previous release sites.

4.2.1 Western Australian releases

Map 1 (following page) shows the final distribution of release sites for *S. doryliformis* in Western Australia for all release years, 1989 to 1999. Releases were made from Gingin (north of Perth) to east of Esperance in the south-east of the State. Most of the releases were along the coastal plain between Perth and Augusta, coinciding with the areas of highest rainfall and highest concentration of dock infested property (see Appendix 4).

4.2.2 Interstate releases

Maps 2, 3, and 4 (following the WA map) show the distribution of *S. doryliformis* release sites established between 1994 and 1999 in each of South Australia, Victoria and New South Wales respectively. Two releases were made in northern Tasmania, one on either side of the estuary in the Tamar Valley; but these sites were not mapped.

4.3 Assessment

The results of surveys to determine the status of the dock moth release sites in all States are shown in Table 4. With the exception of the two Tasmanian releases, more than half of the release sites surveyed in each State showed evidence of moth activity. In Western Australia, where all the release sites were surveyed, over 73% showed evidence of larvae. If the remaining sites show a similar rate of success to those that have already been checked, the chances of the insect becoming firmly established in the dock infested areas in Australia appear assured.

Table 4*: Results of monitoring of release sites set up between 1994 and 1999 in all States.

	WA	Victoria	NSW	SA	Tasmania	Total
Sites	352	96	77	101	2	628
Checked	352	47	37	25	2	463
Positive	257	25	28	16	0	326
% Positive	73.01	53.19	75.68	64	0	70.41

* 'Positive' indicates the presence of larvae, or evidence of larval activity (tunnelling, frass, exuviae). Monitoring was conducted during the larval stage of the moth's life cycle (autumn-winter), when the chances of finding larval activity are greatest.

4.3.1 Dock moth abundance

Persistence of *S. doryliformis* within and around the release sites, two or three years after release, is evidence of establishment of the moth. Table 5 shows the abundance of dock moth larvae in plants sampled both within and at various distances along transects from the centre of the release sites.

Higher incidences of struck plants at the younger release sites were indicative of the large population still resident close to the site, and little dispersal away from it. The older release sites yielded lower levels of struck plants because the moths were widely distributed and the density of dock near the site had been reduced.

Table 5*: Abundance of *S. doryliformis* larvae in dock plants in and around release sites established in Western Australia between 1989 and 1999.

Release year	Total sites	Sites with dock moth	% Plants struck (Range)	% Plants struck (Average)
1989-90	24	14	2.6-30.8	13.1
1990-91	11	8	2.1-36	11.2
1991-92	2	2	12.1-30.1	21.1

Release year	Total sites	Sites with dock moth	% Plants struck (Range)	% Plants struck (Average)
1992-93	4	3	2.5-7.5	4.2
1993-94	11	11	1.3-19.2	7.9
1994-95	97	59	0.8-100	19.8
1995-96	104	74	1.8-95.2	20.2
1996-97	27	23	1.1-76	24.6
1997-98	9	6	20-76.2	39.2
1998-99	119	100	1.3-78.9	19.7

* Not all sites were surveyed in the same year. Results indicate the situation at the last survey date, and include data from all plants dug up at the site at that time.

The results in Table 5 demonstrate that release sites have continued to show persistence of *S. doryliformis* many years after the moth was introduced.
Clearly the moth is established.

4.3.2 Dock moth dispersal

Table 6 shows dispersal data for 48 release sites established between 1989 and 1998. The results of surveys along transects extending from sites of various ages showed that moths began to move out into the paddock as early as the first year after release, and that the distance covered progressively increased with each generation (year). Significantly, struck plants could be found relatively easily over large distances, where the probability of detecting larvae is low, due to the ever increasing area that the moths have dispersed into.

Table 6*: Maximum dispersal of *S. doryliformis* from release sites established in Western Australia between 1989 and 1998.

Years since release	Sites with dock moth	Maximum dispersal (m)		
		Mean	Mean/year	Range
10	4	2312.5	231.2	1250-3840
9	1	300	33.3	300
8	0	0	0	0
7	3	1,766.7	252.4	500-4,000
6	3	1,200	200	750-1,600
5	9	755.5	151.1	375-1,500
4	2	600	150	600
3	8	233.8	77.9	30-500
2	16	263.4	131.7	30-2,000
1	2	40	40	30-50

* Not all sites were surveyed in the same year. Results indicate the situation at the last survey date, and include data from all plants dug up at the site at that time. Sites are grouped according to the number of years since release at the time of the last survey, rather than release year. There were no data for eight-year-old release sites.

Whilst the maximum dispersal detected, and the rate of dispersal each year were not consistent between sites of similar ages, it is evident that the moth is capable of dispersing 4 km in seven years, and up to 1,000 m in a single generation. The variability is due to a number of factors, including the age of the release site, the size of the resident population of dock moths, the availability of suitable dock plants within the release site, and the density of docks in the paddock surrounding the site.

As the moth population increases in size, the number of mature dock plants with large roots capable of supporting moth larvae in the release site decreases, forcing the moths to move further afield. With each passing generation, the number of suitable dock plants further and further from the site also diminishes, creating a ripple effect as the moths disperse. It follows that the rate of dispersal will be less if there is a very dense infestation of dock in the paddock, but will be greater in patchy situations. The rate of dispersal each year will increase as the dock population succumbs to the moth.

These results indicate that within a very few years, the moth populations will begin to merge with one another and thereby complete the distribution of *S. doryliformis* in WA.

4.3.3 Effect on dock density

Table 7 summarises the results from surveillance of dock density in 26 monitoring sites established between 1989 and 1994. Dock densities in the sites were estimated around the time of release and again one to six years later. The data show considerable reduction in the number of dock plants at each site, from 37.4% two years after release (site 38), to 100% after five years (site 39) or six years (site 14). (Monitoring site details are shown in Appendix 3).

The reduction in dock density was consistently highest in those sites surveyed one year after release. This can be explained by the fact that all the plants in the release site were inoculated with eggsticks, and a high kill rate would be expected. The percentage reduction in dock density in the site then decreases with time as the moths disperse over a greater area, and encounter more plants on which to oviposit. For sites surveyed one year after release, the mean percentage reduction in dock each year was 67.2%; after two years it was 30.3%; four years 22.9%; five years 14.4%; and six years 14.7%.

The moth is clearly having a major impact on the dock population.

Table 7*: Reduction in dock density in monitoring sites established in Western Australia between 1989 and 1994.

Release year	Site No.	Initial density (plant/m^2)	Final density (plant/m^2)	Years	% Reduction	% Reduction per year
1989-90	6	14.5	2.8	1	80.7	80.7
	12	121.5	0.6	1	99.5	99.5
	14	48.5	0	6	100.0	16.7
	15	36.5	6.0	6	83.6	13.9
	18	58.5	12.2	6	79.1	13.2
	20	5.0	2.8	5	44.0	8.8
1990-91	29	12.0	4.0	1	66.7	66.7
	31	30.0	1.4	1	95.3	95.3

Release year	Site No.	Initial density (plant/m^2)	Final density (plant/m^2)	Years	% Reduction	% Reduction per year
	33	48.0	3.4	6	92.9	15.5
	36	18.1	1.5	4	91.7	22.9
1991-92	37	26.0	14.6	1	43.8	43.8
	38	17.4	10.9	2	37.4	18.7
1992-93	39	8.8	0	5	100.0	20.0
	41	32	1.2	6	96.2	16.0
	42	21	8.2	1	60.9	60.9
	43	17.5	7.8	1	55.4	55.4
1993-94	44	54.5	17.4	1	68.1	68.1
	45	31	8.2	1	73.6	73.6
	46	56	32.2	1	42.5	42.5
	47	18.6	8.8	1	52.7	52.7
	49	18.6	4.4	2	76.3	38.2
	50	14.5	4.6	2	68.3	34.1
	51	35.5	8.6	6	75.8	12.6
	52	42	2.6	6	93.8	15.6
	53	23.2	5.2	6	77.6	12.9
	54	53	1.6	6	97.0	16.2

* Dock densities were estimated from quadrat counts, except sites 36, 38, 47 and 50, where initial density was estimated from the number of plants in the release site divided by the area of the release site. 'Years' indicates the interval between the initial and final estimates of density.

Dock moth impact at Mount Barker, WA, before release in 1994 (top), May 1995 (middle) and May, 2000 (bottom).

Dock moth impact at Margaret River ,WA, in March, 1994 (top), May, 1995 (middle) and May 1996 (bottom).

5. BENCHMARKING

5.1 Introduction

The purpose of benchmarking is to establish a baseline measure of the status of dock and the dock moth in Western Australia at the conclusion of the dock moth biological control project. This 'benchmark' can then be utilised to measure the biological and economic impacts of the dock moth's introduction over time. Without quantifying the project's impacts, the long-term benefits of the project could otherwise be unmeasurable, or even unnoticed, due to the relatively slow rate of change. Bear in mind that it is estimated that the dock moth will require about 25 years to complete its spread throughout Western Australia.

Benchmarking was not a component of the original project concept but, at the planned completion of the project in 1999, a surplus of carryover funds had accrued due to economies of scale and generous coverage of staff overheads by Agriculture Western Australia. MLA agreed to utilising the carryover funds to establish 20 benchmark sites in Western Australia. Thus the 1999/2000 year was utilised to locate, establish and quantify the status of dock across a wide geographic portion of the State where dock moth releases had been made in previous seasons. This cost-neutral initiative adds significant value to the project by enabling economic benefits to be tracked over time.

5.2 Site selection and locations

The criteria used to select benchmark sites were:

(a) Wide geographic spread across WA.
(b) Five 'control' sites included with 15 'standard' sites.
(c) Availability of grazed and ungrazed plots on farm.
(d) Enthusiastic farmer collaborators.

Control sites were selected on the basis of their relative isolation from dock moth release sites so that, at least in the initial years, a comparison between dock moth and non-dock moth farms could be made. However, it is recognised that 'control sites' will eventually become 'standard sites' as the dock moth spreads but nevertheless enables an initial contrast to be made.

The final distribution of benchmark sites is shown in the following map.

5.3 Methodology

The guiding principles of benchmark methodology are simplicity and duplicability. These are important criteria and recognise that current staff have and will move on to new areas of employment with a concurrent loss of background knowledge and relevant skills. Consequently, benchmarking methodology has established simple monitoring techniques that can be undertaken by inexperienced staff yet deliver quantifiable impact assessments.

All benchmark site details and assessments are recorded on a MS Access database maintained by Agriculture Western Australia. Site location parameters are detailed and include property location identifiers such as owner name, phone contact, address, GPS

coordinates as well as enterprise details such as stock type, stocking rates, pasture use, cropping history, soil type and others.

Each benchmark property has a pair of pegged and signposted plots that are used for data measurement. The plots are 5 metres x 5 metres in size for each of the grazed and ungrazed treatments. Obviously the ungrazed site is fenced, with either electric or conventional ring-lock/barbed wire depending on the property involved. The four corners of the plots are marked with painted surveyors pegs and also have GPS coordinates recorded. In addition, photographic records of each plot and the general dock infestation in neighbouring paddocks have been kept to enable visual impact records of the properties to be tracked over time.

Data collected at the sites aim to measure both pasture composition and insect impact at each plot. The monitoring data are summarised in the following.

(a) Pasture composition:

From each grazed and ungrazed plot, five quadrat samples are taken from which an estimate of pasture composition is calculated. The location of the quadrat samples is recorded and the same quadrats will be used in subsequent years. The percentage of each pasture component is a simple visual estimate of ground cover at the time of sampling in autumn, within a month of the season 'break'. The visual estimate parameters for each sample are shown in the following table.

Plant species	**% Coverage**
Dock	
Grasses	
Clover/legumes	
Other weeds	
Bare ground	

(b) Dock abundance:

Concurrent with the pasture composition estimates in autumn are more detailed estimates of dock abundance from the same quadrats. In this case both mature dock and seedling counts will be made as a means of determining whether dock seedling plants, or other species, are replacing mature dock plants killed by the dock moth. The dock count parameters for each sample are shown in the following table. The same data will be collected for grazed and ungrazed plots.

Quadrat number	**Number mature dock**	**Number seedling dock**
1.		
2.		
3.		
4.		
5.		

(c) Dock moth confirmation:

At sites where dock moth activity is unknown, dock plants will be dug from the surrounding area to confirm the presence or absence of the biological control agent. A site will be deemed to be free of dock moth if 50 dock plants have no larval infestation.

(d) Dock moth impact:

A summer survey will be used to estimate the impact of dock moth in both grazed and ungrazed plots. The same quadrats as the autumn/winter surveys will be used for the summer assessments. **However, destructive sampling required to estimate the percentage of mature dock plants infested with dock moth must be taken from the surrounding plot area, not within the quadrats.**

The following table summarises the data collected in the summer survey.

Quadrat number	Number dock stems	% Infested plants
1.		*Score from 50 plants dug from plot surrounds*
2.		
3.		
4.		
5.		

(e) Photographic records:

At each monitoring event, photographs of the grazed and ungrazed plots, and the surrounding paddocks, will be taken to include identified landmarks so that a photographic history of the sites can be accumulated over time.

