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Creating multi-functional landscapes: Using exclusion fences to frame feral ungulate management preferences in remote Aboriginal-owned northern Australia

E.J. Ens [a,*], C. Daniels [b], E. Nelson [b], J. Roy [b], P. Dixon [b]

[a] Department of Environmental Sciences, Macquarie University, North Ryde, NSW 2109, Australia
[b] Yugul Mangi Rangers, Yugul Mangi Land and Sea Management, Ngukurr, NT 0852, Australia

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ABSTRACT

Invasive species can have negative and positive impacts for local communities. Conflict between these different values can complicate and sometimes prevent broad-scale management and decision-making. Multi-functional landscapes and community-based conservation paradigms have emerged as constructive approaches to integrating competing interests and the development of sustainable and locally meaningful management planning. Here, we report on a five year feral ungulate exclusion fence project that was used to focus local people's attention on the eco-cultural and socio-economic impacts of feral ungulate invasion in a remote Aboriginal-owned region of northern Australia. Exclusion of feral buffalo, horses and pigs from three culturally significant freshwater billabongs from 2009 to 2013 resulted in variable increases in smooth ground (from 64–93%), ground cover vegetation (from 18–95%) and water lily cover (bush food) (from 20–60%), dependent on the site. The reduction in feral animal ground surface damage in the fenced areas was fastest at the floodplain billabong, Nalawan, which took only a year to become negligible. At the two channel billabongs, Costello and Namaliwiri, feral animal damage was negligible after 3 years. Senior Aboriginal Traditional Owners of these areas were pleased that these environmental assets were protected, but only agreed on the wholesale culling of pigs. Despite recognition of the negative eco-cultural impacts of feral ungulates as observed through the exclusion fence project, they wanted to maintain buffalo and horse on their Country to financially benefit from potential pet-meat and live export industries. Fencing was requested for culturally meaningful sites including those that were used for fishing and were sacred. Fenced areas were viewed by Traditional Owners as "protected" areas of ecological and cultural resources. These multiple management preferences can be combined to build socio-ecological resilience into regional strategic planning for feral ungulate management that will deliver multiple benefits for local communities.

1. Introduction

Worldwide, invasive species have well known negative ecological and economic impacts (Mooney and Hobbs, 2000; Vilà et al., 2011). However, management decisions at local and regional levels often require an understanding of the positive and negative values of invasive species within the social, economic, political, cultural and ecological context, which can be a complicated task (McNeely, 2001; Zavaleta et al., 2001, Hulme, 2003; García-Llorente et al., 2008; Waylen et al., 2010). Invasive species management, like other acts of conservation, is a human choice and different people make different choices based on their priorities, needs, values and beliefs (Mascia et al., 2003). Similar to other conservation interventions (Waylen et al., 2010) the role of stakeholder interest or public "buy-in" is arguably the most important but often overlooked aspect of invasive species management (Hulme, 2006). To enhance communication and cooperation between scientists and the community for improved environmental management, projects that incorporate participatory and collaborative action research, citizen science and social learning approaches are becoming increasingly common (Reed, 2008; Berkes, 2009; Reed et al., 2010); although such initiatives have also received criticism for inequitable use of stakeholder's knowledge systems, preferred methods and priority setting (Eversole, 2003; Stringer et al., 2006; Nelson and Agrawal, 2008). However, collaborative approaches to invasive species management (and other forms of conservation) are necessary to enhance information flow and longer-term cooperation between scientists, on-ground managers, land owners and communities.

Differing perceptions about whether and how to manage invasive species including contestations over the impacts, benefits, preferred approaches and priorities often occur within communities as well as

* Corresponding author at: Centre for Aboriginal Economic Policy Research, The Australian National University, Australia.
E-mail address: emilie.ens@mq.edu.au (E.J. Ens).

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between stakeholder groups and can result in a failure to act (Allan and Southgate, 2002). In a survey of social perceptions of invasive plant, invertebrate and vertebrate species in south west Spain, García-Llorente et al. (2008) identified five discrete stakeholder groups who were characterized by divergent perceptions including: the highest impact species; type of impacts; and motives for management. Notably, where there was a perception of likely economic or other benefit by stakeholders, the invasive species were more accepted and sometimes encouraged. Similarly, in a review of perceptions of introduced *Acacia* species worldwide Kull et al. (2011) found that economic status was the most common driver of perceptions about this plant genus. Generally, "poorer" communities favoured Acacia and "richer" communities view them negatively and as "weeds". Both of these studies, suggested that consultation with different stakeholders (including communities) should be encouraged from the outset of invasive species decision-making processes to ensure that differing perceptions and needs are directly addressed in management plans.

Recently, community-based conservation paradigms have advocated for the creation of multi-functional landscapes, defined as a containing diverse uses, states or management practices (Berkes, 2004; O'Farrell et al., 2010). Multi-functional landscapes are valued by communities because they have social, economic and ecological benefits and can facilitate delivery of a range of ecosystem services (Barrera-Bassols and Toledo, 2005; Reyes-Garcia et al., 2013). This approach is considered particularly beneficial in developing or poor regions which are working dually towards socio-economic development and conservation goals. Although multi-functional landscape objectives are increasingly accepted and there is greater understanding of differing cultural contexts and pressures surrounding decision-makers, how stakeholders and communities translate different perceptions and needs into management planning and action is proving to be more difficult and is not well documented (de Groot et al., 2010; Reyes-Garcia et al., 2013).

