Assessment of the impact of insecticide spraying of Australian plague locusts

JULY 2001

EPA
South Australia

Government
of South Australia

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Cover photograph: Australian plague locust, *Chortoicetes terminifera*
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EXECUTIVE SUMMARY

This report is a review of a study commissioned by the Environment Protection Agency to assess the impacts of pesticides on aquatic ecosystems as a result of extensive locust spraying in South Australia in the spring of 2000.

Approximately 505,000 hectares of land was sprayed with insecticides between September and December 2000 to control a major locust plague. Concerns for the environmental impacts of widespread spraying were addressed through cooperative arrangements between Primary Industries and Resources South Australia, the Environment Protection Agency and the State Water Monitoring Coordinating Committee.

The study aimed to assess the impacts of fenitrothion and fipronil on off-target aquatic ecosystems. Water and macroinvertebrate sampling was conducted at nine sites in the southern Flinders Ranges both before and after spraying. Water samples were analysed for physical and chemical parameters, and screened for the presence of fenitrothion and fipronil in addition to other pesticides. Macroinvertebrate samples were analysed using the SA Monitoring River Health Subsampling Protocol model to determine any changes in community structure.

No pesticides were found in water samples collected from the nine sites after spraying in the area. Overall there was no indication that the macroinvertebrate communities were impacted by the locust spraying operation.

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INTRODUCTION

The Australian plague locust, *Chortoicetes terminifera*, is a native insect. Usually eggs are laid in autumn, remain dormant during winter and hatch in spring; they develop according to temperature and moisture. Under ideal conditions, eggs laid in summer can hatch within 14–16 days, so several generations of locusts can hatch in one season.

High rainfall in Queensland early in 2000 followed by humid weather provided ideal breeding conditions for locusts. Monitoring of the weather conditions and locust numbers from summer to autumn 2000 indicated a major plague of locusts would occur in South Australia in spring 2000.

A South Australian Government program was developed which aimed to combine the efforts of the Australian Plague Locust Commission (APLC), landowners, the Local Government Authority (LGA) and Primary Industries and Resources South Australia (PIRSA). The program aimed to disperse locust numbers to prevent the formation of swarms and reduce widespread damage.

Concerns for the environmental impacts of widespread spraying were addressed through cooperative arrangements between PIRSA, the Environment Protection Agency (EPA) and the State Water Monitoring Coordinating Committee. A study of environmental impact from the use of fenitrothion and fipronil was commissioned by the EPA.

The study assessed whether detectable concentrations of either insecticide were present in local waterways following spraying, and determined whether the spraying program adversely impacted on non-target aquatic organisms in nearby streams in the Flinders Ranges. The EPA commissioned the study to assess impacts on off-target aquatic ecosystems, rather than land-based terrestrial ecosystems that were directly sprayed, to address concerns for chemical trespass and off-site environmental impacts.

LOCUST CONTROL

After hatching, locusts mature in 4–6 weeks and are able to fly and form swarms. They eat a wide range of plants including pasture grasses, cereal crops, berry fruits, grapevines, some ornamentals, tree fruits, and nuts and vegetables. Swarms can travel up to 20 km a day and can migrate at night if sufficient green feed has been available. Consequently, they have the potential to destroy a large percentage of the State's export income. Experts predicted that, if left unchecked, the locust plague could infest the wine-growing regions in the Barossa Valley and South East, and also cause substantial damage in Adelaide (PIRSA, 2000).

Locusts can be controlled chemically at the nymph and adult stages, and large chemical control campaigns are common in most affected States. Immediately after hatching, locust nymphs congregate in dense groups or bands. Treatment of small areas containing these dense masses of nymphs can effectively control potentially damaging populations. More than one spraying may be needed as eggs may hatch over a period of several weeks.

The most promising alternative to chemical pesticides is Green Guard®, a fungal pathogen (*Metarhizium anisopliae*) specific to locusts and grasshoppers. However, chemical spraying is regarded as the most effective method of controlling plague populations of *C. terminifera*, given the huge area under control, difficulty of land transport and access, and the need for urgent response to outbreaks.

