



# Alignment between values of dryland pastoralists and conservation needs for small mammals

Jane Addison\* and Chris R. Pavey

CSIRO Land and Water, P.O. Box 2111, Alice Springs, NT, 0870, Australia

**Abstract:** Policies for conservation outside protected areas, such as those designed to address the decline in Australian mammals, will not result in net improvements unless they address barriers to proenvironmental behavior. We used a mixed-methods approach to explore potential value-action gaps (disconnects between values and subsequent action) for small mammal conservation behaviors among pastoralists in dryland Australia. Using semistructured surveys and open-ended interviews ( $n = 43$ ), we explored values toward small mammals; uptake of a range of current and intended actions that may provide benefit to small mammals; and potential perceived barriers to their uptake. Pastoralists assigned great conservation value to small mammals; over 80% ( $n = 36$ ) agreed to strongly agreed that small mammals on their property were important. These values did not translate into stated willingness to engage in voluntary cessation of wild-dog control ( $r^2 = 0.187$ ,  $p = 0.142$ ,  $n = 43$ ). However, assigning great conservation value to small mammals was strongly related to stated voluntary willingness to engage in the proenvironmental behavior most likely to result in benefits to small mammals: cat and fox control ( $r^2 = 0.558$ ,  $p = 0.000$ ,  $n = 43$ ). There was no significant difference between stated voluntarily and incentivized willingness to engage in cat and fox control ( $p = 0.862$ ,  $n = 43$ ). The high levels of willingness to engage in voluntary cat and fox control highlight a potential entry point for addressing Australia's mammal declines because the engagement of pastoralists in conservation programs targeting cat and fox control is unlikely to be prevented by attitudinal constraints. Qualitative data suggest there is likely a subpopulation of pastoralists who value small mammals but do not wish to engage in formal conservation programs due to relational barriers with potential implementers. A long-term commitment to engagement with pastoralists by implementers will thus be necessary for conservation success. On-property cat and fox control programs that build and leverage trust, shared goals, collaboration, and shared learning experiences between stakeholders and that explicitly recognize the complexity of small mammal dynamics and the property-level ecological knowledge of pastoralists are more likely to gain traction.

**Keywords:** cats, conservation, proenvironmental behaviors, stewardship, trust, value-action gap

Alineación de Valores de Pastores en Tierras Secas con las Necesidades de Conservación de Mamíferos Pequeños

**Resumen:** Las políticas para la conservación afuera de las áreas protegidas, como aquellas designadas para enfocarse en la declinación de los mamíferos australianos, no resultarán en mejoras netas a menos que estén dirigidas a las barreras ante el comportamiento pro-ambiental. Utilizamos una estrategia de métodos mixtos para explorar el potencial de los vacíos de acción-valor (desconexiones entre los valores y las acciones subsecuentes) para los comportamientos de conservación de los mamíferos pequeños entre los pastores en las tierras secas de Australia. Con el uso de censos semi-estructurados y entrevistas de preguntas abiertas ( $n = 43$ ), exploramos los valores en torno a los mamíferos pequeños; la aceptación de un rango de acciones actuales e intencionadas que pueden proporcionar beneficios para los mamíferos pequeños; y el potencial de las barreras percibidas ante esta aceptación. Los pastores asignaron un valor alto de conservación a los mamíferos pequeños; más del 80% ( $n = 36$ ) estuvieron de acuerdo o considerablemente de acuerdo con que los mamíferos pequeños en su propiedad eran importantes. Estos valores no se tradujeron a una disposición mencionada por participar en el cese voluntario del control de perros salvajes ( $r^2 = 0.187$ ,  $p = 0.142$ ,  $n =$

\*Current address: James Cook University, 1 James Cook Drive, Townsville, Qld 4811, Australia, email jane.addison023@gmail.com  
Paper submitted March 20, 2016; revised manuscript accepted August 1, 2016.

