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To Bait or Not to Bait: A Discrete Choice Experiment on Public Preferences for Native Wildlife and Conservation Management in Western Australia

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ABSTRACT

Foxes and feral cats are invasive predators threating biodiversity in many places around the world. Managing these predators to protect threatened species should involve careful consideration of biological, geographic, economic, and social aspects to ensure informed and effective decision-making. This study investigates people's preferences for the ways in which foxes and feral cats are managed at a conservation site in Western Australia using a discrete choice experiment. We further aim to quantify the non-market values of two native threatened species protected by management; Numbats and Woylies. The attributes evaluated in the survey included: increased populations of Numbats and Woylies, cost of management, and a range of invasive feral predator management strategies (1080 baiting, fencing, trapping, and community engagement). Results show that respondents prefer a combination of management strategies over the strategy of 1080 baiting that is currently being implemented, particularly combinations that include trapping and community engagement. There is also strong public support for increased Numbat and Woylie populations. Willingness to pay was, on average, $21.76 for 100 Numbats and $7.95 for 1000 Woylies. Including images of the threatened species in the choice sets does not influence willingness-to-pay estimates. We further discuss how familiarity with the species influences value. Our results feed into the conservation decision making process about feral species management in the region.

1. Introduction

Invasive feral predator management is crucial to ensure the survival of many native species. Invasive predators such as European red foxes (*Vulpes vulpes*) (hereafter, foxes) and feral cats (*Felis catus*) seriously threaten biodiversity in many parts of the world and are listed among the world's worst invasive species (Lowe et al., 2000). In Australia, predation by foxes and feral cats were listed as key threatening processes in the Federal Environment Protection and Biodiversity Conservation (EPBC) Act (DoE, 2013; DoE, 2015a; DoE, 2015b). Feral cats and foxes are opportunistic predators with a wide dietary range. Their adaptability allowed them to exploit diverse habitats and rapidly colonize the Australian mainland after being introduced by Europeans in the 19th century (Denny and Dickman, 2010; Saunders et al., 2010). Feral cats prey on 400 Australian vertebrate species including 28 IUCN-listed threatened species (Doherty et al., 2015), and have been linked to the early extinctions of seven mammalian species (Denny and Dickman, 2010). Foxes and feral cats are currently a predatory threat to 103 and 142 EPBC-listed threatened species, respectively (DoE, 2013; DoE, 2015a; DoE, 2015b).

Controlling invasive feral predator populations is imperative to increasing native species' populations (Friend, 1994; Kinnear et al., 2010). In many cases, protection or reintroduction of native wildlife is much more successful if invasive feral predators are managed concurrently e.g., Sharp et al. (2014), Short et al. (1992).

Management strategies for fox and feral cat populations have commonly focused on lethal methods like poison baiting, shooting, and trapping with soft-jaw or cage-style traps, and non-lethal methods like predator-exclusion fencing (DEWHA, 2008; DoE, 2015a). Poisoned meat baits are often used when managing large sites, and when primary food sources (rabbits, mice, native species) are absent or in low numbers (DoE, 2015a). Shooting and trapping are more labor intensive and expensive and are generally not preferred for broad-scale control but are effective in smaller areas (DoE, 2015a; Saunders et al., 2010). Other fox management techniques focus on den fumigation, den destruction, and fertility control (Saunders et al., 2010), while those for cats have also included the use of specially trained dogs and the introduction of *feline panleucopaenia* (Denny and Dickman, 2010).

The complete eradication of foxes and feral cats at a conservation site using lethal techniques is near impossible (unless the site is a small

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island), because they disperse over large areas and can reappear after predator management been carried out—unless management is implemented periodically (Moseby et al., 2009). In such cases, exclusion-fencing can be an effective strategy to mitigate threats to native species, and is being favored in many regions including Australia, New Zealand, and southern Africa (Hayward and Kerley, 2009). Once feral predators and other invasive species within the enclosure have been eradicated, fencing creates feral-free 'islands' allowing native species to thrive. Exclusion fences, however, have high installation costs, are not 100% effective at preventing predator incursions, and require frequent maintenance which can be time-consuming and labor- and cost-intensive. Ecological costs such as inbreeding and poorly developed threat-defense mechanisms can result from preventing the movement of animals (Hayward and Kerley, 2009). Fences are also not independent of other management strategies since predators within the enclosure need to be eradicated anyway (Long and Robley, 2004).

Although the aim of invasive feral predator management is to safeguard threatened species and increase their survivability, it is not simply the end result that matters. Management takes place in a social context that needs to consider community preferences for different management strategies. It is likely that people have preferences for the *means* of achieving conservation outcomes as well as for the outcomes themselves. This has been shown by, for example, Johnston and Duke (2007), who found that respondents significantly preferred state conservation easements over other techniques that can be used to preserve agricultural lands. Similarly, in a study on marine ecology conservation in Western Australia, Rogers (2013b) found that utility for the same conservation outcomes differed depending on the management process specified: respondents typically preferred processes that were less restrictive in terms of human use of the marine reserve. More recently, Sheremet et al. (2017) also concluded that public support (for forest disease control) is conditional on the type of control measures used. On the other hand, Hanley et al. (2010) found that respondents were largely indifferent to how conservation objectives (for raptors in Scottish moorlands) were achieved, implying that the benefits are roughly equal across management alternatives if the same level of environmental protection is achieved. Our study contributes to this literature by assessing whether people have different preferences for different methods to manage invasive species.