Local councils and landowners were approved to use carbaryl, chlorpyrifos, diazinon, fenitrothion, fipronil and various synthetic pyrethroids in the locust control program. PIRSA assumed responsibility for aerial spraying, aiming to kill the maximum number of locusts per day using fipronil in pastoral country and fenitrothion on cropping country.

By 12 December 2000, approximately 505,000 hectares had been sprayed as part of the control program, including more than 420,000 ha sprayed by the State Government, 64,700 ha by local councils, 20,000 ha by the APLC, and sprayings by individual landholders.

BACKGROUND

Insecticides

It is inevitable that there will be loss of non-target insects and other invertebrates when using insecticides to control one species of insect within a spray block (Bunn *et al,* 1993). The application of fenitrothion and fipronil is governed by strict control regimes, including the observation of buffer zones around residences and sensitive areas such as waterways and public water supply dams (Australian Plague Locust Commission, 2000). Fenitrothion requires large buffer zones as it is inherently prone to spray drift (National Registration Authority for Agricultural and Veterinarian Chemicals, 1999). Fipronil was not to be used near populated areas and only employed in northern pastoral areas of the State (PIRSA, 2000). Although buffer zones around waterways help minimise the risk to water supplies and aquatic organisms, there is still the risk of off-target applications, spray drift and runoff from rain.

Fenitrothion

General

Fenitrothion is a broad-range non-systemic organophosphorous insecticide that has been registered for use in Australia for over 30 years. Common uses for fenitrothion include the protection of stored cereal grains, and grain storage equipment and structures, from insect attack, the control of nymphal bands and adult swarms of plague locusts, and insect control for a broad range of crops. Fenitrothion exerts its toxicity through indirect inhibition of cholinesterase through its transformation to fenitrooxon.

Fenitrothion is rapidly broken down in most animals and over 85% is excreted as breakdown products in the urine within four days (Agriculture WA, 2000). Meat from animals exposed to the insecticide may be eaten after a withholding period of 14 days. Similarly, eggs laid by poultry exposed to the insecticide should contain no detectable residues after one week (Agriculture WA, 2000). Fenitrothion has been shown to have high acute toxicity to birds. Its use was banned in Canada in 1997 after it was linked to significant increased mortality of forest songbirds (Mineau, 1999). Fenitrothion is known to have harmful effects on terrestrial invertebrates including honeybees, ants and springtails.

Effects on aquatic systems

Fenitrothion is considered to be moderately toxic to fish (USEPA, 1987), of medium toxicity to aquatic worms (Briggs, 1992) and very highly toxic to aquatic invertebrates (USEPA, 1987). It is known to adhere strongly to suspended solids and sediments (Spectrum Laboratories, 1999). Organic pollutants, such as pesticides, can become trapped in surface foam on water. It is therefore possible fenitrothion has a greater deleterious effect on surface-dwelling invertebrates and may also impact on surface-laid eggs of some frog species. Fenitrothion is not very persistent in the aquatic environment, with its estimated half-life being typically 1–10 days (Foundation for Water Research, 1990). Bioaccumulation data suggest a moderate tendency to accumulate in aquatic organisms (Spectrum Laboratories, 1999), but extensive food-chain bioconcentration is not expected as fenitrothion is rapidly eliminated by most vertebrates and invertebrates (Foundation for Water Research, 1990).

Fipronil

General

Fipronil is a relatively new insecticide belonging to the phenyl pyrazole class of pesticides. It acts as an insecticide with contact and stomach action by disrupting the insect central nervous system via the aminobutryic acid (GABA) regulated chloride channel. While it takes 7–10 days to kill the insect, it does possess good residual effect.

