Safety assessment of Felixer™ grooming traps in the semi-arid Western Rangelands of WA

Figure 1. *a) First western quoll detected on Eurardy Reserve in December 2020, b) two additional quolls detected at Eurardy and two more quolls detected at Hamelin Reserve in May 2021. c) Feral cats prey on native fauna on these conservation reserves and d) a recent boom in feral cat breeding means there is an urgent need for additional control methods to limit escalating growth in feral cat populations.*

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Summary

A safety assessment of Felixer™ grooming traps on three conservation reserves in the Western Rangelands found non-target risks to be low. Over the course of the non-toxic trials, 100% of detection events identified as targets were feral cats (*Felis catus*). None of the other detections were identified as targets, including humans, vehicles, macropods, rabbits (*Oryctolagus cuniculus*), and various bird species indicating that the risk to humans and native fauna of using these devices is low. The risk assessment for two threatened species that have been detected by our monitoring cameras, the western quoll (*Dasyurus geoffroii*) and the malleefowl (*Leipoa ocellata*) indicates the risk of lethal impacts on individuals of either of these threatened species is low to very low, based on 1080 sensitivity and other Felixer™ trials. Two malleefowl detections in these trials were not identified as targets (no quolls were detected). Substantial population benefits to these and other native fauna are expected if feral cat activity can be effectively reduced.

Introduction

Australia's native fauna face a range of threats including degradation and clearing of the natural habitat that provides their food and shelter, as well as introduced species. Rabbits (*Oryctolagus cuniculus*), feral cats (*Felis catus*) and foxes (*Vulpes vulpes*) are among the top ten introduced species that pose a threat to the highest numbers of Australia's listed threatened species (Kearney et al 2019). Rabbits damage and destroy native plant species, reducing food and shelter that native fauna depend on, while foxes and feral cats impose compounding predation pressure on small to medium animal species. The impact of feral cats on native fauna is particularly challenging to manage, given their low uptake of toxic baits, and requires a multi-faceted approach that integrates control of multiple species and use of multiple methods of control.

Bush Heritage is a not-for-profit conservation organization that works across Australia; our purpose is to return the bush to good health. We take a holistic approach to ecosystem restoration, working to restore native vegetation (e.g. through managing total grazing pressure and, in some cases, revegetation projects) as well as native animal species by managing threats they face, including introduced predators. Management of feral cats is a focus of effort in the West Region, including on three conservation reserves in the semi-arid Midwest of WA, Hamelin, Eurardy, and Charles Darwin reserves. We implement feral cat management in an integrated manner: i) enhancing native vegetation so that native fauna have resources for population growth and shelter from introduced predators, ii) using 'bottom-up' predator population management, for example controlling rabbits that support predator population growth, and iii) using 'top-down' management including multiple lethal control methods.

Any 'top-down' approach to controlling introduced species using lethal toxins introduces a risk of negatively impacting native species. In Western Australia, many native species are somewhat resistant to sodium monofluoroacetate (1080) due to its natural occurrence in native plant species, and this toxin is widely used in control programs, including for rabbits, foxes, dingoes, and feral cats. However, broadscale deployment of 1080 baits in general means that the toxin is accessible to many species in addition to the target species, resulting in some lethal non-target impacts depending on species body size and sensitivity. For example, Mitchell's hopping-mice (*Notomys mitchellii*) have been captured on camera consuming Eradicat® baits (Doherty et al 2021) that contain 4mg of 1080, representing a lethal dose for these small animals (Table 1).