Wildlife policies to increase populations of threatened and endangered species should involve careful consideration of biological, geographic, economic, and social aspects to ensure informed and inclusive decision-making and, ultimately, policy success (Rogers, 2013b). Understanding the socio-economic impact of conservation decisions enables a more efficient use of limited resources available for the task. Economic research can guide policy decision-making by analyzing the cost-effectiveness of conservation actions e.g. Busch and Cullen (2009), Helmstedt et al. (2014). Of interest to the current study are the socio-economic (non-market) *benefits* that different eradication strategies may generate. Quantifying the non-market benefits of conservation actions, as well as the values of the species being protected, allows these benefits to be included in a benefit-cost analysis to assess which conservation policy options will be optimal from a social welfare perspective. While there exist a small number of non-market valuation studies for threatened species in Australia (Jakobsson and Dragun, 2001; Tisdell and Nantha, 2007; Wilson and Tisdell, 2007; Zander et al., 2014) there are, to the best of our knowledge, no studies quantifying the social welfare impacts of fox and feral cat management. There are some studies that estimate households' willingness to pay (WTP) for the management of other invasive species in other parts of the world. For example, Florida residents' WTP to control invasive plants in state Parks (Adams et al., 2011); French households' WTP to reduce nuisance from invasive Asian ladybirds (Chakir et al., 2016); and UK households' WTP for tree disease control programs in UK forests (Sheremet et al., 2017).

We focus on the socio-economics of fox and feral cat management at a fragmented conservation site in southwest Western Australia (WA); Dryandra Woodland, to ensure the survival of two of the state's threatened species at the site; the endangered Numbat (*Myrmecobius fasciatus*) and the critically endangered Woylie (*Bettongia penicillata ogilbyi*). The site has a high concentration of feral cats and foxes. The objectives of this paper are (i) to determine people's preferences for different strategies to manage fox and feral cat populations in Dryandra Woodland, and (ii) to quantify the non-market values of Numbats and Woylies in monetary terms.

We use a discrete choice experiment (DCE) to estimate non-market vales associated with fox and feral cat management for Numbat and Woylie conservation. The DCE was carried out in collaboration with the Department of Biodiversity, Conservation and Attractions (DBCA), Western Australia. Results of this survey may be used to inform conservation policies for invasive feral predator management in Western Australia.

2. Methodology

2.1. Conservation Site

Dryandra Woodland is a conservation site about 160 km south-east of Perth, WA (Fig. 1). It exists as 17 discrete fragments scattered across 50 km with a total area of 28,066 ha with blocks ranging from 87 to 12,283 ha (DEC, 2011). It is surrounded by farmland and has a high concentration of feral cats and foxes. Being extremely fragmented, it has a high perimeter to area ratio which makes the implementation of invasive feral predator management challenging. Apart from supporting the largest area of remnant vegetation in the region, the Woodland has high conservation value as it is home to several threatened species of flora and fauna (DEC, 2011). It is one of two sites with original populations of the endangered Numbat, and one of three sites supporting original populations of the critically-endangered Woylie (de Tores and Marlow, 2012), and is the only conservation site with original populations of both Numbats and Woylies—the species of interest in our study. Along with biodiversity conservation, the Woodland is used for recreation, timber production, and Aboriginal land use (DEC, 2011). The importance of the Woodland for conservation and cultural uses mean that its management is also likely to be of interest to the broader WA community.

Both Numbats and Woylies were widely distributed prior to European arrival in Australia, with Woylies distributed across the continent south of the tropics (Fig. 2). The population of Numbats in Dryandra Woodland declined from about 800 mature individuals in 1992 to about 80 at present (M. Page, DBCA, pers. comm.). The population of Woylies in the Woodland declined from about 30,000 mature individuals in 2001 to about 2000 at present (M. Page, DBCA, pers.

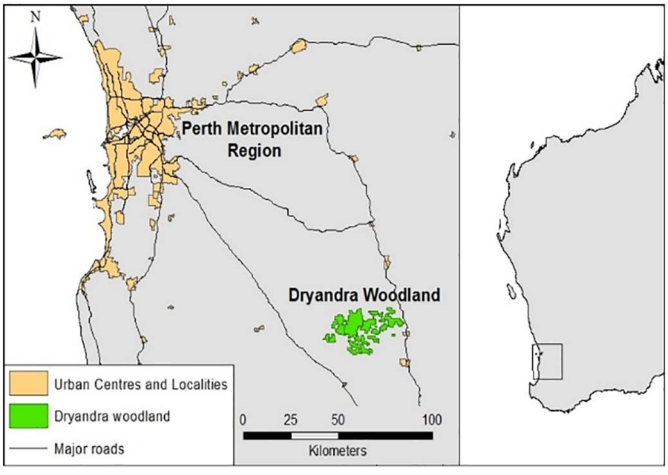

Fig. 1. Location of Dryandra Woodland Relative to Perth and Western Australia.