Typical benchmarking site.

NB: A summary of all initial benchmarking data is compiled in Appendix 4.

5.4 Future assessments

The aim of the benchmarking initiative is to facilitate the measurement of dock moth impact on the dock population over the next 25 years as the insect spreads and achieves its maximum impact. Measurements of pasture composition and dock abundance will enable changes to pasture productivity to be estimated and this can be linked to economic benefit to producers. At the time of the surveys farmers will complete a questionnaire so that economic parameters can be assessed. Questions include statements on herbicide use, paddock use, stocking rates, enterprise changes and others. The project will therefore be positioned to measure long-term benefits accruing from dock biological control.

The frequencies of monitoring and funding arrangements to undertake benchmark site assessments have not been developed. However, it is hoped that autumn and summer surveys will be completed with Agriculture WA funds in the first 2 years after the completion of the project (2001 and 2002). Although dramatic change in the measured parameters is not expected within this timeframe, it is nevertheless important to develop strong early collaborator support and confirm baseline data. After this the frequency of monitoring could be spaced out to as little as once every 5 years but complemented by annual postal questionnaires and feedback to collaborators.

6. COMMUNICATION

The biological control of dock project received a varied exposure in the media, and was well publicised to farmers in WA through AGWEST publications.

6.1 Press releases

25 August 1994	*The Countryman* Moth takes toll of dock
26 September 1995	*Albany Advertiser* South-west farmers test a new method of dock control
5 October 1995	*The Countryman* Dock moth called in to control pasture weed
5 October 1995	*Farm Weekly* Biological control of dock shows promise
24 May 1996	News release WA bred dock moth headed east

6.2 AGWEST Farmnote and Journal articles (see Appendix 6)

1992	Journal of Agriculture, Dept of Agriculture WA, Vol. 33 p. 152-5 Clearwing moths are key to dock control

1995	Agriculture Western Australia, Farmnote No. 70/95 Dock moth – a biological control for dock
1999	Primary Focus, Agriculture Western Australia, No. 5 p. 3 Controlling dock – success!

6.3 AGWEST newsletter to farmers

The *Agricultural Memo* is a regular newsletter to farmers produced 3-4 times per year by the District Offices of Agriculture Western Australia. It contains topical articles relevant to the farmers of the District in which it is circulated. A selection of the articles on the biocontrol of dock project include:

January 1992	Dock (Bunbury)
August 1993	Clearwing moth for dock control (Busselton)
April 1994	More releases of the dock clearwing moth are planned (Harvey)
September 1994	Moth takes toll of dock (Manjimup)
December 1994	Dock control (Albany)
January 1996	(Free!) Biological control of dock – farmers needed! (Harvey)
November 1996	Dock biocontrol (Harvey)
December 1996	Free biological control – Free phone 1800 683 585 (Manjimup)
December 1996	Free biological control (Bunbury)
December 1997	Biological control of dock (Harvey)

6.4 Agricultural publications

April 1993	*Farming Ahead with the Kondinin Group*, No. 16, p. 40-41 Clearwing moths hold key to dock control Kingsley Fisher, WA Department of Agriculture
February 1994	*Hoofbeats*, Vol. 15 No. 5, p. 19 Biological control for dock infested pastures
September 1997	*Farming Ahead with the Kondinin Group*, No. 69, p. 66 Moth scores points in the war against dock Geoff Strickland and Roselia Fogliani, Agriculture WA

6.5 Field Days and Workshop

9 December 1994	Don and Ken MacLeay's Blackrock Angus Stud Vasse Highway, Vasse
9 December 1994	Cos Cordi's Dairy Warner Glen Road, Warner Glen
8 February 1995	Kerry, Geoff and Ian Littlefair's Dairy Vasse Highway, Pemberton
20 September 1995	Andrew and Liz Marshall's farm South Coastal Highway, Denmark

10 October 1995	Beef Focus Farm Field Day Tom Grisdale's farm Bessell Road, Rosa Glen
27-28 August 1996	Biological Control of Dock Workshop Agriculture Western Australia, South Perth

6.6 Other

1992	Cross Country Rural News program (national television)
1996	Cross Country Rural News program (national television)

Project staff were interviewed by national and rural radio stations on various occasions during the project. The interviews were mostly broadcast at the end of winter or early spring to coincide with recruitment of new participants, or in response to a press release.

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8. ACKNOWLEDGMENTS

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Important interstate collaborators include Ian Faithful (Victoria), Dennis Hopkins, Ken Henry and John Heap (SA), Barry Sampson, Bob Thurling, Peter Proctor and Paul Sullivan (NSW). Their collaboration and untiring efforts were fundamental to national success.

Finally the assistance of a very large number of AGWEST staff is gratefully acknowledged. In particular, the key technical officers employed in the project were invaluable. Dane Gehradte, Dawn Hutchinson, Shelley McDavitt and Mark Pleysier worked tirelessly seven days a week throughout the project to maintain the dock moth colonies. Kingsley Fisher managed earlier projects and was fundamental in the design and concepts utilised in this project.

Many other AGWEST advisers and staff, including public relations and support personnel, contributed greatly and all are acknowledged for their efforts. Special mention is made of Bill Russell, Bill Smart, Ron McTaggart, Mike Grimm, Ernie Haggett, Phil Barrett-Lennard and Tom Sweeny.

Photographs were taken by Simon Eyres, Peter Maloney and Mark Pleysier.

APPENDIX 1

BIOLOGICAL CONTROL OF DOCK PROGRAM

Research by the Western Australian Department of Agriculture and the Meat Research Corporation over the past decade has resulted in the importation and release of an insect that is capable of controlling dock. The insect, a clearwing moth called *Chamaesphecia doryliformis,* has been released at more than 200 sites in the south-west of Western Australia over the past four years and has established at more than half of these sites.

Current research has concentrated on developing a technique which will enable producers to assist with the widespread distribution of the insect in dock-infested areas. The technique involves placing 'eggsticks' onto the dock plants in the field during summer. Eggsticks are toothpicks with moth eggs glued to them; the eggs hatch in the field and the small larvae immediately attack the root of the dock plant.

A number of criteria for site selection and preparation are essential to establishing the insect using the eggstick technique. The following protocol for eggstick release is recommended to ensure successful establishment of the moth. If you have any questions or comments, please phone Roselia Fogliani or Geoff Strickland on **Free call 1800 683 585** or 08 9368 3886 and 08 9368 3756 respectively; or fax 08 9368 3223.

REQUIREMENTS

(a) Half a hectare of 'mature' dock with a density of at least 10 plants/m^2

The actual size of the release site will vary depending on the dock density, but should include about 1000 plants. It is essential that there be an adequate supply of dock in the immediate vicinity of the release site so that the new moths will have plants nearby upon which to lay eggs.

(b) The dock roots should be at least 1-1.5 cm in diameter

Roots smaller than 1 cm in diameter may not provide enough food for the larvae to complete development.

(c) The proposed release area must not be sprayed with herbicides or insecticides prior to release

A suitable time interval between spray application and release of the insects has yet to be determined, but will depend on the persistence of individual chemicals in the field. In addition, producers should ensure that chemicals are not applied in the immediate vicinity for at least 2 years post-release.

(d) Areas of dock which are low-lying and prone to flooding in winter should be avoided

(e) The release area must be left undisturbed for a period of 2 years after the initial release and it is recommended that the area be fenced for this time

If fencing is not possible, stock and vehicles are to be excluded for at least 1 month post-release to ensure that eggsticks are not disturbed before the larvae establish in the dock root. The actual release area must be marked by star-poles, or something similar, so that future impact assessments can be made.

(f) The release area must be accessible to Departmental staff who will regularly monitor the progress of the insect.

PRE-RELEASE

(a) Mow release area so that dock stems are about 5-8 cm long

The area could be located in a mown hay paddock, or cut with a domestic lawn mower, brush-cutter, hand shears or secateurs. The area can be raked lightly, if necessary, to expose the cut stems. Some ground cover left behind will provide protection from the high temperatures experienced at soil level.

EGGSTICK DELIVERY

(a) 'Combs' of eggsticks in polystyrene strips will be provided. Sufficient eggsticks to inoculate 800-1000 dock plants will be packed into broccoli boxes for transport by commercial carriers. The boxes should be kept cool but not refrigerated before use.

(b) Delivery will be to the nearest depot of an appropriate transport agent. When possible, several consignments will be despatched to a central pick up point, such as a Department District Office, for collection.

(c) Producers will be notified at least 3 days in advance of dispatch to confirm delivery details and ensure the timely collection of eggsticks.

RELEASE PROCEDURE

(a) Eggsticks are to be placed in the release area within 1 or 2 days of being received or collected

Early morning or late afternoon are optimal times for release. Releases hould not be attempted if rain is forecast within a few days of the intended release date.

(b) A period of about 6 hours is required for 1 person to insert eggsticks into 800 plants.

(c) Eggsticks are to be inserted into the central pith of the cut dock stem, at a rate of 1 eggstick per plant

Plants with multiple stems are easily identified by gently 'tugging' on one stem and observing which other stems move. Only 1 stem per plant need receive an

eggstick. If the stems are being cut with secateurs, it is necessary to cut only the stem into which the eggstick is to be inserted. Care must be taken to ensure that movement of the remaining stems does not dislodge the eggstick once in place. The actual area within the plot boundary should be marked out (eg. with string) to assist in keeping within the area, and the person releasing should progress in one direction backing away from plants which have received eggsticks. This will ensure that no plants are missed, and that eggsticks are not accidentally knocked out once inserted.

Every dock plant within the release site is to be inoculated in this way until all the eggsticks have been inserted, rather than distributing them across an entire paddock. This will ensure that the moths will emerge in close proximity to one another, thus facilitating mate location whilst the population is still small.

(d) The eggsticks should be grasped firmly with two fingers below the attached eggs to avoid dislodging eggs

The dock stem should be held steady near the cut end whilst the eggstick is being inserted. If necessary, the mown stem may be snipped with secateurs to provide a level surface for insertion. Likewise, if the stem shatters (as thin stems are likely to do) the shattered portion can be snipped off before re-insertion. Stem nodes should also be snipped back as they are too hard for the eggstick point to penetrate.

(e) Eggsticks with fewer than 3 eggs attached, and sticks which 'lose' their eggs during the release procedure are to be discarded.

POST-RELEASE

(a) Stock and vehicles are to be excluded from the actual release area for at least 1 month (preferably 2 months) post-release to ensure that eggsticks are not disturbed before the larvae establish in the dock root.

(b) Producers should ensure that insects and/or eggs are not 'harvested' or removed from the release area and its immediate surrounds for transfer to other paddocks or properties. This is to enable a large enough population of the biocontrol agent to build up and establish successfully. For the same reason, the eggsticks received in a consignment should all be placed in the same location and not divided between two or more sites.

Arrangements can be made for additional consignments to be forwarded to large properties with widely distributed dock problems.

APPENDIX 2

PROJECT QUESTIONNAIRES

A. Dock moth assessment:- Egg-stick 'release' questionnaire
B. Dock moth assessment:- Inoculation success questionnaire
C. Dock moth assessment:- Moth emergence questionnaire
D. Dock moth assessment:- Establishment & dispersal questionnaire
E. Dock moth assessment form

DOCK MOTH ASSESSMENT:

EGGSTICK 'RELEASE' QUESTIONNAIRE

Name: ..... **Postal address:** .....

Phone: ..... **Town / Code:** .....

Fax: ..... **State:** .....

[CN:] ..... **Today's date:** .....

Dock moth eggsticks were despatched on: .....

1. When did you take delivery of the eggsticks? **(write date)** .....

2. What was the condition of the consignment on receival?
   - o **Excellent**
   - o **Good**
   - o **Poor**

3. What was the weather like for the first 4 days after you put the eggsticks in the paddock? **(Please tick boxes for each day)**

Day 1.	o Fine and hot o Little rain	o Fine and cool o Rainy	o Cloudy
Day 2.	o Fine and hot o Little rain	o Fine and cool o Rainy	o Cloudy
Day 3.	o Fine and hot o Little rain	o Fine and cool o Rainy	o Cloudy
Day 4.	o Fine and hot o Little rain	o Fine and cool o Rainy	o Cloudy

4. To enable us to map the distribution of releases, please provide the *location number* of the property where the release site is located.

5. Please tell us which types of dock are most important on your property. Rate each as 1 = most abundant; 2 = less abundant; or 3 = rare or not seen. **(Refer to Infonote: 'Docks' on page 20 to identify docks.)**

o Swamp dock	o Fiddle dock	o Curled dock
o Clustered dock	o Broadleaved dock	o Wiry dock

6. Where is the release site located ? **(Please tick the appropriate box)**

- o In a fenced tree plant area
- o In a fenced section of silage / hay paddock
- o In an unfenced section of silage / hay paddock
- o Other (please specify) .....

7. What is your main farming enterprise? **(Please tick the appropriate box)**

- o Beef
- o Dairy
- o Other (please specify)

8. Comments: **(If you would like to make additional comments please use this space)**

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Thank you for completing this questionnaire.
The information will assist us to improve delivery and inoculation methods.
Please return the questionnaire in the reply paid envelope enclosed as soon as possible.