In tropical northern Australia, there are divergent perceptions about many feral invasive ungulates including buffalo (*Bubalus bubalis*), horses (*Equus caballus*), pigs (*Sus scrofa*), donkeys (*Equus asinus*), cattle (*Bos taurus*) and goats (*Capra hircus*) (Robinson et al., 2005; Albrecht et al., 2009; Ens et al., 2010). Feral ungulates are considered by the Northern Territory Government as Major Pests that should be eradicated (Natural Resource Management Ministerial Council, 2007). Feral pigs are listed nationally as a Key Threatening Process under the Australian *Environmental Protection and Biodiversity Conservation Act 1999*. However, sport hunting, pet-meat, live export and tourism industries place economic and recreational value on these species, especially buffalo and pigs (Albrecht et al., 2009). Aboriginal people, the second largest land owning group in northern Australia following pastoralists (J. Woinarski et al., 2007), have divergent views of different feral animal species amongst themselves and from other social groups due to complexes of ecological, cultural, spiritual, historical, financial and food values (Robinson et al., 2005; Albrecht et al., 2009). For example, Robinson et al. (2005) noted that the Jawoyn Aboriginal people of Kakadu National Park consider buffalo a bush meat and would like more of them, horses as bush pets for which damage is tolerated and pigs as a bush threat requiring extermination. As a result of differing stakeholder viewpoints and contestation between governments, hunting groups, pastoralists, conservationists and Aboriginal Traditional Owners in northern Australia, there has been no comprehensive or long-term plan for management of feral ungulates in this large and sparsely populated region (Bradshaw et al., 2007; Saalfeld, 2014), despite widespread recognition of its high biological and cultural value (J.C.Z. Woinarski et al., 2007; Moritz et al., 2013). Many land managers, Traditional Owners and stakeholders are working to gain an understanding of divergent values of feral ungulates in northern Australia (Robinson et al., 2005) which have been predicted to converge in time (Albrecht et al., 2009; Vaarzon-Morel, 2010). However, currently integrated management strategies that address the aspirations of local land owners and local capacity and resourcing limitations in this remote region of Australia largely remain elusive (but see Ens and Kerins, 2009).

Research on the ecological impacts of hard-hooved ungulate species in northern Australia has largely focused on coastal floodplain habitats. Buffalo create swim channels on coastal floodplains that facilitate salt water intrusion to inland areas and affects floodplain fringe vegetation (Skeat et al., 1996; Mulrennan and Woodroffe, 1998). Buffalo have also been implicated in significant vegetation structure change on floodplains (Finlayson et al., 1994; Cowie et al., 2000) and in savanna woodlands (Stocker, 1971; Taylor and Friend, 1984; Werner, 2005; Werner et al., 2006). However there have been few studies on the ecological impacts of feral ungulates in freshwater habitats in northern Australia (but see Ens et al., 2010; Ens et al., 2012a) which was the focus of the present study. Many Aboriginal Ranger groups in northern Australia aspire to reduce the cultural and ecological impacts of invasive ungulates on their ancestral clan estates; however, they are often restricted by conflicting local perceptions, technical capacity and management resources (Weston et al., 2012).

The aim of this study was to raise community awareness of the eco-cultural impacts of feral buffalo, pigs and horses on culturally significant freshwater billabongs in south eastern Arnhem Land (SEAL), northern Australia (Daniels et al., 2012; Ens et al., 2012a). To enhance local understanding of the eco-cultural impacts of feral buffalo, pigs and horses and inform local decision-making, we adopted a collaborative action research approach and established a feral ungulate exclusion and eco-cultural monitoring program.

2. Methods

2.1. Study site history and geography

This study was conducted for five years from 2009 to 2013 in remote south eastern Arnhem Land, northern Australia, near the Aboriginal community of Ngukurr (Fig. 1). Ngukurr is a small remote Australian Aboriginal town with a population of about 1000 people of whom about 95% identify as Aboriginal (Taylor et al., 2000). The town of Ngukurr was established first as a mission in 1908 and was inhabited by Aboriginal people from at least seven traditional language groups. For 60 years Ngukurr was under "church mission control" (Taylor et al., 2000) which despite offering some protection to local Aboriginal people from the "new" settlers (Harris, 1993), resulted in considerable disempowerment and the coercive loss of traditional practices. Roper River Kriol replaced traditional languages shortly after the establishment of the mission and remains the primary language of the region (Harris, 1993). A period of self-determination and local community government control occurred from the 1970's. However in 2000 Taylor et al. found that Ngukurr had negligible employment (3.7%), low socio-economic status by Australian standards and relied heavily on welfare payments by the Australian government. This situation has largely continued although there have been some new employment opportunities such as through the Indigenous Ranger (Working on Country) program and the local Yugul Mangi Development Aboriginal Corporation's hotel.

In this paper we refer to the broader Ngukurr community including senior to young people; Traditional (land) Owners and Jungayi (Traditional land managers) as decision-makers for what happens on Country according to Traditional Law; and the Yugul Mangi Rangers who are Ngukurr community members and Traditional Owners and Jungayi of different clan estates. The Yugul Mangi Rangers are employed by the Australian Government to "Care for Country" in the region in consultation and collaboration with other Traditional Owners and Jungayi.

The Yugul Mangi Rangers and other Aboriginal Traditional Owners of south eastern Arnhem Land are in the consultation phase for an Australian Government funded Indigenous Protected Area (IPA) (Fig. 1). Once approved, the IPA program will provide additional resources to manage the natural and cultural values of this land, which is locally referred to as 'Country' (see Smyth, 1994). As part of this process, Traditional Owners are required to produce a management plan for the proposed IPA which details how they intend to reduce