An innovative new device, the Felixer™ grooming trap, has considerably lower non-target impacts than broadscale toxic baiting and is a valuable option to add to the toolbox of lethal control options. The device is designed to target toxin delivery to feral cats by using an algorithm to target animals matching a cat's body shape. While the Felixer™ is a relatively new tool, a large number of safety trials have been completed around Australia, including two in Western Australia (Dunlop et al 2020, Wayne et al 2021). These have shown that non-target species are very rarely mis-identified as targets. Early iterations of the sensor algorithm identified low rates of targeting poultry (similar to malleefowl), tammar wallaby (*Macropus eugenii*), dog, and kangaroo (Read et al 2019). However, more recent studies have shown low to no error rates: 1 of 1633 detections (representing 1 of 154 tammar wallabies in Wayne et al 2021), 0 of 1305 detections in Dunlop et al 2020, 0 of 1024 detections in Moseby et al 2020, 2 of 527 (representing 1 of 1 wombat and 1 of 2 foxes in Bentley et al 2020). These studies included 226 detections of northern quoll (*Dasyurus hallucatus*) and 14 of spotted-tailed quoll (*Dasyurus maculatus*), none of which were identified as targets (Dunlop et al 2020, Bentley 2020).

In this study, we aimed to investigate the safety of Felixer™ devices for use on Bush Heritage conservation reserves to reduce threats faced by native species in the semi-arid Midwest of WA, Hamelin, Eurardy, and Charles Darwin reserves. We designed the safety trial around the goal and approach for their intended deployment:

Goal: Assess the temporal and spatial impact of a novel feral cat control device on cat activity.

Approach: Deploy Felixer™ devices in a network of on-road monitoring cameras, targeting current hotspots of feral cat activity in sequential deployments, and monitoring feral cat activity before and after each deployment to assess the temporal scale of impacts, and at neighbouring cameras to assess the spatial scale of impacts.

Methods

Risk Assessment

We used historic monitoring data, from both camera trapping and pitfall trapping, combined with data on species sensitivity to sodium monofluoroacetate (1080), where available, to identify species at risk of ingesting lethal doses of 1080 from Felixer™ units.

Non-toxic field trials

Since we propose to deploy Felixer™ units at hotspots of feral cat activity identified by an existing array of monitoring cameras within our Baited Treatment areas, we conducted six-week trials at two different sites per Reserve (Table 1 and Fig. 1). Felixer™ units were operated in photo-only mode (without toxin) to test the target-specificity of the devices and set-ups in the context of the landscapes and faunal communities of the Midwest region.

Table 1. Trial site details.

Reserve	Serial#	Site	Location
Hamelin	SP030198	HAM_CAM_65	-26.563702, 114.197563
Hamelin	SP030198	HAM_CAM_77	-26.366899, 114.260025
Eurardy	SP030197	EUR_CAM_14	-27.552029, 114.675758
Eurardy	SP030197	EUR_CAM_20	-27.6259, 114.6802
Charles Darwin	SP030197	CDR_SOC15	-29.737, 116.9489
Charles Darwin	SP030198	CDR_NOC18	-29.5544, 116.9646

Results & Discussion

Risk assessment

Threatened species detected on monitoring cameras include western quoll on Hamelin and Eurardy and malleefowl on all three reserves. Western quoll have been detected twice on Hamelin (both in May 2021) in more than 18 months of continuous operation of 45 cameras (>30,000 trap-nights), and three times on Eurardy (once in Dec 2020 and twice in May 2021; analysis of full camera dataset at Eurardy is yet to be finalised). Malleefowl have been detected a total of 264 times and at 72% of 43 monitoring cameras at Charles Darwin Reserve, and 17 times at 8.9% of 45 monitoring cameras at Hamelin. For comparison, over the same time periods, feral cats have been detected more than 450 times and at 98% of cameras at Charles Darwin Reserve and more than 1400 times and at 100% of 45 cameras at Hamelin.

The desktop risk assessment (Appendix A) indicated that risk was very low for malleefowl and low for western quolls. It is possible malleefowl could be identified as targets, but they have high

tolerance for 1080 and would have to consume gel of 20 cartridges to reach a lethal dose. Western quolls are probably slightly less likely to be identified as targets, based on trials on other quoll species (Dunlop et al 2020, Bentley et al 2020), but they are more sensitive to 1080. They would need to consume gel from an estimated 1.23 cartridges to reach a lethal dose and are thus considered at low risk.