DOCK MOTH ASSESSMENT: INOCULATION SUCCESS QUESTIONNAIRE

Name: ..... **Postal address:** .....

Phone: ..... **Town / Code:** .....

Fax: ..... **State:** .....

[CN:] .....

Thank you for inoculating your property with dock moth eggsticks. It is now important that the success of the inoculation be evaluated. Please take a few minutes to check your release site and answer the following questions **(just tick the boxes)**.

1. Is your release site still fenced off to stock? o Yes o No

2. Have you sprayed within 50 m of the release area since you put out the eggsticks with:

   - insecticides? o No o Yes (If 'yes', please list) .....
   - herbicides? o No o Yes (If 'yes', please list) .....

3. Can you see any effect of dock moth on individual dock plants? Dock plants which have failed to regenerate new leaves during autumn are likely to be dead.

   o Yes, many dead plants o Yes, a few dead plants o No dead plants yet

4. Please dig up 20 dock plants* at random from within the release area. Cut the 'carrots' open and check for dock moth larvae (see Figure 3 in the dock moth Farmnote). The larvae will be inside the tunnels in the root and may be enclosed in thick 'sacs' within the tunnels. The tunnels will also contain quantities of insect droppings. (Note that plants with leaves may also contain larvae as not all infested plants will be killed in the first season.)

   * *Do not dig up seedlings which have germinated after the release was made.*

   o Larvae found o Larvae not found

5. Comments: **(If you would like to make additional comments please use this space)**

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Thank you for making the effort to complete this questionnaire.
The information will assist us to improve delivery and inoculation methods.
Please return the questionnaire in the reply paid envelope enclosed as soon as possible.

DOCK MOTH ASSESSMENT: MOTH EMERGENCE QUESTIONNAIRE

Name: ..... **Postal address:** .....

Phone: ..... **Town / Code:** .....

Fax: ..... **State:** .....

[CN:] .....

Thank you for inoculating your property with dock moth eggsticks. Emergence of moths from inoculated plants is due to occur in late spring and summer. Emergence will be earlier or later in different districts depending on local weather conditions. For example, moths will emerge earlier in the season in warm areas and later in cooler areas.

Please take a few minutes to check your release site and answer the following questions **(just tick the boxes).**

1. Is your release site still fenced off to stock? o Yes o No

2. Have you sprayed within 50 m of the release area since you put out the eggsticks with:

   - insecticides? o Yes, when? o No
   - herbicides? o Yes, when? o No

3. Can you see any effect of dock moth on individual dock plants?

   o Yes, many dead plants o Yes, a few dead plants o Not yet

4. Moth emergence should have commenced by the end of December in most areas. Please check for evidence of moth emergence by looking around the bases of the plants in the release site for pupal cases protruding from the top of the dock stem stumps, or the crown of the plant, or from the ground near the plant. (See Figure 4 in the dock moth Farmnote). You may even see a moth!!

   Can you see any signs of moth emergence from the release site?

   o Yes, many pupal cases o Yes, a few pupal cases
   o No pupal cases o Yes, moths seen

5. Comments: **(If you would like to make additional comments please use this space)**

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Thank you for completing this questionnaire.
The information will assist us to improve inoculation methods.

Please return the questionnaire in the reply paid envelope enclosed as soon as possible.

DOCK MOTH ASSESSMENT: ESTABLISHMENT AND DISPERSAL QUESTIONNAIRE

Name: ..... **Postal address:** .....

Phone: ..... **Town / Code:** .....

Fax: ..... **State:** .....

[CN:] .....

Thank you for inoculating your property with dock moth eggsticks. It is now important to check the release site to determine if the moth has established and begun dispersing from the release site. Please take a few minutes to check your release site and answer the following questions **(just tick the boxes).**

1. To check how far the dock moth has spread, please dig up 15 plants each at 50 m, 100 m and 200 m from the release site. The direction in which the plants are taken is not important. Cut the 'carrots' open and check for dock moth larvae (see Figure 3 in the dock moth Farmnote). Dig up plants which have evidence of having flowered last summer (flower stem or stump of flower stem still present).

   Did you find dock moth larvae at:
   - ♦ 50 m: o Yes o No
   - ♦ 100 m: o Yes o No
   - ♦ 200 m: o Yes o No

2. Have you noticed a difference in the amount of dock in your paddocks near the release site?

   o Yes, much less dock o Yes, less dock o No, not yet

3. Comments: **(If you would like to make additional comments please use this space)**

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Thank you for completing this questionnaire.
The information will assist us to improve inoculation methods.
Please return the questionnaire in the rely paid envelope enclosed as soon as possible.

DOCK MOTH ASSESSMENT FORM

Release Date:
Name of Owner: Date Visited:

GPS Readings:

Map of release site:
(Include enough detail to enable someone unfamiliar with the area to find the site. Also include landmarks such as trees, sheds, creeks, fence lines, and North point.)

THE SITE

1. Most abundant dock type/s: fiddle / curly / clustered / wiry / broad-leafed

2. Soil type: sandy / loam / clay / gravelly / other.....

3. Where is the site located?
   fenced tree plant fenced/unfenced section of hay / silage / pasture paddock
   other…….

4. Is the site very wet / water logged? Y N

5. Main farming enterprise: beef / dairy / wool / other…….

OBSERVATIONS

6. Signs of moth survival: dead plants / pupal cases

7. Is there less dock in the release site compared to the immediate surrounds?
   Y N

8. Is there anything else that might be important/relevant (if moths don't appear to have survived)?

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SAMPLING OF DOCK PLANTS

9. Larvae found at: 0m / 50m / 100m / 200m / 300m / further

10. Larvae found (if applic) along fence line/other undisturbed area ……..distance ……

11. Direction of transect: (draw a line representing the transect on the map)
compass reading

QUESTIONS FOR OWNER (if applicable/possible)

12. Has any herbicide/insecticide been sprayed within 50m of the site release?
If yes, what was used and when? …….

13. Has he/she noticed any difference in the dock density in the paddock and its immediate surrounds since the release? If yes, indicate % reduction (estimate).

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ADDITIONAL COMMENTS

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APPENDIX 3

Survey results for monitoring sites of *S. doryliformis* established in Western Australia between 1989 and 1995

Data are from the latest survey (DL = dead larvae; ES = eggsticks; L = larvae; N = nothing found/never established; OS = old strike).

No.	Release season	Release month	Landowner or Manager	Locality / Shire	Farming enterprise	Release method	Last surveyed	Found	% Plants struck	Maximum dispersal
1	1989/90	Oct. '89	AGWEST - VRS	Vasse / Busselton	Research stn	L	2 May '94	N	0	0
2	1989/90	Oct. '89	AGWEST - VRS	Vasse / Busselton	Research stn	L	2 May '94	N	0	0
3	1989/90	Nov. '89	Hawson, M.G.	Wanneroo / Wanneroo	Horses	L	6 Sep. '90	L	one plant	0
4	1989/90	Oct. '89	Unknown	Carbarup / Busselton	Cattle	L	5 May '94	N	0	0
5	1989/90	Oct. '89	McLean, G.	Metricup / Busselton	Cattle	L	4 May '94	N	0	0
6	1989/90	Oct. '89	Duggan	Cowaramup / Augusta-Margaret River	Dairy	L	15 Jun. '95	L	30.8	750 m
7	1989/90	Oct. '89	Johnston, I.P.	Witchcliffe / Augusta-Margaret River	Cattle	L	12 Jun. '96	L	10	1250 m
8	1989/90	Oct. '89	Smith, S.D.	Carbarup / Busselton	Cattle	L	12 Jun. '95	L	2.6	50 m
9	1989/90	Oct. '89	Gangemi, P.	Serpentine /Serpentine-Jarrahdale	Cattle	L	3 Oct. '90	DL, OS	many	0
10	1989/90	Nov. '89	Kitchen, J.	Boyanup / Capel	Cattle	L	26 Apr. '94	N	0	0
11	1989/90	Nov. '89	Willett, T.	Boyup Brook / Boyup Brook	Sheep	L	16 Jan. '90	no dock	0	0
12	1989/90	Nov. '89	Tuckett, R.L.	Tonebridge / Boyup Brook	Sheep	L	1 Jun. '00	N	0	0
13	1989/90	Nov. '89	Owen, M.W.	Frankland / Boyup Brook	Sheep	L	1 Jun. '00	L	13.4	2160 m
14	1989/90	Oct. '89	Jenkins, G.W.	Denbarker / Plantagenet	Cattle	L	30 May '00	L	10.5	3840 m
15	1989/90	Nov. '89	Banks, R.A.	Frankland / Boyup Brook	Sheep	L	22 Jun. '95	L	7.9	375 m
16	1989/90	Nov. '89	Denning, H.J.	Lowden / Donnybrook-Balingup	Cattle	L	26 Apr. '94	N	0	0
17	1989/90	Nov. '89	Leach, D.J.	Boyanup / Capel	Cattle	L	26 Apr. '94	N	0	0
18	1989/90	Nov. '89	Struthers, M.	Frankland / Cranbrook	Sheep	L	21 Jun. '95	L	6.3	800 m
19	1989/90	Dec. '89	Noakes, E.G.	Warner Glen / Augusta-Margaret River	Dairy	L	3 May '94	N	0	0
20	1989/90	Nov. '89	AGWEST - MBRS	Mt Barker / Plantagenet	Research stn	L	17 May '95	L	19.6	1500 m
22	1989/90	Dec. '89	Mattinson, D.C.	Napier / Plantagenet	Cattle	L	20 Jun. '95	L	8	750 m
23	1989/90	Dec. '89	McIntosh, O.R.	Denmark / Denmark	Sheep	L	10 May '00	L	19.5	1250 m
24	1989/90	Dec. '89	Woodward, G.	Narrikup / Plantagenet	Dairy	L	16 May '00	L	13.1	2000 m
25	1990/91	Nov. '90	Thompson, J.	W. Mundijong / Serpentine-Jarrahdale	Cattle	L	6 May '94	L	3.5	30 m
26	1989/90	Dec. '89	Weightman, D.	Margaret River / Augusta-Margaret River	Cattle	L	8 May '95	L	15.1	750 m
27	1990/91	Nov. '90	Money, G.G.V.	Pinjarra / Murray	Cattle	L	6 May '94	L	2.1	60 m
28	1990/91	Nov. '90	Evans, W.E.	Yelverton / Busselton	Cattle	L	5 May '94	N	0	0
29	1990/91	Nov. '90	McDonald, P.T.	Karridale / Augusta-Margaret River	Cattle	L	13 Jun. '96	L	10	800 m
30	1990/91	Nov. '90	Hallett, C.	Kudardup / Augusta-Margaret River	Sheep, cattle	L	13 Jun. '96	L	8.4	700 m
31	1990/91	Nov. '90	Johnston, I.R.	Augusta / Augusta-Margaret River	Cattle	L	13 Jun. '96	L	9.5	375 m
32	1990/91	Nov. '90	O'Dea, B.J.	Alexandra Bridge / Augusta-Margaret River	Seed grower	L	3 May '94	N	0	0
33	1990/91	Nov. '90	Muir, S.	Nyamup / Manjimup	Cattle	L	2 Jun. '00	L	12.2	300 m
34	1990/91	Nov. '90	Moyes, H.S.	Bridgetown / Bridgetown-Greenbushes	Sheep	L	29 Apr. '94	N	0	0
35	1990/91	Dec. '90	Irvin, J.	Coolup / Murray	Horses	L	29 Apr. '94	L	36	30 m
36	1990/91	Dec. '90	Guthridge, L.W.	Nannup / Nannup	Cattle	L	20 May '98	L	8.1	800 m