43). Sin embargo, asignarle un gran valor de conservación a los mamíferos pequeños estuvo relacionado fuertemente con la disposición voluntaria mencionada por participar en el comportamiento pro-ambiental con mayor probabilidad de resultar en beneficios para los mamíferos pequeños: el control de gatos y zorros ( $r^2 = 0.558$ ,  $p = 0.000$ ,  $n = 43$ ). No hubo una diferencia significativa entre la disposición mencionada voluntariamente y la alentada por participar en el control de gatos y zorros ( $p = 0.862$ ,  $n = 43$ ). El nivel alto de disponibilidad por participar voluntariamente en el control de gatos y zorros resalta un punto de entrada potencial para enfocarse en las declinaciones de los mamíferos de Australia, porque no es probable que la participación de los pastores en los programas de conservación con el objetivo de controlar gatos y zorros sea prevenida por restricciones actitudinales. Los datos cualitativos sugieren que probablemente hay una sub-población de pastores que valoran a los mamíferos pequeños pero no desean participar en programas formales de conservación debido a las barreras de relación con los implementadores potenciales. Entonces será necesario un compromiso a largo plazo con los pastores por parte de los implementadores para que haya éxito de conservación. Es más probable que ganen tracción los programas de control de gatos y zorros en las propiedades que construyan y fomenten la confianza, los objetivos compartidos, la colaboración y las experiencias de aprendizaje compartido entre los accionistas y que reconozcan explícitamente la complejidad de las dinámicas de los mamíferos pequeños y el conocimiento ecológico a nivel propiedad de los pastores.

**Palabras Clave:** administración, comportamientos pro-ambientales, confianza, conservación, gatos, vacío de valor-acción

## Introduction

Debate continues over the most appropriate responses to the global defaunation crisis. Foremost among the issues under consideration is whether land sparing or land sharing is the most appropriate way of dealing with the dual challenges of conservation and food production (Fischer et al. 2014; Law & Wilson 2015). Dryland Australia, where substantial areas of uncleared land are used extensively for livestock production, provides an important variation on the land-sharing and land-sparing debate. Contemporaneous with pastoral development, dryland Australia has experienced the world's worst rate of mammal extinction (Johnson 2006), the primary cause of which is predation by introduced European red foxes (*Vulpes vulpes*) and feral domestic cat (*Felis catus*) rather than pastoral production (Johnson 2006; Woinarski et al. 2015). This predation is also the primary cause of ongoing declines in mammal abundance (Woinarski et al. 2015).

The most effective way to deal with ongoing defaunation in areas characterized by sparsely settled populations and high human-population turnover and for which scientific knowledge is lacking (Stafford Smith 2008) may be to involve those who are most consistently available through time and space. Important refuges for many threatened mammals now occur in small pockets within large pastoral properties outside the formal conservation estate (Morton et al. 1995; Pavey et al. 2015). The incorporation of many fragmented refuges into a land-sparing conservation estate may be prohibitively expensive. Pastoralists hold primary responsibility for land management over many areas of biodiversity concern, at least for part of the time during boom-bust climatic cycles (Morton et al. 1995). The acceptability to these landholders of a formalized land-sharing arrangement to specifically

address mammal decline has not been explored. Despite the belief by sectors of the conservation movement that livestock production is a direct and marked contributor to mammal declines (Gill 2003), little is known about the attitudes or intents of pastoralists in dryland Australia in relation to mammal conservation.

We used mixed methods to identify potential value-action gaps (i.e., the disconnect between values and subsequent action) for small mammal conservation among dryland pastoralists. We hypothesized that there is a value-action gap between their valuation of small mammals and proenvironmental behaviors such as the control of predators and reduced grazing pressures and that financial constraints are the main barrier to the uptake of these behaviors. We asked pastoralists what attributes they desired in a conservation program. We did so as we believe an improved understanding of current constraints to management of small mammals by dryland pastoralists will help policy and program designers identify potential entry points for a conservation program that addresses small mammal decline.

## Methods

### Conceptual Framework

Incorrect assumptions about barriers to the uptake of proenvironmental behaviors can lead to failed environmental programs (Curtis & De Lacy 1996; Blake 1999). To be effective, programs must recognize the individual, social, and relational or institutional barriers to action, some of which may be difficult to change (Blake 1999). An individual's belief about consequences of proenvironmental behaviors (i.e., environmental values) and how much weight the individual assigns to these consequences drive intention to act to resolve conservation problems

(Blake 1999). However, values are not always a clear predictor of action (Kollmuss & Agyeman 2002). Subjective norms relating to social influence, an individual's perception of social pressures around a particular behavior, can act as barriers or conduits to pro-environmental behavior, for example. Intention to act is also controlled by social, individual, and institutional constraints and uncertainty (Ajzen 1991; Blake 1999). Individual barriers (e.g., cognitive overload), responsibility barriers (e.g., lack of ownership of the problem in question), and practical constraints (e.g., time or finances) may prevent people from adopting proenvironmental behaviors, as can lack of trust (Gilmour et al. 2015). Combined these factors may lead to behavioral intention and, ultimately, action (Ajzen 1991). We structured our exploration of potential constraints to behavior that benefits small mammals around potential antecedents and barriers that may contribute to the value-action gap.