The amount of 1080 in one Felixer™ gel cartridge (8mg) represents a lethal dose (>LD_{50}) for a number of small native mammal and bird species found on the three reserves (Appendix A), but they were deemed at very low risk of a lethal interaction with a Felixer™ because their small body size would make it difficult for them to trigger the target-specific sensors.

Among introduced species, feral cats, the primary target species, are assessed as being at very high risk due to the combination of their high likelihood of being identified as targets and sensitivity to 1080. In addition, foxes and dingos (especially young) are also at high risk of lethal interactions, while risks to other introduced species range from very low to moderate.

The risk to humans is very low, and they would need to consume gel from 20 cartridges to reach a lethal dose.

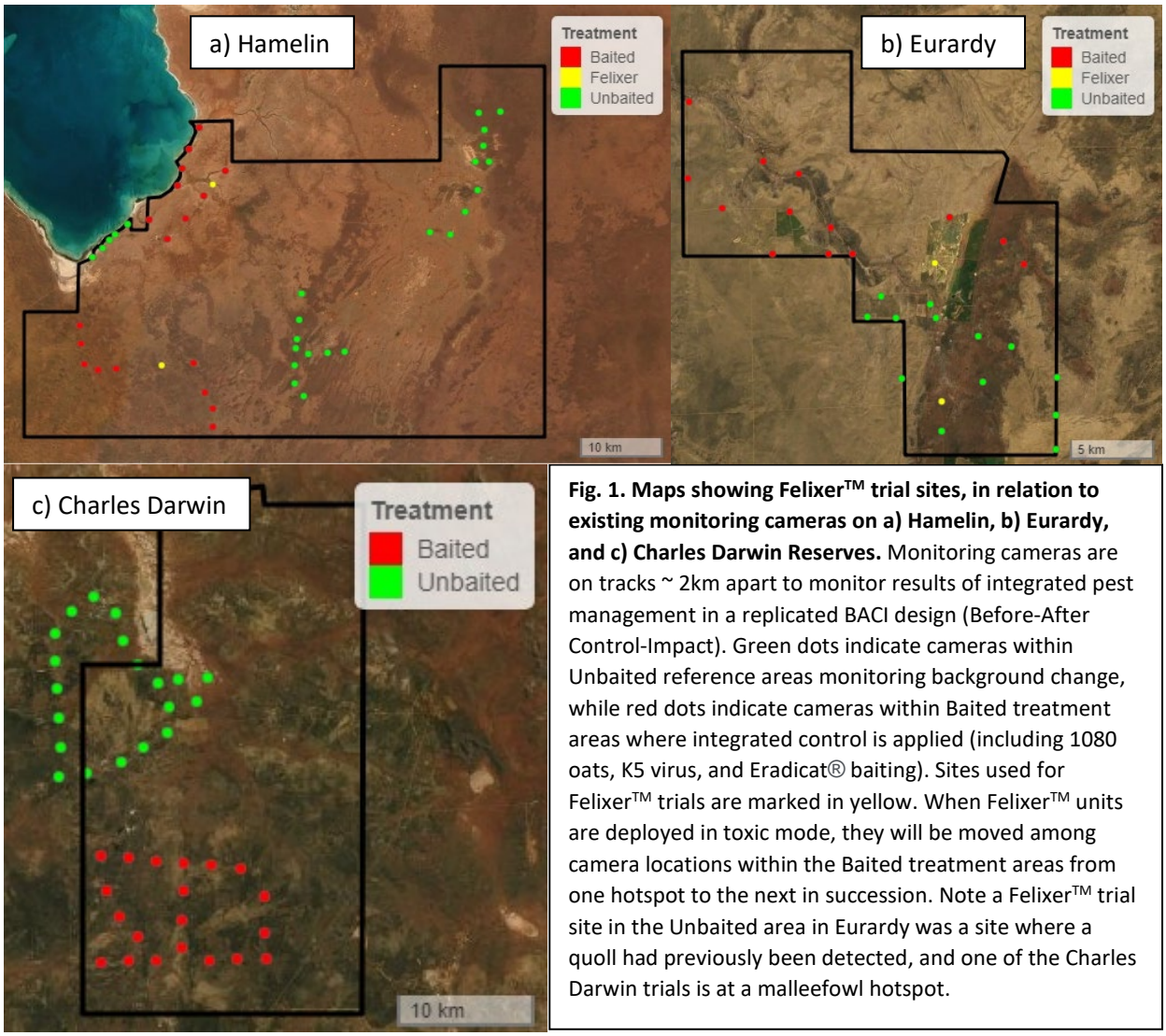

Fig. 1. Maps showing Felixer™ trial sites, in relation to existing monitoring cameras on a) Hamelin, b) Eurardy, and c) Charles Darwin Reserves. Monitoring cameras are on tracks ~ 2km apart to monitor results of integrated pest management in a replicated BACI design (Before-After Control-Impact). Green dots indicate cameras within Unbaited reference areas monitoring background change, while red dots indicate cameras within Baited treatment areas where integrated control is applied (including 1080 oats, K5 virus, and Eradicat® baiting). Sites used for Felixer™ trials are marked in yellow. When Felixer™ units are deployed in toxic mode, they will be moved among camera locations within the Baited treatment areas from one hotspot to the next in succession. Note a Felixer™ trial site in the Unbaited area in Eurardy was a site where a quoll had previously been detected, and one of the Charles Darwin trials is at a malleefowl hotspot.

Non-toxic field trials

We completed a total of 271 trap-days in photo-only mode, at 6 sites on 3 reserves (trial duration ranged from 23* to 76 days per site, see Table 2 for details). During this period, the devices were triggered a total of 423 times by a variety of passing animals including humans, as well as vehicles (Appendix B).