No.	Release season	Release month	Landowner or Manager	Locality / Shire	Farming enterprise	Release method	Last surveyed	Found	% Plants struck	Maximum dispersal
37	1991/92	Dec. '91	Seed, T.	Osmington / Augusta-Margaret River	Sheep, cattle, horses	L	22 May '96	L	30.1	600 m
38	1991/92	Nov. '91	Minchin, W.P.	Jindong / Busselton	Cattle	L	21 May '96	L	12.1	600 m
39	1992/93	Nov. '92	Davis, G.A.	Coolup / Murray	Cattle	L	26 Jul. '00	L	7.5	4000 m
41	1992/93	Nov. '92	Comer, K.S.	Mount Barker / Plantagenet	Cattle, horses	L	18 May '00	N	0	0
42	1992/93	Nov. '92	Steinert, I.D.	Lower King / Albany	Sheep	L	18 May '00	L	2.6	500 m
43	1992/93	Dec. '92	Seed, T.	Osmington / Augusta-Margaret River	Sheep, horses	L+ES	22 May '96	L	2.5	200 m
44	1993/94	Nov. '93	Martin, D.O.	Rosa Glen / Augusta-Margaret River	Sheep	L+ES	23 May '96	L	4.1	50 m
45	1993/94	Nov. '93	Haddon, N.	Yoongarillup / Busselton	Dairy	L+ES	21 May '96	L	17.8	250 m
46	1993/94	Nov. '93	Yates, J.	Witchcliffe / Augusta-Margaret River	Dairy	L+ES	26 Jun. '96	L	7.9	125 m
47	1993/94	Nov. '93	Lumsden, T.	Rosa Glen / Augusta-Margaret River	Dairy	L+ES	23 May '96	L	4.4	100 m
48	1993/94	Dec. '93	Connolly, L.	Forest Grove / Augusta-Margaret River	Sheep, cattle	L+ES	22 May '96	L	3.3	30 m
49	1993/94	Dec. '93	Brennan, L.	Witchcliffe / Augusta-Margaret River	Dairy	L+ES	22 May '96	L	2.6	50 m
50	1993/94	Dec. '93	Weightman, D.	Margaret River / Augusta-Margaret River	Cattle	L+ES	14 Jun. '96	L	8.4	2000 m
51	1993/94	Feb. '94	Enright, T.	South Stirlings / Plantagenet	Cattle	ES	17 May '00	OS	1.3	0 m
52	1993/94	Jan. '94	Pugh, J.	Narrikup / Plantagenet	Cattle	ES	17 May '00	L	6	750 m
53	1993/94	Feb. '94	AGWEST - MBRS	Mt Barker / Plantagenet	Research stn	ES	30 May '96	L	19.2	500 m
54	1993/94	Jan. '94	Knight, T.	Lower Kalgan / Albany	Cattle	ES	15 May '00	L	12.2	1600 m
55	1994/95	Dec. '94	Kentish, N.	Keysbrook / Serpentine-Jarrahdale	Cattle	ES	27 Jun. '95	N	0	0
56	1994/95	Feb. '95	MacLeay, K.	Vasse / Busselton	Cattle	ES	11 Jun. '96	N	0	0
57	1994/95	Mar. '95	Cordi, C.	Warner Glen / Augusta-Margaret River	Dairy	ES	12 Jun. '96	L	0.8	30 m
58	1994/95	Mar. '95	Bettridge, G.	E. Nannup / Nannup	Vineyard ex cattle	ES	25 May '98	L	15.3	450 m

APPENDIX 4

Survey results for release sites of *S. doryliformis* established by farmers in Western Australia between 1994 and 1999.

Data are from the latest survey (DL = dead larvae; L = larvae; M = moth; N = nothing found/never established; OS = old strike; P = pupae; S = recent strike).

Rel. No.	Release season	Release month	Landowner or Manager	Locality / Shire	Farming enterprise	Last surveyed	Found	% Plants struck	Maximum dispersal
1	1994/95	Nov .'94	Hawson MJ	Pinjar / Wanneroo	Horses	4 Jun. '98	L	41.7	400 m
2	1994/95	Dec. '94	Brockman F	Scott River / Nannup	Trees ex cattle	10 Jun. '98	L	7.2	30 m
3	1994/95	Dec. '94	Camari MS	Cundinup / Nannup	Cattle	18 May '98	N	0	0
4	1994/95	Dec. '94	Cutbush J	Yoongarillup / Busselton	Dairy	30 Jul. '98	L,P	3.1	0
5	1994/95	Dec. '94	Faed GT	Forest Grove / Augusta-Margaret River	Cattle	5 Aug. '98	L	4.5	20 m
6	1994/95	Dec. '94	Harvie M	Treeton / Augusta-Margaret River	Cattle	4 Sep. '97	L	82.6	0
7	1994/95	Dec. '94	Keynes D	Vasse / Busselton	Orchard, sheep	28 Jul. '98	N	0	0
8	1994/95	Dec. '94	Maughan T	Lowden / Donnybrook-Balingup	Cattle	10 Aug. '98	L	30.6	0
9	1994/95	Dec. '94	O'Byrne T	Quindalup / Busselton	Cattle	28 Jul. '98	L	17.8	20 m
10	1994/95	Dec. '94	O'Mahony D	Yelverton / Busselton	Sheep, horses	20 Aug. '97	L	5.8	50 m
11	1994/95	Dec. '94	Rowlands J	Chapman Hill / Busselton	Cattle	20 Aug. '97	L	3.2	150 m
12	1994/95	Dec. '94	Sherington DJ	Ambergate / Busselton	Horses	19 Aug. '97	N	0	0
13	1994/95	Dec. '94	Smith K.Z.	Treeton / Augusta-Margaret River	Cattle	3 Sep. '97	N	0	0
14	1994/95	Dec. '94	Smith P	Acton Park / Busselton	Cattle, sheep	3 Sep. '97	N	0	0
15	1994/95	Dec. '94	Teale J	Ludlow / Busselton	Dairy	4 Aug. '98	L	4.4	0
16	1994/95	Dec. '94	Tognela RD	Cowaramup / Busselton	Cattle	3 Sep. '97	L	5	0
17	1994/95	Jan. '95	Arthur D	Treeton / Augusta-Margaret River	Cattle	20 Jul. '98	N	0	0
18	1994/95	Jan. '95	Avery C	Scott River / Nannup	Cattle	26 May '98	N	0	0
19	1994/95	Jan. '95	Baker A	Rosa Brook / Augusta-Margaret River	Cattle	23 Jul. '98	N	0	0
20	1994/95	Jan. '95	Briney JA	Alex. Bridge / Augusta-Margaret River	Dairy	27 May '98	N	0	0
21	1994/95	Jan. '95	Campbell S	Warner Glen / Augusta-Margaret River	Cattle	21 Jul. '98	N	0	0
22	1994/95	Jan. '95	Carpenter C	Newlands / Donnybrook-Balingup	Hobby farm	12 Aug. '98	L	1.3	0
23	1994/95	Jan. '95	Carter C	Carbarup River / Busselton	Dairy	19 Aug. '97	N	0	0
24	1994/95	Jan. '95	Corbett L	Karridale / Augusta-Margaret River	None	27 May. '98	N	0	0
25	1994/95	Jan. '95	Cusack P	Alex. Bridge / Augusta-Margaret River	Cattle	8 Dec. '99	N	0	0
26	1994/95	Jan. '95	Green B D	Donnybrook / Donnybrook-Balingup	Livestock, orchard	21 Aug. '97	N	0	0
27	1994/95	Jan. '95	Grisdale T	Rosa Glen / Augusta-Margaret River	Horses	20 Jul. '98	L	9.4	0
28	1994/95	Jan. '95	Harper JJ	Forest Grove / Augusta-Margaret River	Cattle	22 Jul. '98	L	2	20 m
29	1994/95	Jan. '95	Haywood BJ	Forest Grove / Augusta-Margaret River	Vineyard	3 Aug. '98	L	18.8	0
30	1994/95	Jan. '95	Hedderwick J	Alex. Bridge / Augusta-Margaret River	Cattle	22 Jul. '98	N	0	0
31	1994/95	Jan. '95	Hutton C	Scott River / Nannup	Dairy, cattle minor	25 May '98	L	11.8	35 m
32	1994/95	Jan. '95	Kornaus RM	Treeton / Augusta-Margaret River	Cattle, vineyards	4 Sep. '97	N	0	0
33	1994/95	Jan. '95	Maidment GB	Cowaramup / Augusta-Margaret River	Cattle	30 Jul. '98	L	1.1	0
34	1994/95	Jan. '95	McCormick BE	Metricup / Busselton	Cattle	3 Sep. '97	L	14.3	0
35	1994/95	Jan. '95	McNab A	Scott River / Nannup	Dairy	25 May '98	OS	6.1	0

Rel. No.	Release season	Release month	Landowner or Manager	Locality / Shire	Farming enterprise	Last surveyed	Found	% Plants struck	Maximum dispersal
36	1994/95	Jan. '95	McSwain K	Ambergate / Busselton	Dairy	21 Aug. '97	N	0	0
37	1994/95	Jan. '95	Moir M P	Margaret River / Augusta-Margaret River	Cattle	2 Sep. '97	N	0	0
38	1994/95	Jan. '95	Palme R	Margaret River / Augusta-Margaret River	Cattle	2 Sep. '97	L	27.3	0
39	1994/95	Jan. '95	Reid P	Karridale / Augusta-Margaret River	Cattle	21 Jul. '98	N	0	0
40	1994/95	Jan. '95	Salmon B	Margaret River / Augusta-Margaret River	Cattle	site destroyed	N	N	N
41	1994/95	Jan .'95	Tallentire PW	Gidgegannup / Swan	Cattle	17 Jul. '98	OS	3.1	0
42	1994/95	Jan. '95	Tate T	Rosa Brook / Augusta-Margaret River	Dairy	20 Jul. '98	N	0	0
43	1994/95	Jan. '95	van Zyl G	Karridale / Augusta-Margaret River	Cattle	21 Jul. '98	L	15	40 m
44	1994/95	Jan. '95	Walters D	Chapman Hill / Busselton	Cattle	20 Aug. '97	N	0	0
45	1994/95	Jan .'95	Watson BT	Osmington / Augusta-Margaret River	Cattle	29 Jul. '98	L,P	43.3	15 m
46	1994/95	Jan .'95	Yelverton K	Vasse / Busselton	Cattle	20 Aug. '97	N	0	0
47	1994/95	Feb .'95	Angel W	Middlesex / Manjimup	Cattle	21 May '98	L	5.4	0
48	1994/95	Feb .'95	Armstrong G	Northcliffe / Manjimup	Dairy	9 Jun. '98	N	0	0
49	1994/95	Feb .'95	Batley B J	Willyabrup / Busselton	Cattle, vineyards	3 Sep. '97	N	0	0
50	1994/95	Feb .'95	Burnett P	Witchcliffe / Augusta-Margaret River	Dairy	29 Jul. '98	L	2.3	0
51	1994/95	Feb .'95	Edwards G	East Manjimup / Manjimup	Cattle	20 May '98	L	4.8	0
52	1994/95	Feb .'95	Fouracres MJ	Scott River / Nannup	Cattle, sheep	26 May '98	N	0	0
53	1994/95	Feb .'95	Johnston PB	Boyanup / Capel	Cattle	5 Aug. '98	L	22.2	0
54	1994/95	Feb .'95	Lindberg S	Kudardup / Augusta-Margaret River	Cattle	3 Aug. '98	L	1	0
55	1994/95	Feb .'95	Lindsay MD	Nannup / Nannup	Cattle	20 May '98	L	8.6	0
56	1994/95	Feb .'95	Mathews DR	Scott River / Nannup	Cattle	28 May '98	N	0	0
57	1994/95	Feb .'95	Mathews DR	Scott River / Nannup	Cattle	Site destroyed	N	N	N
58	1994/95	Feb .'95	Rowe J	Boyanup / Capel	Cattle	5 Aug. '98	L	6.2	0
59	1994/95	Feb .'95	Thorn R	Middlesex / Manjimup	Dairy	21 May '98	N	0	0
60	1994/95	Feb .'95	Tosana MJ	Boyanup / Capel	Cattle	6 Aug. '98	N	0	0
61	1994/95	Feb .'95	Tuthill P	West Manjimup / Manjimup	Dairy	20 May '98	L	47.5	200 m
62	1994/95	Feb .'95	von Hofe K	Nyamup / Manjimup	Cattle	11 Jun. '98	N	0	0
63	1994/95	Mar .'95	Bathgate J	Dwellingup / Murray	Sheep, horses	22 Sep. '99	L	2.8	0
64	1994/95	Mar .'95	Bell F	Bullsbrook / Swan	Cattle	17 Jul. '98	L	6.8	0
65	1994/95	Mar .'95	Bowie JE	Greenbushes / Bridgetown-Greenbushes	Cattle	19 May '98	L	20	5 m
66	1994/95	Mar. '95	Bowie JE	Winnejup / Bridgetown-Greenbushes	Cattle	19 May '98	L,P	69	500 m
67	1994/95	Mar. '95	Bryant J	Gidgegannup / Swan	Cattle	27 Jan. '00	L	71.4	0
68	1994/95	Mar. '95	Burkett M	Pinjarra / Murray	Cattle	29 Sep. '99	S	3.6	0
69	1994/95	Mar. '95	Campbell N	Benger / Harvey	Cattle	11 Aug. '98	L	12.5	0
70	1994/95	Mar. '95	Clark J	Bakers Hill / Northam	Horses	11 Sep. '97	L	44.4	0

