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Abstract: European starlings (*Sturnus vulgaris*) are one of the most abundant and widespread bird species on earth. Introduced to Australia in the late 1850s, their highly adaptive ecology has enabled them to become a major pest. Concerns include public health and safety, economic impacts, detrimental environmental effects, and bird strikes at airports. Unfortunately current Australian control methods are ineffective and more efficacious, humane methods need to be developed. A feasibility study was undertaken of the likely risks/benefits of avicide DRC 1339 (3-chloro-4-methylbenzenamine hydrochloride) in Australia. This included a risk-analysis, a multi-industry survey and non-toxic bait trials to assess target-specificity. Results indicated that European starlings were one of three key bird species affecting intensive agriculture; there was strong support for better bird control techniques; and the risk to 82% of the native bird species recorded at the test sites was assessed as low or very low. Potential bait carrier trials demonstrated behavioral differences between United States and Australian starlings and hence the main application will initially be restricted to sites such as intensive livestock production facilities where starlings are already accustomed to feeding. Therefore, the project now aims to demonstrate DRC 1339 efficacy under Australian conditions and achieve registration.

Key Words: 3-chloro-4-methylbenzenamine hydrochloride, Australia, avicide, bait trials, DRC-1339, invasive species, risk analysis, starlings, *Sturnus vulgaris.*

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INTRODUCTION

European starlings have been classified as one of the top 100 worst invasive species worldwide (Lowe et al. 2000). They are a major pest in Australia (Figure 1) in that they cause significant economic damage to a variety of primary production industries (e.g., viticulture, horticulture, and livestock). They also have a significant negative impact on biodiversity and a marked social impact in urban environments. Starlings are further known to impact on human health and safety. The problems they cause include:

- Disease transmission (to animals and humans);
- Feed and water contamination;
- Droppings (nuisance, spreading weeds, contaminating wool);
- Impacting on natural biodiversity (overtaking nesting hollows and spreading weeds); and
- Economic losses (feed and crop consumption, clean-up costs from droppings, weed removal).

Due to their gregarious nature, extremely large flocks can occur throughout much of the year. Such aggregations of birds often foul public facilities when roosting overnight. Pairs and their young sully roofs with mites and dirty nesting material when flocks break up during the breeding season, also creating fire hazards. Contamination of areas with accumulated starling droppings poses a health risk, such as fouling rainwater used for drinking. Weber (1979) found over 25 important diseases can be carried by starlings, including bacterial, viral, mycotic, protozoal and numerous parasites, transferable to humans and livestock. The spores of *Histoplasmosis* are airborne, so starlings have the potential to affect much greater areas than just the primary site fouled. They have been known to be involved in bird strikes to aircraft. Starlings also are of detriment to native fauna and flora in that they disperse weeds and compete with native fauna for food and nesting resources.

Starlings often eat and foul large quantities of feed intended for livestock. For example, a flock of 200 starlings may eat around 80 kg of grain per week and contaminate even more with their

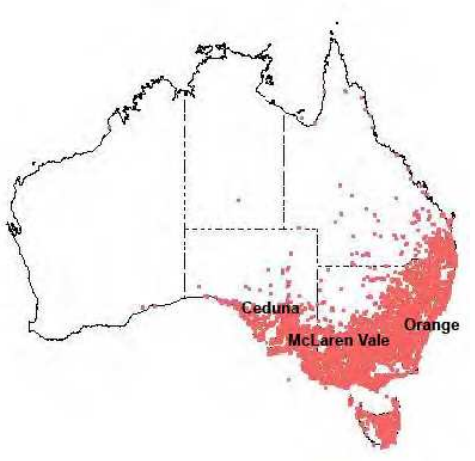

Figure 1. Pilot study sites in relation to starling distribution in Australia.

droppings (New York State Department of Environmental Conservation 2004). In addition, their droppings may foul water intended for livestock which then has to be cleaned daily at the expense of farmer's time and increased water wastage; an issue with stricter water restrictions due to severe drought conditions in Australia. They also foul livestock bedding which may spread Salmonella and other diseases to animals, and contaminate sheep fleeces with their droppings while ox-pecking. DRC-1339 has been the single most effective means of reducing feed and animal losses by starlings in the United States livestock feeding operations (Besser et al. 1967). DRC-1339, however, has never been used in Australia.

FEASIBILITY STUDY RESULTS

A postal survey of intensive livestock producers (piggeries and feedlot operators) and grain handling facilities identified starlings as one of the three main pest bird species that impact on their industries, the other two being introduced sparrows and native cockatoos (Lapidge et al. 2006). Various methods of control are currently used to help alleviate the impacts of pest birds in Australia, including scaring devices, netting and shooting. Many primary producers also opt to not undertake control despite suffering pest bird damage. Netting is the only technique that is reportedly effective, but implementation may be cost prohibitive.

The survey also indicated strong support for the development of more humane and cost-effective pest bird control techniques because current methods rely largely on shooting and use of unregistered chemicals (particularly inorganic insecticides) for poisoning birds. There was a widespread intention amongst feedlot and piggery operators to use poison bait if it was found to be cost effective, target-specific and humane. Acceptance of such a product was considerably less when horticulturists were asked the same question. A small, but significant, market potential therefore exists for the use of DRC-1339 in Australia, particularly in the intensive livestock industries. Interest from the Western Australian Government has also been registered.