Felixers™ identified animals as targets in 15 cases (3.5% of all detections), none of which were non-target species. A threatened species, the malleefowl, was detected twice during the trials at CDR, and not identified as a target in either case. The tests included a wide range of other non-targets, including humans, macropods, rabbits, and a variety of bird species both on the ground and in the air, none of which were mis-identified as targets.

All 15 animals identified as targets by the Felixer™ units were feral cats. A further 18 feral cat detections were not identified as targets.

Table 3. Summary of non-toxic Felixer™ trials in the Midwest.

Site	Date Start	Date End	Days	Photos	Targets: Total	Targets: Non-Cat	Targets: Cat	Cats Not Targeted
HAM_ CAM65	26-Jun-21	8-Aug-21	43	33	6	0	6	1
HAM_ CAM77	20-Aug-21	2-Oct-21	43	111	4	0	4	1
EUR_ CAM14	11-Jun-21	26-Aug-21	76	137	4	0	4	8
EUR_ CAM20	31-Aug-21	15-Oct-21	46	80	1	0	1	6
CDR_SOC15*	20-Dec-21	12-Jan-22	23	22	0	0	0	0
CDR_NOC18*	18-Dec-21	27-Jan-22	40	40	0	0	0	2

* The units were placed 10 Dec and retrieved 27 Jan, however the window of time photos were being taken was shorter (dates shown in table). There is potential to do further trials if necessary.

Conclusion

Currently, threatened species like western quoll and malleefowl are detected in low numbers (especially in the case of western quoll) on these conservation reserves, whereas feral cat activity is high, suggesting potential for considerable conservation benefit of incorporating Felixer™ units into the integrated pest management program. Malleefowl are potentially at risk of being mis-identified as targets (Read et al 2019), but that was not the case for two detections in this trial, and the species is deemed to be at very low risk of ingesting a lethal dose of poison due to their high tolerance of 1080. Western quoll were not detected by Felixers™ during these trials, but in other studies quolls have not been mis-identified as targets by Felixers™ (Dunlop et al 2020, Bentley 2020).