Rel. No.	Release season	Release month	Landowner or Manager	Locality / Shire	Farming enterprise	Last surveyed	Found	% Plants struck	Maximum dispersal
71	1994/95	Mar. '95	Colvin BE	Nth Dinninup / West Arthur	Trees	12 Aug. '98	L	76	0
72	1994/95	Mar. '95	Dawson R	Cundinup / Nannup	Cattle	18 May '98	S	5	0
73	1994/95	Mar. '95	Elliott GM	Keysbrook / Serpentine-Jarrahdale	Cattle	27 Aug. '97	L	27.3	0
74	1994/95	Mar. '95	Guest E	Greenbushes / Bridgetown-Greenbushes	Cattle	19 May '98	L	12.5	0
75	1994/95	Mar. '95	Heather BK	Oakford / Serpentine-Jarrahdale	Cattle	16 Jul. '98	N	0	0
76	1994/95	Mar. '95	Jenkins M	Waroona / Waroona	Cattle	27 Aug. '97	L	9.1	15 m
77	1994/95	Mar. '95	Love D	Coolup / Murray	Cattle	13 Oct. '99	L	30	0
78	1994/95	Mar. '95	Marchetti J	Waroona / Waroona	Cattle	27 Aug. '97	L	14.3	0
79	1994/95	Mar. '95	Money J	Nth Dandalup / Murray	Cattle	22 Aug. '97	L	17.2	0
80	1994/95	Mar. '95	Prowse N	West Pinjarra / Murray	Cattle	22 Aug. '97	L	62.5	0
81	1994/95	Mar. '95	Sceresini R	Waroona / Waroona	Dairy	27 Aug. '97	L	5.3	20 m
82	1994/95	Mar. '95	Stokes IK	Nth Dandalup / Murray	Cattle	22 Aug. '97	L	16.7	0
83	1994/95	Mar. '95	Tomas B	Cundinup / Nannup	Cattle	18 May '98	L	17.8	10 m
84	1994/95	Mar. '95	van Merwyk T	Serpentine / Serpentine-Jarrahdale	Cattle	16 Jul. '98	L,OS	100	0
85	1994/95	Mar. '95	Wallace S	Pinjarra / Murray	Horses	12 Oct. '99	S	25	0
86	1994/95	Mar. '95	Webster M	Sawyers Valley / Mundaring	Sheep	23 Sep. '99	L	6.1	0
87	1994/95	Mar. '95	Willmott NJ	Brookhampton / Donnybrook-Balingup	Cattle	11 Jun. '98	L	13.5	20 m
88	1994/95	Mar. '95	Wilson J	Northcliffe / Manjimup	Dairy	9 Jun. '98	L	4.4	0
89	1994/95	Mar. '95	Wolrige L	Marybrook / Busselton	Cattle AI services	19 Aug. '97	N	0	0
90	1994/95	Mar. '95	Wyllie J	Waroona / Waroona	Cattle	14 Oct. '99	L	22.2	0
91	1995/96	Nov. '95	Bell K	Gelorup / Capel	Dairy	6 Aug. '98	L	70	0
92	1995/96	Nov. '95	Bryce KB	Boyanup / Capel	Cattle	4 Aug. '98	L	4.4	0
93	1995/96	Nov. '95	Cusack M	Moodiarup / West Arthur	Sheep	6 Jul. '98	L	78.1	0
94	1995/96	Nov. '95	Hannay P	Waroona / Waroona	Cattle	13 Oct. '99	N	0	0
95	1995/96	Nov. '95	Lindberg HA	Mt Barker / Plantagenet	Dairy	24 Jun. '98	L	1.8	0
96	1995/96	Nov. '95	Merrilees D	Middlesex / Manjimup	Cattle	22 May '98	N	0	0
97	1995/96	Nov. '95	Poad A	Dardanup / Dardanup	Dairy	6 Aug. '98	L	3.3	80 m
98	1995/96	Nov. '95	Richardson N	Capel / Capel	Hobby farm	4 Aug. '98	N	0	0
99	1995/96	Nov. '95	Schaber P	Boyanup / Capel	Cattle, horses	4 Aug. '98	L	1.9	20 m
100	1995/96	Nov. '95	Smith GM	Cowaramup / Augusta-Margaret River	Cattle	Site destroyed	N	N	N
101	1995/96	Nov. '95	Tuckey K	Pinjarra / Murray	Cattle	30 Sep. '99	N	0	0
102	1995/96	Nov. '95	ver Brugge RE	Dardanup / Dardanup	Cattle	10 Aug. '98	S	7.1	0
103	1995/96	Nov. '95	Vinicombe V	Serpentine / Serpentine-Jarrahdale	Cattle	16 Jul. '98	OS,DL	17	50 m
104	1995/96	Dec. '95	Baker A	Treeton / Augusta-Margaret River	Cattle	23 Jul. '98	L	22.2	60 m
105	1995/96	Dec. '95	Bevan-Glynn	Unicup / Manjimup	Cattle	9 Jun. '98	N	0	0

Rel. No.	Release season	Release month	Landowner or Manager	Locality / Shire	Farming enterprise	Last surveyed	Found	% Plants struck	Maximum dispersal
106	1995/96	Dec. '95	Burkett M	Pinjarra / Murray	Cattle	29 Sep. '99	L	71.4	0
107	1995/96	Dec. '95	Chapman G	Chapman Hill / Busselton	Dairy	27 Jul. '98	L	5.3	0
108	1995/96	Dec. '95	Collins M	Kendenup / Plantagenet	Sheep	23 Jun. '98	L	8.7	0
109	1995/96	Dec. '95	Corbett L	Karridale / Augusta-Margaret River	None	27 May '98	L	12.1	0
110	1995/96	Dec. '95	Frantom J	Albany / Albany	Horses	25 Jun. '98	L,P	35.7	0
111	1995/96	Dec. '95	Goerling DJ	Boyup Brook / Boyup Brook	Sheep	9 Jun. '98	L	14.5	0
112	1995/96	Dec. '95	Hancock Robin	Denmark / Denmark	Vineyard ex pasture	18 Jun. '98	N	0	0
113	1995/96	Dec. '95	Hedderwick J	Alex. Bridge / Augusta-Margaret River	Cattle	22 Jul. '98	DL	12.5	0
114	1995/96	Dec. '95	Mackie T	Mt Barker / Plantagenet	Sheep	23 Jun. '98	L	59.1	10 m
115	1995/96	Dec. '95	Newbold S	Manjimup / Manjimup	Sheep	22 May '98	L	26.9	70 m
116	1995/96	Dec. '95	Norton C	Chorkerup / Albany	Cattle, sheep	25 Jun. '98	L	5.9	0
117	1995/96	Dec. '95	Parke N	Alex. Bridge / Augusta-Margaret River	Cattle	7 Dec. '99	N	0	0
118	1995/96	Dec. '95	Rose R	Coolup / Murray	Cattle	12 Oct. '99	S	25	0
119	1995/96	Dec. '95	Samsa FM	Balingup / Donnybrook-Balingup	Dairy	8 Jun. '98	N	0	0
120	1995/96	Dec. '95	Saw T	Witchcliffe / Augusta-Margaret River	Cattle	2 Dec. '99	S	5	0
121	1995/96	Dec. '95	Sissoev A	Ambergate / Busselton	Potatoes	30 Jul. '98	L	3.5	50 m
122	1995/96	Dec. '95	Sloan DP	Collie / Collie	Cattle	11 Aug. '98	L	11.4	0
123	1995/96	Dec. '95	Sue KJ	Ambergate / Busselton	Cattle	28 Jul. '98	L	4.9	0
124	1995/96	Dec. '95	Trigwell BE	Yoongarillup / Busselton	Cattle	28 Jul. '98	N	0	0
125	1995/96	Dec. '95	Tucker W	Harvey / Harvey	Sheep	14 Oct. '99	L	5	0
126	1995/96	Dec. '95	Tyrell K	Waterloo / Dardanup	Cattle	12 Aug. '98	N	0	0
127	1995/96	Dec. '95	Varis FM	Cordering / West Arthur	Cattle	11 Aug. '98	L	4.8	0
128	1995/96	Dec. '95	ver Brugge RE	Dardanup / Dardanup	Cattle	10 Aug. '98	S	5.4	0
129	1995/96	Dec. '95	Waters R	Cowaramup / Augusta-Margaret River	Cattle	30 Jul. '98	L	5.9	0
130	1995/96	Dec. '95	Watts D	Harvey / Harvey	Cattle	11Aug. '98	L	2.3	30 m
131	1995/96	Jan. '96	Andrews L	Lower Kalgan / Albany	Cattle, sheep	7 Jul. '98	L	12.2	50 m
132	1995/96	Jan. '96	Bampfield RG	Manypeaks / Albany	Cattle, trees	7 Jul. '98	L	3.4	50 m
133	1995/96	Jan. '96	Barkovic J	Kronkup / Albany	Cattle	16 Jun. '98	L	30	0
134	1995/96	Jan. '96	Beer T	Pinjarra / Murray	Cattle	30 Sep. '99	S	18.8	0
135	1995/96	Jan. '96	Burrow A	Youngs Siding / Albany	Cattle	16 Jun. '98	N	0	0
136	1995/96	Jan. '96	Carey J	Dunsborough / Busselton	Holiday cottages	25 Nov. '99	S	2.5	0
137	1995/96	Jan. '96	Chapman G	Yoongarillup / Busselton	Dairy	27 Jul. '98	L	5.9	0
138	1995/96	Jan. '96	Clothier B	Mt Barker / Plantagenet	Cattle	25 Jun. '98	L	95.2	0
139	1995/96	Jan. '96	Codee J	Torbay / Albany	Cattle	16 Jun. '98	L	10	0
140	1995/96	Jan. '96	Crouch R	Dinninup / Boyup Brook	Sheep, fat lambs	10 Jul. '98	L	22.2	15 m

Rel. No.	Release season	Release month	Landowner or Manager	Locality / Shire	Farming enterprise	Last surveyed	Found	% Plants struck	Maximum dispersal
141	1995/96	Jan. '96	Dunnet J	Scott River / Nannup	Cattle	27 May '98	L,P,OS	20	0
142	1995/96	Jan. '96	Flottman RA	Redmond / Albany	Cattle	17 Jun. '98	L	20.7	0
143	1995/96	Jan. '96	Grantham R	Pinjarra / Murray	Cattle	14 Oct. '99	S	6.9	0
144	1995/96	Jan. '96	Hortin FV	Kronkup / Albany	Dairy	25 Jun. '98	L,M	11.8	0
145	1995/96	Jan. '96	Hutton D	Capel / Capel	Dairy	31 Jul. '98	N	0	0
146	1995/96	Jan. '96	Keenan T	Redmond / Albany	Cattle	17 Jun. '98	OS	1.8	0
147	1995/96	Jan. '96	Lambert F	Lower King / Albany	Cattle	7 Jul. '98	L	1.5	20 m
148	1995/96	Jan. '96	Lee D	Jingalup / Kojonup	Sheep	26 Jun. '98	L	38.1	20 m
149	1995/96	Jan. '96	Lock R	Mettler / Albany	Sheep	8 Jul. '98	L,P	36.9	150 m
150	1995/96	Jan. '96	Lucas JF	Manypeaks Nth / Albany	Cattle	9 Jul. '98	N	0	0
151	1995/96	Jan. '96	Lucas JF	Manypeaks Nth / Albany	Cattle	9 Jul. '98	L,P	4.1	0
152	1995/96	Jan. '96	Marshall AL	Albany / Albany	Cattle	15 Jun. '98	L	16	0
153	1995/96	Jan. '96	Marshall AL	Albany / Albany	Cattle	15 Jun. '98	N	0	0
154	1995/96	Jan. '96	Mostert T	Redmond / Albany	Dairy	17 Jun. '98	L	18.2	0
155	1995/96	Jan. '96	Mountford R	Manypeaks / Albany	Cattle, sheep	7 Jul. '98	L	2	0
156	1995/96	Jan. '96	Parkin C	Keysbrook / Serpentine-Jarrahdale	Cattle	22 Sep. '99	S	11.1	0
157	1995/96	Jan. '96	Parkin C	Keysbrook / Serpentine-Jarrahdale	Cattle	22 Sep. '99	S	3.4	0
158	1995/96	Jan. '96	Prosser L	Scott River / Nannup	Cattle	26 May '98	L,P	17.1	0
159	1995/96	Jan. '96	Ritchie R	Harvey / Harvey	Cattle	11 Aug. '98	L	7.7	0
160	1995/96	Jan. '96	Sheir HE	Burekup / Dardanup	Cattle	10 Aug. '98	L	9.4	0
161	1995/96	Jan. '96	Shine D	Scott River / Nannup	Cattle	27 May '98	N	0	0
162	1995/96	Jan. '96	Smallwood R	Redmond / Albany	Cattle	17 Jun. '98	L,OS	15	0
163	1995/96	Jan. '96	Tomlinson JG	Manypeaks / Albany	Cattle	7 Jul. '98	DL	6.7	20 m
164	1995/96	Jan. '96	Tomlinson JG	Lower Kalgan / Albany	Cattle	9 Jul. '98	L	24.4	40 m
165	1995/96	Jan. '96	Townsend KN	Narrikup / Plantagenet	Cattle	26 Jun. '98	L	2.9	150 m
166	1995/96	Jan. '96	Webb HP & J	Narrikup / Plantagenet	Dairy	17 Jun. '98	N	0	0
167	1995/96	Feb. '96	Boyd R	Dunsborough / Busselton	Garden	5 Aug. '98	N	0	0
168	1995/96	Feb. '96	Brock W	Muchea / Chittering	Cattle	17 Jul. '98	L	3.5	50 m
169	1995/96	Feb. '96	Carter D	Youngs Siding / Albany	Cattle	16 Jun. '98	N	0	0
170	1995/96	Feb. '96	Coffey M	Denbarker / Plantagenet	Cattle	18 Jun. '98	L	61.5	0
171	1995/96	Feb. '96	Fisher J	Albany / Albany	Cattle	16 Jun. '98	OS	2.7	0
172	1995/96	Feb. '96	Grunder R	Keysbrook / Serpentine-Jarrahdale	Cattle	16 Jul. '98	L	17.4	0
173	1995/96	Feb. '96	Hart D	Lower Chittering / Swan	Cattle	4 Jun. '98	L,OS	95.4	0
174	1995/96	Feb. '96	Hull M	Coolup / Murray	Cattle, sheep	24 Aug. '98	L	10	0
175	1995/96	Feb. '96	Kajmak A	Kendenup / Plantagenet	Hobby farm	23 Jun. '98	L,P	50.9	20 m