Risk to a large majority (82%) of the Australian native bird species recorded at the test sites was assessed as low or very low and the toxin was assessed as highly humane (Dawes 2005, Dawes 2006). Lapidge et al. (2006) consequently trialed various bait substrates in three different climatic regions across Australia where starlings cause an impact. Figure 1 shows locations of: semi-arid pastoral Ceduna, SA (mean annual rainfall 290 mm), the Mediterranean climate wine-grape growing region of McLaren Vale, SA (mean annual rainfall 660 mm) and a temperate water waste facility in Orange, NSW (mean annual rainfall 940 mm). Trials of potential bait substrates confirmed the apparent difference between starling dietary behavior in Australia compared with the United States and, hence, the main application will initially be restricted to intensive livestock production facilities where feeding on non-live food has been well established.

Feeding trials in broadacre settings suggested that: (1) starlings are highly neophobic with respect to new food materials and foodstuffs presented in unaccustomed manners, and (2) other birds such as gulls and mynas may out-compete starlings for artificially-presented feed. The most universally accepted and starling-specific bait was raisins. Bread and dripping was another popular bait medium, but most (in New South Wales) to all (in South Austraila) of this material was taken by non-target species.

DRC 1339 AND OFF TARGET SPECIES

The open use of DRC 1339 in Australia would put non-target species at risk, especially considering that no species-specific potential carrier bait substrate was found. In particular, high susceptibility to the active compound is indicated for members of the Corvidae (crows, ravens), Columbidae (doves, pigeons), Laridae (gulls), Phasianidae (quail) and Anatidae (ducks) bird families (Eisemann et al. 2002). As further

discussed below, contained use of DRC 1339 could minimize risk to potentially susceptible non-target species, while assisting significant 'high-intensity' primary production enterprises to reduce problems currently associated with pest birds.

Since the chemical is metabolized and its non-toxic metabolites excreted by starlings in about two hours, it is considered non-hazardous to predators or scavengers. Starlings that ingest the toxicant die one to three days after treatment, and dead birds are usually found at their roosting, loafing or feeding areas (DeCino et al. 1966). DRC 1339 also degrades rapidly when exposed to moisture, sunlight, heat or UV radiation (e.g., Tawara et al. 1996). It is environmentally safe in that it binds tightly to soils, has low mobility, degrades rapidly and will not migrate. The useful life of exposed baits can vary between a couple of hours when under high humidity and sunlight to more than a week under dark, dry conditions. Therefore, there is little potential for secondary hazards to non-target animals with DRC 1339.

Studies show that a Cooper's hawk (*Accipiter cooperii*), a marsh hawk (*Circus cyaneus*), and a sparrow hawk (*Falco sparverius*) that subsisted on field-killed DRC 1339 starlings for 3- and 4-month periods showed no ill effects (DeGrazio 1968). One report of secondary toxicity occurred when crows ate the gut contents of pigeons killed with Starlicide (see ACVM 2002 and Cummings et al. 2002). Cunningham et al. (1979) estimated that a sensitive species (i.e., cat, owl, and American magpie) could be at risk only if its diet consisted wholly of DRC 1339-poisoned starlings for more than 30 continuous days; however, risk is minimal because use and exposure to bird carcasses occurs for just under two weeks.

Techniques to reduce non-target bird hazards include limiting bait exposure on bait sites, diluting treated bait with untreated bait, positioning bait lanes away from field edges, and observing pre-baited fields to avoid those with non-target species present. Where starlings exist in high numbers, such as around piggeries, they often exclude all other species, hence preventing non-target birds from entering the area. The commercial set up of study sites such as piggeries, feedlots and grain bunkers, also tend to exclude native bird species. Another level of safety sometimes used is presenting baits in feeding trays with a thin wire mesh. This allows the slender beaks of starlings to reach the food whilst excluding parrots and other granivorous birds with short or rounded beaks. Additional precautions to be taken in future studies include searching for and collection of carcasses during baiting and the 5-day post-treatment period. Searches will be aided by locating flight paths and communal roost sites during the 10-day pre-treatment period.

Both starling neophobia/competition and non-target bird safety could potentially be resolved by pre-feeding starlings with accustomed feedstuffs at suitable baiting locations adjacent to regular feeding sites prior to deployment of the poisoned material. This approach is likely to be particularly applicable to sites of predictable high concentration feeding, such as piggeries and feedlots. Effective management of starlings at these sites would: (1) reduce a major pest bird impact on primary production in Australia, and (2) assist in reduction of recruitment and dispersal of replacement members for existing populations.

PROJECT FUTURE

This project aims to demonstrate the feasibility and efficacy of using DRC 1339 for managing starlings under Australian conditions. The trials are planned to take place at intensive livestock production and grain-handling facilities where large numbers of starlings often congregate and cause significant economic losses. The chemical is widely used for this purpose in the US where, despite starlings being ground foraging insectivores, a range of non-live bait substrates can be used successfully to carry the chemical to the birds (e.g., DeGrazio 1968, Cummings et al. 2002). However, our earlier pilot project with non-toxic baits demonstrated that starlings in Australia will only take non-live baits at sites where they were already accustomed to feeding on similar foods, such as at intensive livestock and grain-handling facilities.

Trials will occur across a range of agricultural production sites (differing climates, livestock foods or grains, and different potential non-target bird issues), because it is necessary to submit data for product registration that demonstrates efficacy under a range of Australian conditions. It will also result in more efficacious and more humane pest bird management at these commercial facilities. The project is currently supported by the National Feral Animal Control Program (Natural Heritage Trust), Invasive Animals Cooperative Research Centre and Australian Pork Limited.

RESEARCH BENEFITS

This project will improve the health and welfare for livestock and wildlife, the environment in general, and the community, through improved

starling management in Australia. DRC 1339 is used extensively in the US for the same purpose, but has not been tested in Australia. The project will determine whether or not the chemical is useful under Australian conditions. It will achieve this through critically assessing the efficacy and cost-per-starling-removed value as well as flow-on benefit for control techniques, including no control. This will provide new information, and will lead to, with appropriate extension activities and acceptance, improved starling management throughout Australia.

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