Field persistence is low to moderate in water and soil, with three major degradates formed in soil and two major metabolites in water. Fipronil degrades slowly in water and sediment; its half-life on treated vegetation has been determined at 3–7 months, depending on the substrate and the habitat where it is applied (Belayneh, 1998). When fipronil was used to control African locusts in Madagascar between 1996 and 1999, the mortality of many bird and mammal species increased, leading the government to withdraw authorisation for its use against locust swarms in February 1999 (PLAAG, 1999).

Effects on aquatic systems

Fipronil is toxic to a wide range of aquatic invertebrates, and is very highly toxic to oysters, shrimps and other crustaceans (Diallo *et al*, 1998; Lahr *et al*, 1998). Some of its metabolites are also more toxic to freshwater invertebrates than the parent substance (van der Valk *et al*, 1998). Metabolic studies showed that there was a potential for bioaccumulation of the photodegradate MB 46513 in fatty tissues (USEPA, 1998). In aquatic environments, fipronil residues rapidly move from the water to the sediment, with over 95% of the residues being found in or on sediments within one week of application (Hamon *et al*, 1996).

METHODS

Experience with previous outbreaks of *C. terminifera* in South Australia indicated that the southern Flinders Ranges, Mid North, northern Eyre Peninsula and Riverland were regions likely to require insecticide spraying. Nine sites were established for water and macroinvertebrate sampling, both before and after spraying, in the southern Flinders Ranges of South Australia (Figure 1). These sites were chosen as they were representative of an area likely to be sprayed extensively, and were also representative of habitat of significant environmental value. They were distributed across the likely impact zone, and background information on the sites was also available from previous sampling between 1994 and 1999 as part of the national Monitoring River Health program.

Several water samples were collected at each site to determine physical and chemical water quality parameters in the laboratory, including the presence of fenitrothion and fipronil in a pesticide scan. Other pesticides targeted in the scan included Simazine, Atrazine, Azinphos-Methyl, Diazinon, Hexazinone, Malathion, Parathion, Parathion-Methyl and Prometryne. The detection limit for all pesticides was 0.5 µg/L.

The macroinvertebrates were sampled from standardised still water edge habitat and flowing water riffle habitat (where present), using a 250 µm mesh sweep net over a 10 m area. The macroinvertebrates were preserved in the field with 4% formalin, and later identified and enumerated in the laboratory using the SA Monitoring River Health Subsampling Protocol.

The results of the macroinvertebrate sampling were run through the current Australian River Assessment System[1] models for South Australia. The models describe the invertebrate communities expected to occur at a site in the absence of significant human impact, based on an assessment of other least disturbed reference sites that have similar stream characteristics.

[1] AusRivAS—a prediction system used to assess the biological health of Australian rivers, developed under the National River Health Program.

RESULTS

Sites were first sampled between 9 and 10 October 2000, before large scale spraying in the catchment areas. Sampling was also conducted on 28 November and 1 December 2000, after most of the spraying had been completed.

No fenitrothion or fipronil (or any other pesticide targeted in the scan) was detected in the water column at any site either before or after spraying. In addition, the other chemical parameters measured did not change significantly from one survey to the next. Some parameters changed slightly, probably due to the change in season—e.g. water temperature generally increased, while conductivity generally decreased, probably due to the input of rainwater.

The numbers of taxa from the nine sampling sites both before and after spraying were similar. Generally, a slight increase in the numbers of individual taxa was recorded after pesticide spraying (Figure 2). Comparison of macroinvertebrate samples taken before and after sampling showed a slight decrease in abundance. The differences in abundance between sampling times is most likely to be due to natural variability or differences in technique between people collecting and analysing the samples. Overall there was no indication that the macroinvertebrate communities had been impacted by the locust spraying operation.

CONCLUSIONS

- No pesticides were found in water samples collected from the nine sites after pesticide spraying in the area surveyed.
- There was no indication that the macroinvertebrate communities were impacted by the locust spraying operation.