Rel. No.	Release season	Release month	Landowner or Manager	Locality / Shire	Farming enterprise	Last surveyed	Found	% Plants struck	Maximum dispersal
176	1995/96	Feb. '96	Lucas JF	Manypeaks Nth / Albany	Cattle	9 Jul. '98	N	0	0
177	1995/96	Feb. '96	McCormack A	Pinjarra / Murray	Cattle	22 Sep. '99	S	12.1	0
178	1995/96	Feb. '96	Newton G	Waroona / Waroona	Cattle	24 Aug. '98	N	0	0
179	1995/96	Feb. '96	Newton G	Waroona / Waroona	Cattle	24 Aug. '98	L,P	95.2	0
180	1995/96	Feb. '96	Smith DM	Porongurup / Plantagenet	Cattle	24 Jun. '98	L	8.2	100 m
181	1995/96	Feb. '96	Trickett B & E	Coolup / Murray	Cattle	11 Oct. '99	L	15	0
182	1995/96	Feb. '96	Urbaniak G	Keysbrook / Serpentine-Jarrahdale	Sheep	16 Jul. '98	L	50	0
183	1995/96	Feb. '96	Wills C	Yoongarillup / Busselton	Dairy	30 Jul. '98	N	0	0
184	1995/96	Feb. '96	York W	Mt Barker / Plantagenet	Cattle	24 Jun. '98	OS,DL	4.8	0
185	1995/96	Mar. '96	Brighton JL	Alex. Bridge / Augusta-Margaret River	Cattle	27 May '98	L	19.3	30 m
186	1995/96	Mar. '96	McLarty D	Pinjarra / Murray	Cattle	28 Sep. '99	N	0	0
187	1995/96	Mar. '96	Rowell WG	Dunsborough / Busselton	None	28 Jul. '98	L	43.3	0
188	1996/97	Nov. '96	Lesiter/Ruggles	Beverley / Beverley	None	23 Sep. '99	L	68.9	500 m
189	1996/97	Nov. '96	Nield P	Winnejup / Bridgetown-Greenbushes	Cattle	8 Jun. '98	L	48.3	0
190	1996/97	Nov. '96	Salmon B	Margaret River / Augusta-Margaret River	Cattle	22 Jul. '98	L,P	21.3	0
191	1996/97	Nov. '96	Tyler RJ	Waroona / Waroona	Cattle	13 Oct. '99	N	0	0
192	1996/97	Dec. '96	Alves-Viera P	Waroona / Waroona	Cattle	24 Aug. '98	L	8.7	0
193	1996/97	Dec. '96	Alves-Viera P	North Dandalup / Murray	Horses	30 Sep. '99	L	5.5	0
194	1996/97	Dec. '96	Dow P	Capel / Capel	Cattle	4 Aug. '98	L	12.5	0
195	1996/97	Dec. '96	Emery A	Augusta / Augusta-Margaret River	Cattle	21 Jul. '98	S	2.8	0
196	1996/97	Dec. '96	Holly C	Pinjarra / Murray	Horses	29 Sep. '99	N	0	0
197	1996/97	Dec. '96	Long B	Esperance / Esperance	Sheep	15 Jun. '99	N	0	0
198	1996/97	Dec. '96	Venn M	Pinjarra / Murray	Cattle	28 Sep. '99	L	7.7	0
199	1996/97	Dec. '96	Ward B	Coolup / Murray	Hay	12 Oct. '99	L	7.1	0
200	1996/97	Jan. '97	Anderson R	Collie / Collie	Cattle	14 Jan. '00	S	57.1	0
201	1996/97	Jan. '97	Armstrong	Yarloop / Harvey	Cattle	14 Oct. '99	L	14.3	0
202	1996/97	Jan. '97	Avery C	Scott River / Nannup	Cattle	26 May. '98	L	31	0
203	1996/97	Jan. '97	Della Giustina E	Yornup / Bridgetown-Greenbushes	Cattle	8 Jun. '98	L,P	17.1	0
204	1996/97	Jan. '97	Ford K	Rosa Brook / Augusta-Margaret River	Cattle	29 Jul. '98	L,P	20	0
205	1996/97	Jan. '97	Gaull B	Forest Grove / Augusta-Margaret River	Cattle	2 Dec. '99	S	11.8	0
206	1996/97	Jan. '97	Judd D	Esperance / Esperance	Sheep	15 Jun. '99	L	52.4	50 m
207	1996/97	Jan. '97	Keys B	Rosa Brook / Augusta-Margaret River	Cattle, olives	29 Jul. '98	L	1.1	0
208	1996/97	Jan. '97	Kluball A	Forest Grove / Augusta-Margaret River	Horses	22 Jul. '98	S	26.7	0
209	1996/97	Jan. '97	Norman V	Unicup / Manjimup	Cattle	10 Jun. '98	N	0	0
210	1996/97	Jan. '97	Norrish T	Kojonup / Kojonup	Sheep	10 Jul. '98	L	34.8	0

Rel. No.	Release season	Release month	Landowner or Manager	Locality / Shire	Farming enterprise	Last surveyed	Found	% Plants struck	Maximum dispersal
211	1996/97	Jan. '97	Rowell WG	Dunsborough / Busselton	Permaculture	28 Jul. '98	L	1.9	0
212	1996/97	Jan. '97	Scotland R	Wellington Mills / Dardanup	Cattle	10 Aug. '98	S	13.3	0
213	1996/97	Jan. '97	Walsh P	Kojonup / Kojonup	Cattle	10 Jul. '98	L	76	10 m
214	1996/97	Feb. '97	Velios N	Manjimup / Manjimup	Cattle	21 May '98	L,P	25.7	50 m
215	1997/98	Nov. '97	Johnson B	Coolup / Murray	Cattle	11 Oct. '99	L	20	0
216	1997/98	Nov. '97	Knight G	Gelorup / Capel	Horses	5 Aug. '98	L	41.2	0
217	1997/98	Nov. '97	Prowse N	Pinjarra / Murray	Cattle	27 Oct. '99	L	76.2	0
218	1997/98	Jan. '98	York W	Mt Barker / Plantagenet	Cattle	24 Jun. '98	L	28	0
219	1997/98	Feb. '98	Bock T	Westcliffe / Kojonup	Sheep	6 Jul. '98	L	29.6	0
220	1997/98	Feb. '98	Judd D	Esperance / Esperance	Sheep	15 Jun. '99	L	40	50 m
221	1998/99	Nov. '98	Ailakis A	Pemberton / Manjimup	Cattle	15 Dec. '99	S	19.1	0
222	1998/99	Nov. '98	Aldridge T	Glenmervyn / Donnybrook-Balingup	Cattle	8 Dec. '99	S	6.5	0
223	1998/99	Nov. '98	Anderson H	Walpole / Denmark	Cattle	16 Dec. '99	N	0	0
224	1998/99	Nov. '98	Bansemer A	Serpentine / Serpentine	Horses	29 Oct. '99	L	5.3	0
225	1998/99	Nov. '98	Birch K	Donnybrook / Donnybrook-Balingup	Cattle	9 Dec. '99	S	8.9	0
226	1998/99	Nov. '98	Bolton S	Bridgetown / Bridgetown-Greenbushes	Cattle	9 Dec. '99	N	0	0
227	1998/99	Nov. '98	Dewar NL	Gingin / Gingin	Hobby farm	27 Oct. '99	L	8.8	0
228	1998/99	Nov. '98	Dixon B	Gnowellen / Albany	Sheep	17 Jun. '99	S	4.2	0
229	1998/99	Nov. '98	Dumbrell W	Walpole / Denmark	Dairy	16 Dec. '99	S	15.4	0
230	1998/99	Nov. '98	Dumbrell W	Walpole / Denmark	Dairy	16 Dec. '99	S	8.8	0
231	1998/99	Nov. '98	Dumbrell W	Walpole / Denmark	Cattle	16 Dec. '99	S	4.3	0
232	1998/99	Nov. '98	Eime S	Esperance / Esperance	Cattle	15 Jun. '99	N	0	0
233	1998/99	Nov. '98	Fitt	Collie / Collie	Horses	28 Oct. '99	L	8.6	0
234	1998/99	Nov. '98	Fleay C	Buckingham / Collie	Sheep	3 Nov. '99	N	0	0
235	1998/99	Nov. '98	Fry PJ	Benger / Harvey	Dairy	28 Oct. '99	N	0	0
236	1998/99	Nov. '98	Gillibrand J	Serpentine / Serpentine	Horses	28 Oct. '99	L	10.5	0
237	1998/99	Nov. '98	Gillibrand J	Serpentine / Serpentine	Horses	28 Oct. '99	N	0	0
238	1998/99	Nov. '98	Gray R	Margaret River / Augusta-Margaret River	Cattle	1 Dec. '99	S	10.3	0
239	1998/99	Nov. '98	Gray S	Wundowie / Swan	Sheep	27 Jan. '00	S	No data	0
240	1998/99	Nov. '98	Gray S	Wundowie / Swan	Sheep	27 Jan. '00	L	31.8	0
241	1998/99	Nov. '98	Hall E	Kendenup West / Plantagenet	Sheep	17 Nov. '99	L	28.6	0
242	1998/99	Nov. '98	Ladyman D	Jingalup / Kojonup	Cropping	11 Nov. '99	L	10.2	0
243	1998/99	Nov. '98	McCullagh B	Treeton / Augusta-Margaret River	Cattle	30 Nov. '99	S	3.4	0
244	1998/99	Nov. '98	Nix K	Winnejup / Boyup Brook	Cattle, sheep	19 Nov. '99	S	7.7	0
245	1998/99	Nov. '98	O'Byrne T	Quindalup / Busselton	Cattle	25 Nov. '99	N	0	0

Rel. No.	Release season	Release month	Landowner or Manager	Locality / Shire	Farming enterprise	Last surveyed	Found	% Plants struck	Maximum dispersal
246	1998/99	Nov. '98	O'Byrne T	Quindalup / Busselton	Cattle	25 Nov. '99	S	11.8	0
247	1998/99	Nov. '98	O'Byrne T	Quindalup / Busselton	Cattle	25 Nov. '99	N	0	0
248	1998/99	Nov. '98	Pearce B	Kojaneerup / Albany	Sheep	12 Jan. '00	S	16	0
249	1998/99	Nov. '98	Robinson CS	Dardanup / Dardanup	Sheep	23 Nov. '99	S	14.8	0
250	1998/99	Nov. '98	Rowlands J	Chapman Hill / Busselton	Cattle	30 Nov. '99	S	6.8	0
251	1998/99	Nov. '98	Smith B	Osmington / Augusta-Margaret River	Alpacas	2 Dec. '99	S	12.5	0
252	1998/99	Nov. '98	Worts P	Jingalup / Kojonup	Cropping	11 Nov. '99	L	75	0
253	1998/99	Dec. '98	Campbell N	Benger / Harvey	Cattle	28 Oct. '99	S	2.4	0
254	1998/99	Dec. '98	Corker R	Kulikup / Boyup Brook	Sheep	10 Nov. '99	L	2.9	0
255	1998/99	Dec. '98	Dorigo P	Denmark / Denmark	Cattle	13 Jan. '00	S	2.7	0
256	1998/99	Dec. '98	Farrell L	Pemberton / Manjimup	Cattle	15 Dec. '99	S	56	0
257	1998/99	Dec. '98	Foster A	Mundijong / Serpentine-Jarrahdale	Clay mining site	26 Oct. '99	S	7.7	0
258	1998/99	Dec. '98	Fricker B	Elleker / Albany	Cattle	19 Nov. '99	S	1.3	0
259	1998/99	Dec. '98	Gray H	Coolup / Murray	Cattle	29 Oct. '99	L	9.5	0
260	1998/99	Dec. '98	Gray H	Coolup / Murray	Cattle	29 Oct. '99	L	14.3	0
261	1998/99	Dec. '98	Imberti J	Boscabel / Kojonup	Sheep	12 Nov. '99	S	60	0
262	1998/99	Dec. '98	Jeffery C	Winnejup / Boyup Brook	Cattle	15 Dec. '99	S	25	0
263	1998/99	Dec. '98	Leggerini M	Walpole / Denmark	Dairy	16 Dec. '99	N	0	0
264	1998/99	Dec. '98	Letchford C	Bridgetown / Bridgetown-Greenbushes	Cattle	10 Dec. '99	S	78.9	0
265	1998/99	Dec. '98	Linford/Forte	Witchcliffe / Augusta-Margaret River	Goats	1 Dec. '99	S	45	0
266	1998/99	Dec. '98	Marshall D	Boyup Brook / Boyup Brook	Sheep	11 Nov. '99	L	6.9	0
267	1998/99	Dec. '98	Mastaglia R	Greenbushes / Bridgetown-Greenbushes	Cattle	9 Dec. '99	S	38.1	0
268	1998/99	Dec. '98	McCullagh B	Treeton / Augusta-Margaret River	Cattle	30 Nov. '99	S	5	0
269	1998/99	Dec. '98	McGinty B	Greenbushes / Bridgetown-Greenbushes	Cattle	9 Dec. '99	S	15.2	0
270	1998/99	Dec. '98	Miller D	Cowaramup / Augusta-Margaret River	Dairy	1 Dec. '99	S	18.5	0
271	1998/99	Dec. '98	Nettleton K	Boyanup / Capel	Cattle	26 Nov. '99	N	0	0
272	1998/99	Dec. '98	O'Byrne T	Quindalup / Busselton	Cattle	25 Nov. '99	N	0	0
273	1998/99	Dec. '98	O'Byrne T	Quindalup / Busselton	Cattle	25 Nov. '99	N	0	0
274	1998/99	Dec. '98	Penfold M	Rosabrook / Augusta-Margaret River	Cattle	2 Dec. '99	S	5.9	0
275	1998/99	Dec. '98	Penfold M	Rosabrook / Augusta-Margaret River	Cattle	2 Dec. '99	S	10	0
276	1998/99	Dec. '98	Pessotto R	Palgarrup / Bridgetown-Greenbushes	Sheep	15 Dec. '99	S	18.2	0
277	1998/99	Dec. '98	Slapp R	Witchcliffe / Augusta-Margaret River	Cattle, sheep	2 Dec. '99	S	4.3	0
278	1998/99	Dec. '98	Winchcombe K	Yornup / Bridgetown-Greenbushes	Sheep	14 Dec. '99	S	19	0
279	1998/99	Jan. '99	Armstrong	Waroona / Waroona	Cattle	26 Oct. '99	N	0	0
280	1998/99	Jan. '99	Bashford M E	Karridale / Augusta-Margaret River	Cattle	8 Dec. '99	S	10	0