Overall risk to other native fauna was very low. No other species were mis-identified as targets in our trials, and most are deemed to have a very low likelihood of being mis-identified as targets. Kangaroos could be mis-identified as targets, but would need to ingest gel of over 200 cartridges to reach a lethal dose.

These trials demonstrated Felixers™ to be a highly target-specific method of feral cat control within the faunal communities of the Midwest of WA. As such they represent a humane approach to feral cat control, with far lower non-target impacts than broadscale distribution of 1080 baits. Our

proposed project will assess whether landscape-scale decreases in overall cat activity can be achieved by moving Felixers™ among known hotspots of feral cat activity.

References

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Appendix A. Estimated risk of lethal interaction with Felixer™ for a range of species found on Hamelin, Eurardy, and Charles Darwin Reserves, based on estimated size, sensitivity to 1080, likelihood of being targeted and likelihood of ingesting most of gel if targeted.

Threatened species, and species with higher than a 'very low' overall risk of lethal interaction are highlighted in bold. Data sourced from: Wayne et al 2021, Department of Agriculture 2002, APVMA 2008.

Species	Common Name	Avg Adult Mass (kg)	LD50 (mg/kg)	Amount for LD50 (mg)	Estimated # of Felixer hits for LD50 dose	Likelihood of being Felixer target	Likelihood of ingesting most of gel if targeted	Overall risk of lethal interaction
Native Mammals								
Dasyurus geoffroii	**Chuditch**	**1.39**	**7.1**	**9.8**	**1.23**	**Possible**	**Possible**	**Low**
Macropus fuliinosus	Western Grey Kangaroo	4.5	47	1903.5	237.94	Possible	Possible	Very low
Notomys alexis	Spinifex hopping-mouse	0.03-0.56	32.7	0.98-18.3	0.12-2.9	Very low	Possible	Very low
Notomys mitchellii	Mitchell's hopping-mouse	0.05	50.9	2.55	0.32	Very low	Possible	Very low
Pseudomys albocinereus	Ash-grey mouse	0.027	50.9	1.38	0.17	Very low	Possible	Very low
Pseudomys hermannsburgensis	Sandy inland mouse	0.012	38.5	0.45	0.06	Very low	Possible	Very low
Sminthopsis crassicaudata	Fat-tailed dunnart	0.013	2.06	0.02678	0.003	Very low	Possible	Very low
Sminthopsis granulipes	White-tailed dunnart	0.028	11.9	0.33	0.04	Very low	Possible	Very low
Sminthopsis macroura	Stripe-faced dunnart	0.022	0.95	0.0209	0.003	Very low	Possible	Very low
Native Birds								
Anas supercillosa	Black Duck	1.1	18.4	20.24	2.53	Very low	Possible	Very low
Aquila audax	Wedge-tailed Eagle	4.85	9.1	44.18	5.52	Very low	Possible	Very low
Barnardius zonarius	Port Lincoln Parrot	0.179	10.8	1.93	0.24	Very low	Possible	Very low
Chenonetta jubata	Wood Duck	0.82	11.8	9.64	1.21	Very low	Possible	Very low
Colluricincla harmonica	Grey shrike-thrush	0.06	12	0.72	0.09	Very low	Possible	Very low
Corvus bennetti	Little crow	0.38	12.8	4.88	0.61	Very low	Possible	Very low
Corvus coronoides	Australian raven	0.5	5.1	2.55	0.32	Very low	Possible	Very low
Dromaius novaehollandiae	Emu	39.5	102	4029	503.63	Very low	Possible	Very low