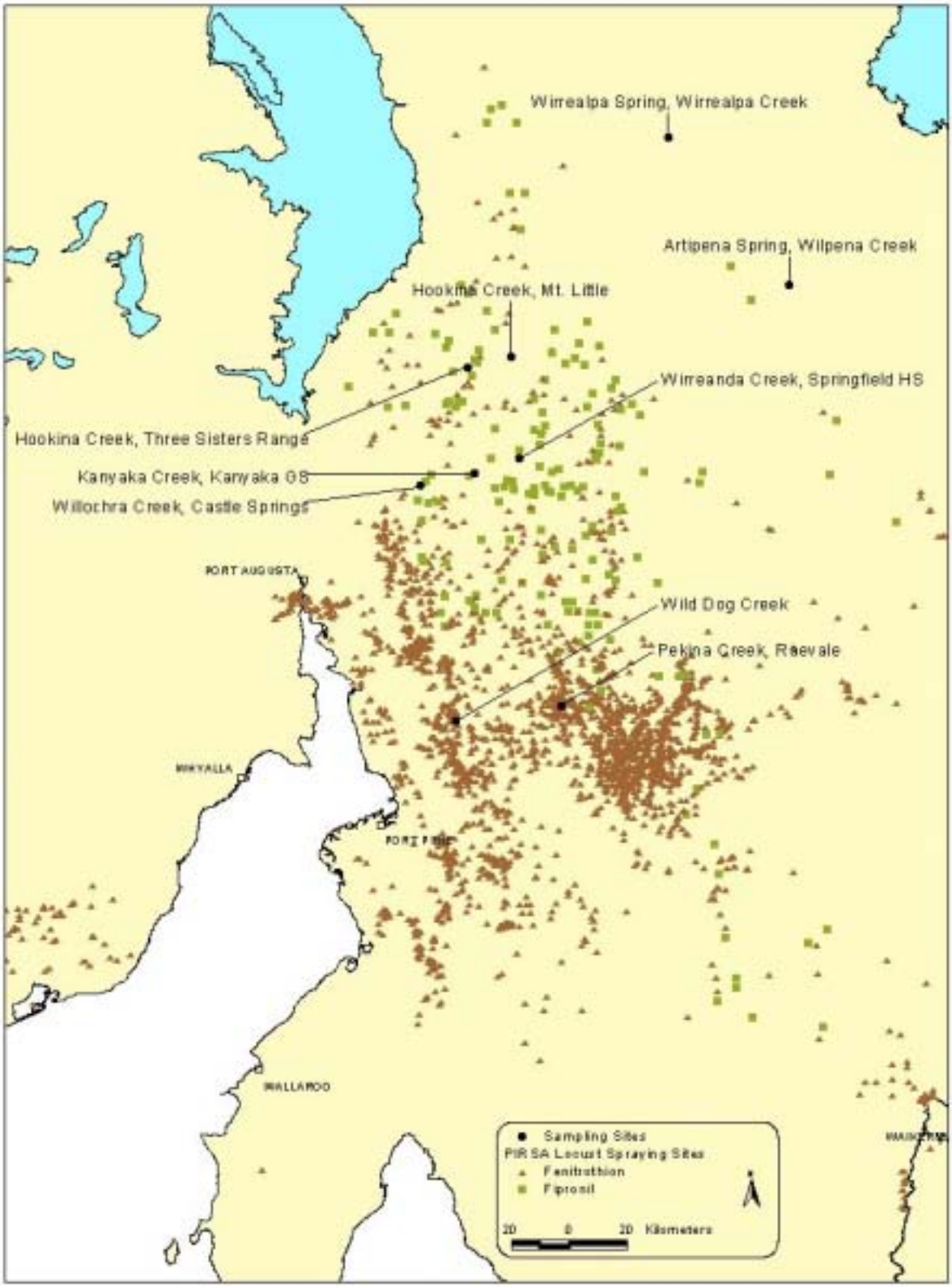

Figure 1: Sampling sites and PIRSA locust spraying sites

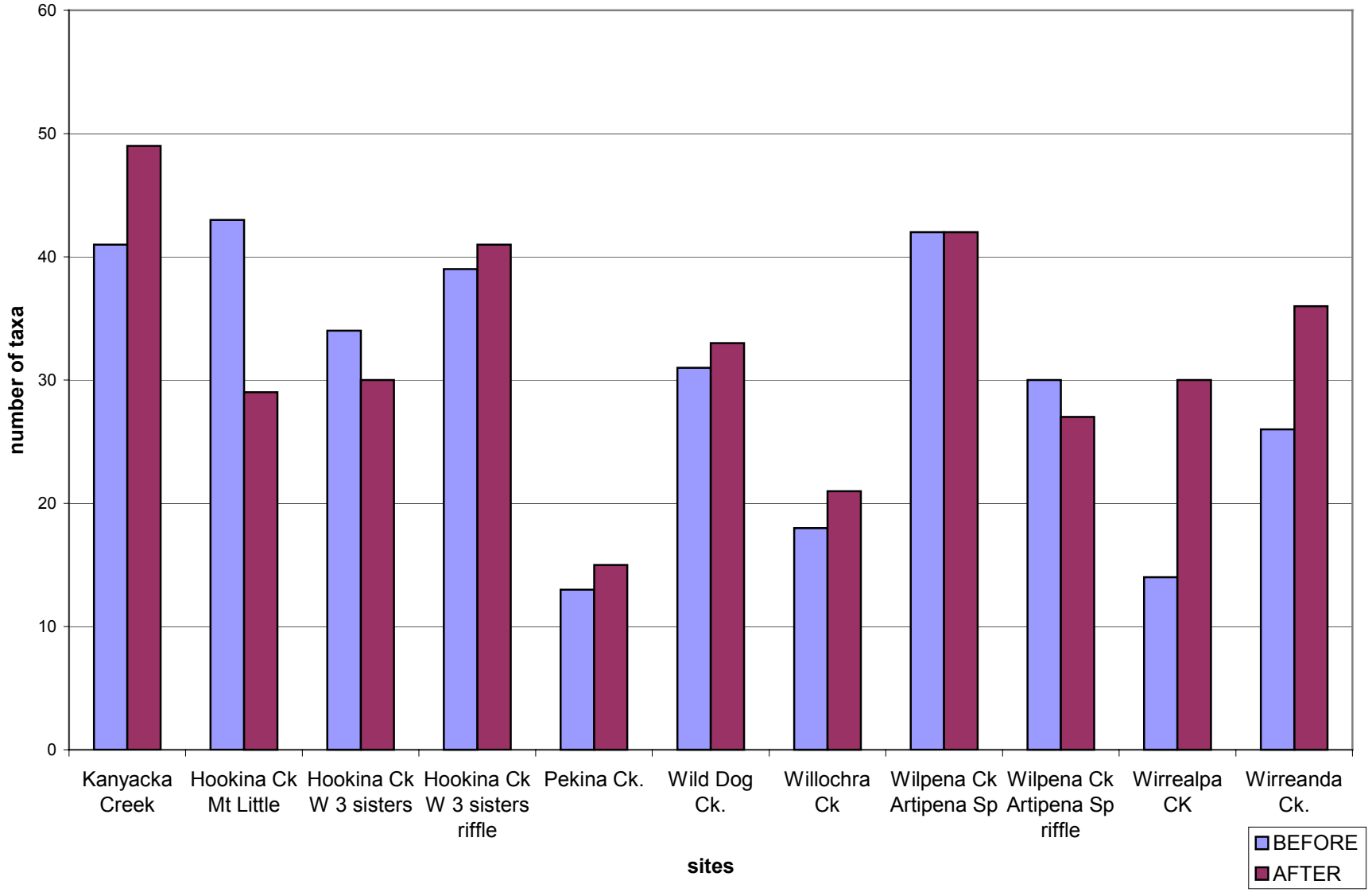

Figure 2: Number of taxa per sample collected in the Flinders Ranges, South Australia

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