Rel. No.	Release season	Release month	Landowner or Manager	Locality / Shire	Farming enterprise	Last surveyed	Found	% Plants struck	Maximum dispersal
281	1998/99	Jan. '99	Benzie/Armstrong	Waroona / Waroona	Irrigated lucerne	26 Oct. '99	N	0	0
282	1998/99	Jan. '99	Blumann N	Gibson / Esperance	Cropping	16 Jun. '99	L	44	0
283	1998/99	Jan. '99	Bock T	Kulikup / Boyup Brook	Sheep	10 Nov. '99	L	26.1	0
284	1998/99	Jan. '99	Cooper D	Redmond / Albany	Cattle	11 Jan. '00	S	68	0
285	1998/99	Jan. '99	Coppin B	Porongurup / Plantagenet	Sheep	18 Nov. '99	L	12.5	0
286	1998/99	Jan. '99	Cordi C	Warner Glen / Augusta-Margaret River	Dairy	7 Dec. '99	S	57.1	0
287	1998/99	Jan. '99	Coverley S	Busselton / Busselton	Horses	24 Nov. '99	S	7.3	0
288	1998/99	Jan. '99	Gray G	Coolup / Murray	Cattle	29 Oct. '99	L	6.7	0
289	1998/99	Jan. '99	Hart D	Chittering / Chittering	Cattle	27 Oct. '99	L	20	0
290	1998/99	Jan. '99	Lucas JF	Manypeaks Nth / Albany	Cattle	17 Jun. '99	S	18.8	0
291	1998/99	Jan. '99	Lucas JF	Manypeaks Nth / Albany	Cattle	17 Jun. '99	S	12.5	0
292	1998/99	Jan. '99	Lucas JF	Manypeaks Nth / Albany	Cattle	17 Jun. '99	N	0	0
293	1998/99	Jan. '99	Lucas JF	Manypeaks Nth / Albany	Cattle	17 Jun. '99	L	18.8	0
294	1998/99	Jan. '99	MacLeay K	Vasse / Busselton	Cattle	3 Dec. '99	S	11.5	0
295	1998/99	Jan. '99	Marinoni P	Kojonup / Kojonup	Sheep	5 Nov. '99	L	6.2	0
296	1998/99	Jan. '99	Panizza B	King River / Albany	Cattle	12 Jan. '00	S	70	0
297	1998/99	Jan. '99	Poad A	Dardanup / Dardanup	Cattle	23 Nov. '99	S	4.9	0
298	1998/99	Jan. '99	Rowell W	Dunsborough / Busselton	Permaculture	24 Nov. '99	S	30.8	0
299	1998/99	Jan. '99	Sherington D	Ambergate / Busselton	Cattle	24 Nov. '99	S	4.8	0
300	1998/99	Jan. '99	Smith P	Acton Park / Busselton	Cattle, sheep	24 Nov. '99	S	22.6	0
301	1998/99	Jan. '99	Tomlinson JG	Manypeaks / Albany	Cattle	18 Jun. '99	L	73.9	0
302	1998/99	Jan. '99	Tomlinson JG	Manypeaks / Albany	Cattle	18 Jun. '99	L	12.8	0
303	1998/99	Jan. '99	Townsend K	Narrikup / Plantagenet	Cattle	18 Nov. '99	L	19	0
304	1998/99	Jan. '99	Webb HP	Narrikup / Plantagenet	Cattle	18 Nov. '99	N	0	0
305	1998/99	Jan. '99	Webb HP	Narrikup / Plantagenet	Cattle	17 Nov. '99	N	0	0
306	1998/99	Jan. '99	Wills C	Busselton / Busselton	Cattle	24 Nov. '99	S	12	0
307	1998/99	Jan. '99	Young	Jingalup / Kojonup	Sheep	11 Nov. '99	S	19	0
308	1998/99	Feb. '99	Ball P	Holly / Katanning	Sheep	10 Nov. '99	L	36.4	0
309	1998/99	Feb. '99	Cummings D	Mayanup / Boyup Brook	Cattle	4 Nov. '99	N	0	0
310	1998/99	Feb. '99	Edmonds I	Walpole / Denmark	Cattle	16 Dec. '99	S	25	0
311	1998/99	Feb. '99	Harvey W	Muradup / Kojonup	Sheep	4 Nov. '99	L	8.1	0
312	1998/99	Feb. '99	Harvey W	Muradup / Kojonup	Sheep	4 Nov. '99	L	7.1	0
313	1998/99	Feb. '99	Kargotich J	Oakford / Serpentine-Jarrahdale	Dairy	26 Oct. '99	L	20.6	0
314	1998/99	Feb. '99	Keys B	Rosa Brook / Augusta-Margaret River	Cattle	1 Dec. '99	S	58.3	0
315	1998/99	Feb. '99	Keys B	Rosa Brook / Augusta-Margaret River	Cattle	1 Dec. '99	S	9.6	0

Rel. No.	Release season	Release month	Landowner or Manager	Locality / Shire	Farming enterprise	Last surveyed	Found	% Plants struck	Maximum dispersal
316	1998/99	Feb. '99	Lock R	Takalarup / Plantagenet	Sheep	17 Nov. '99	L	25	0
317	1998/99	Feb. '99	Loveland S	Jingalup / Kojonup	Cattle, sheep	9 Nov. '99	S	9.3	0
318	1998/99	Feb. '99	McCallum G	Brookton / Brookton	Cattle, sheep	23 Sep. '99	N	0	0
319	1998/99	Feb. '99	McKenzie I	Neridup / Esperance	Cattle	15 Jun. '99	L	40	0
320	1998/99	Feb. '99	Moir K	Wilga / Boyup Brook	Sheep	10 Dec. '99	S	11.5	0
321	1998/99	Feb. '99	Moncrieff C	Mt Barker / Plantagenet	Prime lambs	16 Nov. '99	N	0	0
322	1998/99	Feb. '99	Moyes H	Bridgetown / Bridgetown-Greenbushes	Sheep	9 Dec. '99	S	19.4	0
323	1998/99	Feb. '99	Murray T	Esperance / Esperance	Cattle, sheep	16 Jun. '99	N	0	0
324	1998/99	Feb. '99	Norman V	Unicup / Manjimup	Cattle	14 Dec. '99	S	8.1	0
325	1998/99	Feb. '99	Norton C	Chorkerup / Plantagenet	Cattle, sheep	18 Nov. '99	N	0	0
326	1998/99	Feb. '99	Prowse N	Pinjarra / Murray	Cattle	27 Oct. '99	N	0	0
327	1998/99	Feb. '99	Pyle J	Manypeaks / Albany	Sheep, cattle	12 Jan. '00	S	3.2	0
328	1998/99	Feb. '99	Ross G	Denmark / Denmark	Cattle	13 Jan. '00	N	0	0
329	1998/99	Feb. '99	Rutherford D	Kendenup / Plantagenet	Olives	18 Nov. '99	S	13.3	0
330	1998/99	Feb. '99	Tomlinson JG	Manypeaks / Albany	Cattle	18 Jun. '99	L	23.1	0
331	1998/99	Feb. '99	Welburn J	Denmark / Denmark	Cattle	13 Jan. '00	S	74.1	0
332	1998/99	Mar. '99	Bail K	Denmark / Denmark	Cattle	12 Jan. '00	S	50	0
333	1998/99	Mar. '99	Bellotti F & J	Boscabel / Kojonup	Cattle	9 Nov. '99	L	9.4	0
334	1998/99	Mar. '99	Blumann N	Gibson / Esperance	Cropping	16 Jun. '99	L	38.1	0
335	1998/99	Mar. '99	Dufall B	Kordabup / Denmark	Cattle	17 Dec. '99	S	7.3	0
336	1998/99	Mar. '99	Graham K	Denmark / Denmark	Vineyard	13 Jan. '00	S	11.1	0
337	1998/99	Mar. '99	Hack R	Mayanup / Boyup Brook	Canola, barley	11 Nov. '99	L	4.7	0
338	1998/99	Mar. '99	Lewis JC	Muradup / Kojonup	Sheep	4 Nov. '99	L	3.1	0
339	1998/99	Mar. '99	Marinoni P	Kojonup / Kojonup	Sheep	5 Nov. '99	N	0	0
340	1998/99	Mar. '99	Mostert C	Redmond / Albany	Dairy	17 Nov. '99	S	3.2	0
341	1998/99	Mar. '99	Nye-chart M	Mt Barker / Plantagenet	Cattle	17 Nov. '99	S	5.5	0
342	1998/99	Mar. '99	Pascoe B	Boyup Brook / Boyup Brook	Angora goats	10 Nov. '99	L	45	0
343	1998/99	Mar. '99	Schorer D	Wandering / Wandering	Sheep	16 Nov. '99	L	8.3	0
344	1998/99	Mar. '99	Schorer D	Wandering / Wandering	Sheep	16 Nov. '99	N	0	0
345	1998/99	Mar. '99	Sharpe J	Denmark / Denmark	Cattle	13 Jan. '00	S	12	0
346	1998/99	Mar. '99	Thorn K	North Dandalup / Dardanup	Cattle	23 Nov. '99	S	16	0

APPENDIX 5

Benchmark site pasture and weed data

Benchmark Survey - Pasture Assessment

B1 McKenzie 23/5/00

Vegetation Composition - Percentage coverage in a $1m^2$ sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	<5	<5	20	5	5	5	<5	<5	5	25
Grasses	<5	0	0	0	10	5	<5	<5	<5	<5
Clovers & Legumes	0	0	0	0	0	0	0	0	0	0
Cape Weed	30	25	10	5	5	0	0	0	0	5
Other Weeds	35	45	50	60	65	85	90	85	90	65
Bare Ground	25	25	20	30	15	5	0	5	0	0

Notes - Other weed composition was mainly flatweed

Dock Plant Count - Number in a $1m^2$ sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	6	4	6	3	4	4	2	3	3	8
Seedlings	0	0	1	2	0	0	0	0	0	0

B2 Pearce 18/7/00

Vegetation Composition - Percentage coverage in a $1m^2$ sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	50	60	55	50	60	80	80	85	70	80
Grasses	25	35	40	30	40	<5	10	5	5	10
Clovers & legumes	0	5	0	0	0	10	10	0	25	0
Cape Weed	0	0	5	5	0	0	0	0	0	0
Other Weeds	5	0	0	0	0	0	0	0	0	0
Bare Ground	20	0	0	15	0	5	0	10	0	10

Notes - Other weed composition was mainly silvergrass. Looks like areas of bare ground will be covered by clover later.