Eolophus roseicapilla	Galah	0.25	4.67	1.17	0.15	Very low	Possible	Very low
Falco berigora	Brown Falcon	0.44	30.1	13.23	1.65	Very low	Possible	Very low
Geopelia cuneata	Diamond dove	0.025	35.5	0.89	0.11	Very low	Possible	Very low
Grallina cyanoleuca	Australian magpie-lark	0.07	8.83	0.62	0.08	Very low	Possible	Very low
Gymnorhina tibicen	Australian magpie	0.25	9.93	2.48	0.31	Very low	Possible	Very low
Leioa ocellata	**Malleefowl**	**1.8**	**94**	**169.2**	**21.15**	**Possible**	**Possible**	**Very low**
Melopsittacus undulatus	Budgerigar	0.03	2.13	0.06	0.01	Very low	Possible	Very low
Milvus migrans	Black kite	0.49	18.51	9.07	1.13	Very low	Possible	Very low
Ocyphaps lophotes	Crested Pigeon	0.204	23.5	4.78	0.6	Very low	Possible	Very low
Phaps chalcoptera	Bronzewing Pigeon	0.294	37.6	11.05	1.38	Very low	Possible	Very low
Platycercus icterotis	Western Rosella	0.06	70.5	4.19	0.52	Very low	Possible	Very low
Purpureicephalus spurius	Red-capped Parrot	0.114	23.5	2.67	0.33	Very low	Possible	Very low
Tyto alba	Barn Owl	0.322	21.8	7.01	0.88	Very low	Possible	Very low
Native Reptiles								
Varanus gouldii	Sand Goanna	1.35	47	63.45	7.93	Very low	Very low	Very low
Varanus rosenburgi	Rosenberg's Goanna	1.55	235	354.25	44.28	Very low	Very low	Very low
Introduced species								
Canis familiaris	**Dingo/Wild dog**	**14.5**	**0.11**	**1.6**	**0.2**	**Likely**	**Possible**	**High**
Felis catus	**Feral Cat**	**4.4**	**0.35**	**1.54**	**0.19**	**Likely**	**Likely**	**Very High**
Homo sapiens	Human	80	2	160	20	Possible	Very low	Very low
Oryctolagus cuniculus	**European Rabbit**	**1.6**	**0.4**	**0.64**	**0.08**	**Possible**	**Possible**	**Moderate**
Ovis aries	**Sheep**	**32.9-42.8**	**0.5**	**16.5-21.4**	**2.1-2.7**	**Possible**	**Possible**	**Moderate**
Sus scrofa	Feral pig	55	1.02	56.1	7.01	Possible	Possible	Very low
Vulpes vulpes	**European Fox**	**6.5**	**0.12**	**0.78**	**0.1**	**Likely**	**Possible**	**High**

Appendix B. Animals detected in non-toxic field trials.

Classification	HAM_CAM77	HAM_ CAM65	EUR_CAM14	EUR_CAM20	CDR - NOC18	CDR SOC15
Human	4	3	3	8		1
Vehicle	21	5	7	11	4	2
No Obvious animal	1	8	17	18	12	3
Unknown animal	4		1	9	3	2
Malleefowl						2
Cat	5	7	9	7	2	
Dingo					1	1
Kangaroo	4		1	2	2	
Common Wallaroo	2	2				
Rabbit	3	6	73	17	9	1
Rodent				1		
Short-Beaked Echidna				1		
Bird	27		2	2	5	8
Button-Quail	1				1	2
Chiming Wedgebill	8					
Common Bronzewing	1			2	1	
Common Wallaroo	1					
Crested Bellbird	1					
Crested Pigeon	6					
Crimson Chat	1					
Rufous Whistler				1		
Singing Honeyeater	4					
Spiny-Cheeked Honeyeater	1					
Western Grasswren	2					
White-Browed Babbler	1					
Willie Wagtail		1				

Zebra Finch	2					
Setup		1				