Dock Plant Count - Number in a $1m^2$ sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	28	144	18	57	110	123	42	74	92	57
Seedlings	75	25	122	60	55	38	89	114	23	49

B3 Cooper 24/5/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	20	25	20	30	30	20	10	25	15	30
Grasses	5	10	5	10	5	25	<5	10	5	<5
Clovers & legumes	70	55	50	55	60	40	70	50	50	60
Cape Weed	0	0	0	0	0	0	0	0	0	0
Other Weeds	5	10	25	<5	5	15	15	15	20	5
Bare Ground	0	0	0	0	0	0	0	0	10	0

Notes - Other weed composition was flatweed, sorrel and capeweed

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	14	11	16	28	39	7	12	16	17	34
Seedlings	0	1	2	3	5	0	2	1	1	2

Dock Plant Count - Number in a 1m^2 sample

B4 Hall 19/7/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	5	10	5	5	10	5	15	10	10	10
Grasses	25	35	45	40	40	25	35	30	20	30
Clovers & legumes	20	40	34	35	40	20	15	30	15	20
Cape Weed	50	15	10	20	10	45	35	30	50	40
Other Weeds	0	0	0	0	0	5	0	0	5	0
Bare Ground	5	0	5	0	0	0	0	0	0	0

Notes - Other weed composition was mainly Guildford grass

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	6	18	6	14	11	8	16	8	23	13
Seedlings	0	2	0	1	0	3	1	3	0	4

B5 S Gray 27/7/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	5	5	5	<5	10	10	20	15	5	15
Grasses	0	0	5	10	0	5	5	5	5	10
Clovers & legumes	45	5	5	30	5	0	5	10	0	0
Cape Weed	25	65	10	15	10	70	55	70	80	75
Other Weeds	15	5	65	40	70	15	5	0	10	0

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Bare Ground	10	20	10	0	5	0	10	0	0	0

Notes - Other weed composition was mainly *Erodium* sp.

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	3	1	2	2	6	4	12	4	2	10
Seedlings	0	0	0	0	0	0	1	2	1	0

B6 Bail 13/4/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	25	10	15	10	5	25	25	20	30	25
Grasses	70	75	45	15	40	0	0	25	20	15
Clovers & legumes	<5	15	40	75	55	65	75	55	45	60
Cape Weed	0	0	0	0	0	0	0	0	0	0
Other Weeds	0	0	0	0	0	10	0	0	0	0
Bare Ground	0	0	0	0	0	0	0	0	5	0

Notes - Other weed composition was flatweed and goosefoot

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	16	15	11	6	2	18	6	7	16	12
Seedlings	16	4	6	2	4	14	19	14	27	14

B7 Dumbrell/Anning 24/5/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	25	<5	80	30	45	30	25	45	15	50
Grasses	20	5	5	20	5	10	60	50	60	40
Clovers & legumes	0	0	0	10	5	5	0	0	5	0
Cape Weed	0	0	0	0	0	0	0	0	0	0
Other Weeds	55	90	15	40	45	55	15	5	5	10
Bare Ground	0	0	0	0	0	0	0	0	15	0

Notes -Other weed composition was crab grass, mouse-eared chickweed and *Erodium* sp.

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	15	3	33	25	24	11	7	9	5	10
Seedlings	2	2	5	0	2	3	1	1	0	2

B8 Ailakis 23/5/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	25	30	30	40	20	25	35	30	35	30
Grasses	10	40	20	25	20	55	65	70	60	70
Clovers & legumes	55	30	50	30	60	0	0	0	5	0
Cape Weed	0	0	0	5	0	0	0	0	0	0
Other Weeds	0	0	0	0	0	0	0	0	0	0
Bare Ground	0	0	0	0	0	20	0	0	0	0

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	19	14	9	17	18	7	6	8	18	21
Seedlings	21	10	8	22	14	27	46	37	28	28

B9 Pessotto 20/7/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	<5	20	5	10	15	5	10	10	<5	35
Grasses	80	55	65	45	25	90	90	90	30	55
Clovers & legumes	5	10	0	0	0	0	0	0	<5	0
Cape Weed	0	5	0	0	0	0	0	0	0	0
Other Weeds	0	5	30	45	55	5	0	0	60	10
Bare Ground	10	5	0	0	5	0	0	0	0	0

Notes - Other weed composition was silvergrass, sorrel and *Veronica* sp.

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	2	4	1	1	8	3	6	3	1	6
Seedlings	0	4	4	0	3	0	1	4	0	3

B10 H Gray 26/7/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	20	10	15	15	10	40	35	35	20	40
Grasses	70	50	65	60	60	45	50	50	45	40
Clovers & legumes	5	0	0	5	5	0	5	5	10	5
Cape Weed	5	30	20	20	25	15	10	10	25	15
Other Weeds	0	10	0	0	0	0	0	0	0	0
Bare Ground	0	0	0	0	0	0	0	0	0	0

Notes - Other weed composition was mainly *Veronica* sp.

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	16	15	11	8	17	19	11	22	8	8
Seedlings	2	1	2	1	4	1	0	2	0	0

B11 Rowlands 24/7/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	10	20	20	15	15	75	40	20	25	40
Grasses	75	70	80	60	80	25	60	80	75	60
Clovers & legumes	5	5	0	5	0	0	0	0	0	0
Cape Weed	0	0	0	5	0	0	0	0	0	0
Other Weeds	0	0	0	20	0	0	0	0	0	0
Bare Ground	10	5	0	0	5	0	0	0	0	0

Notes - Other weed composition was mainly thistles

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	7	20	15	12	11	38	41	18	7	19
Seedlings	1	1	3	3	0	12	3	8	9	1

B12 Millar 25/5/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	10	15	20	15	20	35	15	15	25	20
Grasses	30	15	10	15	25	10	25	20	30	15
Clovers & legumes	45	65	50	60	50	25	60	60	25	60
Cape Weed	5	<5	0	0	<5	0	0	0	10	0
Other Weeds	10	0	15	10	0	15	0	5	0	5
Bare Ground	0	0	5	0	0	15	0	0	10	0

Notes - Other weed composition was mainly flatweed

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	5	16	28	2	17	12	13	5	8	9
Seedlings	0	4	10	1	5	5	4	2	2	1

B13 Keys 25/5/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	20	35	40	35	35	45	45	40	15	40
Grasses	0	5	10	<5	5	10	5	5	35	5
Clovers & legumes	<5	15	10	0	10	40	5	30	40	40
Cape Weed	0	0	0	0	0	0	0	0	0	0
Other Weeds	75	45	40	60	50	5	45	25	10	15
Bare Ground	0	0	0	0	0	0	0	0	0	0

Notes - Other weed composition was flatweed, pennyroyal and *Veronica* sp.

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	36	37	89	41	39	70	63	59	30	69
Seedlings	22	8	29	9	12	27	16	12	3	15

B14 Macleay 24/7/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	40	35	15	10	25	10	5	40	20	20
Grasses	45	50	65	45	60	40	30	30	60	30
Clovers & legumes	10	5	15	5	0	5	0	0	5	0
Cape Weed	0	0	0	0	0	0	0	0	0	0
Other Weeds	0	0	0	0	0	0	0	0	0	0
Bare Ground	15	10	5	40	15	45	65	30	15	50

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	34	17	12	15	33	10	1	15	3	15
Seedlings	10	3	3	4	12	2	6	3	7	4

B15 Bellotti 19/7/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	<5	<5	<5	<5	<5	15	25	40	45	45
Grasses	5	5	0	0	0	0	0	0	0	0
Clovers & legumes	0	0	0	0	0	5	5	0	0	0
Cape Weed	0	0	0	0	0	0	0	0	0	0
Other Weeds	10	10	10	10	10	0	0	0	5	0
Bare Ground	80	80	85	85	85	85	70	60	50	55

Notes - Other weed composition was *Erodium* sp. and Guildford grass

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	8	3	4	5	2	4	4	25	38	21
Seedlings	0	0	0	0	0	1	2	7	3	2

B16 Ball 19/7/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	15	5	5	10	10	30	35	35	25	25
Grasses	20	10	20	20	15	50	25	30	25	35
Clovers & legumes	0	0	0	0	0	0	0	0	0	0
Cape Weed	0	0	0	0	0	0	0	0	0	0
Other Weeds	25	60	60	55	65	0	0	0	0	0
Bare Ground	40	25	15	15	10	20	40	35	50	40

Notes - Other weed composition was Guildford grass, *Erodium* sp. and flatweed

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	23	16	12	17	20	10	1	9	2	9
Seedlings	1	2	1	1	2	5	28	9	2	0

B17 Worts 19/7/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	0	<5	<5	<5	5	5	<5	<5	<5	5
Grasses	60	80	80	35	5	80	90	90	70	95
Clovers & legumes	0	5	5	5	<5	5	0	0	0	0
Cape Weed	0	0	0	0	0	5	0	0	0	0
Other Weeds	0	0	0	5	65	0	5	0	5	0
Bare Ground	40	10	10	50	20	5	0	5	20	0

Notes - Other weed composition was silvergrass, Guildford grass and flatweed

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	0	1	2	2	4	1	1	2	1	1
Seedlings	0	0	0	0	0	0	0	3	0	0

B18 Pascoe 20/7/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	10	15	25	25	25	30	15	15	40	30
Grasses	10	15	15	10	5	<5	5	10	5	10
Clovers & legumes	0	0	0	0	<5	0	0	0	0	0
Cape Weed	45	40	30	15	20	10	40	35	0	0
Other Weeds	0	0	0	0	0	25	0	10	40	30
Bare Ground	35	30	30	50	50	30	40	30	15	30

Notes - Other weed composition was *Erodium* sp. and *Veronica* sp.

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	10	20	55	21	46	34	28	36	73	31
Seedlings	0	0	1	1	0	0	1	3	4	0

B19 Letchford 20/7/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	20	15	20	30	15	15	10	15	15	25
Grasses	70	65	70	65	75	80	85	85	70	70
Clovers & legumes	5	5	5	5	5	0	0	0	0	0
Cape Weed	0	5	0	0	5	5	5	0	10	5
Other Weeds	0	0	0	0	0	0	0	0	5	0
Bare Ground	5	10	5	0	0	0	0	0	0	0

Notes - Other weed composition was mainly Guildford grass

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	15	18	26	23	21	9	9	17	15	11
Seedlings	9	6	5	8	4	10	2	5	7	2

B20 Kargotich 27/7/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Dock	20	25	40	20	5	10	10	10	10	15
Grasses	80	50	60	75	80	50	80	90	90	85
Clovers & legumes	0	0	0	0	0	40	5	0	0	0
Cape Weed	0	25	0	5	15	0	0	0	0	0
Other Weeds	0	0	0	0	0	0	5	0	0	0
Bare Ground	0	0	0	0	0	0	0	0	0	0

Notes - Other weed composition was mainly *Veronica* sp.

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot					Ungrazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mature Plants	12	8	12	8	5	3	3	3	3	2
Seedlings	2	1	6	0	1	2	2	0	1	1

C1 Hampel 23/5/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**
Dock	25	20	25	40	20
Grasses	55	5	20	25	40
Clovers/other Legumes	10	0	5	0	0
Cape Weed	0	0	0	0	0
Other Weeds	10	75	50	35	40
Bare Ground	0	0	0	0	0

Notes - other weed composition was mainly flatweed, sorrel and rushes

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**
Mature Plants	9	7	9	19	10
Seedlings	2	2	9	37	17

C2 Curwen 6/4/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

	Grazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**
Dock	20	15	20	5	20
Grasses	75	80	75	90	75
Clovers/other Legumes	5	<5	5	5	<5
Cape Weed	0	0	0	0	0
Other Weeds	0	0	0	0	0
Bare Ground	0	0	0	0	0

Dock Plant Count - Number in a 1m^2 sample

	Grazed Plot				
Square Number	**1**	**2**	**3**	**4**	**5**
Mature Plants	7	6	12	2	5
Seedlings	22	8	19	7	3

C3 Hopkins 26/5/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

Grazed Plot					
Square Number	**1**	**2**	**3**	**4**	**5**
Dock	15	10	10	15	5
Grasses	25	10	20	35	10
Clovers/other Legumes	60	80	70	50	85
Cape Weed	0	0	0	0	0
Other Weeds	0	0	0	0	0
Bare Ground	0	0	0	0	0

Dock Plant Count - Number in a 1m^2 sample

Grazed Plot					
Square Number	**1**	**2**	**3**	**4**	**5**
Mature Plants	35	52	47	34	27
Seedlings	1	3	0	0	0

C4 Williams 20/7/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

Grazed Plot					
Square Number	**1**	**2**	**3**	**4**	**5**
Dock	20	20	25	10	30
Grasses	25	25	20	25	25
Clovers/other Legumes	0	0	0	0	0
Cape Weed	0	0	0	0	0
Other Weeds	50	50	35	50	35
Bare Ground	5	5	20	15	10

Notes - other weed composition was mainly flatweed, sorrel and rushes

Dock Plant Count - Number in a 1m^2 sample

Grazed Plot					
Square Number	**1**	**2**	**3**	**4**	**5**
Mature Plants	14	5	9	5	11
Seedlings	2	1	0	0	0

C5 Nancarrow 28/6/00

Vegetation Composition - Percentage coverage in a 1m^2 sample

Grazed Plot					
Square Number	**1**	**2**	**3**	**4**	**5**
Dock	20	15	25	10	50
Grasses	35	25	40	25	20
Clovers/other Legumes	25	45	20	40	20
Cape Weed	20	15	15	20	5
Other Weeds	0	0	0	5	5
Bare Ground	0	0	0	0	0

Notes - other weed composition was mainly *Veronica* sp.

Dock Plant Count - Number in a 1m^2 sample

Grazed Plot					
Square Number	**1**	**2**	**3**	**4**	**5**
Mature Plants	34	41	29	39	56
Seedlings	4	2	1	5	2

APPENDIX 6

AGWEST Farmnote and journal articles