### Dryland Australia

The Australian drylands are characterized by high climatic variability and unpredictability, low productivity, sparse populations, high human population turnover, a small pool of experts, remote governance, and distant markets (Stafford Smith 2008). Settlements are widely spaced, and much of the area is under large pastoral leases. Pastoralist households are typically composed of 40- to 60-year olds (ACRIS 2008; Waudby et al. 2012); have an average length of property ownership of 29 years (range 1–91 years); and have an average period under current management of 19 years (range 1–55 years; DPIF 2010). Fifty-three percent of on-property managers are also freehold or lease owners by area (DPIF 2010), and 55% belong to a natural resource management (NRM) group (Holmes & Day 1995).

Direct influence and investment in NRM by governments in the Australian drylands has declined (Hunt 2003). Participatory action research, direct land-use agreements between NRM program implementers and landholders, and market-based instruments (MBIs) with landholders have grown in dominance nationally (Lockie & Higgins 2007), but these are still relatively sparsely applied in the drylands (but see Hacker et al. 2010). A lack of monitoring and evaluation means making conclusions about program efficacy is difficult, but there is little evidence that the programs that exist have substantially benefitted small mammals. Anecdotal lessons from initial attempts suggest that financial barriers are not the only barrier to the uptake of more proconservation management practices, but they failed to highlight other barriers that may lead to improved program design. Given that pastoralists are important land managers in dryland Australia (Morton et al. 1995), further investigation of barriers to their involvement in conservation programs is imperative.

### Data Collection and Analysis

Using semistructured surveys and open-ended interviews, we explored pastoralist values toward small mammals; uptake of a range of current and intended actions that may provide benefit to small mammals; and potential perceived barriers to their uptake. Despite the large size of our study area (Fig. 1), the number of potential respondents was 174. To maximize respondent sample size, J.A. contacted every potential respondent in the study area through various communication avenues. A database of the contact details of pastoralists was assembled using telephone directories and information from key sources associated with the pastoral industry. Initially, a hardcopy survey was mailed with a self-addressed envelope to all potential respondents. A SurveyMonkey version was also created (SurveyMonkey, Palo Alto, California [www.surveymonkey.com]). Links to this online survey were included in the hardcopy survey and in local newsletter articles and were emailed directly to pastoralists via 3 NRM organization representatives in Queensland, southern Northern Territory, and South Australia. A fax number was also provided with the hardcopy version. Follow-up telephone calls were made in the early evenings and weekends to each of the pastoral properties to ask if telephone interviews could be conducted in lieu of hardcopy or internet responses. We received 43 responses: hardcopy, 18; formal telephone interview, 6; SurveyMonkey, 17; and email, 2. This resulted in an estimated response rate of 25%. On-property, unstructured follow-up discussions were then held with 3 self-identified pastoralists. All research was granted approval by the CSIRO Social Science Human Research Ethics Committee (permit 107/12).

Standard demographic variables were elicited as closed-ended and categorical responses and included questions on pastoral production (e.g., length of time on the property, membership in NRM organizations). Values placed on small mammals were elicited via 7-point Likert items (1, strongly disagree; 7, strongly agree) with the statements “I value small mammals.” “Good natural resource management is important to me.” and “Live-stock production and small mammal conservation can occur at the same time.” Values placed on small mammals were also explored with open-ended questions, including “What environmental issues exist on your property that you know about?” and “Is there anything else you'd like to say about small mammal conservation?” Current pro-environmental behaviors were elicited via a closed-ended question with a list of 8 NRM activities, any of which could be selected. We asked “If you are trying to manage [any previously nominated environmental issues on your property], what activities do you do?” A list of 9 NRM activities and an *other* option were provided as was space to provide an open-ended response. Responses to “What are your plans for your property/properties in the short

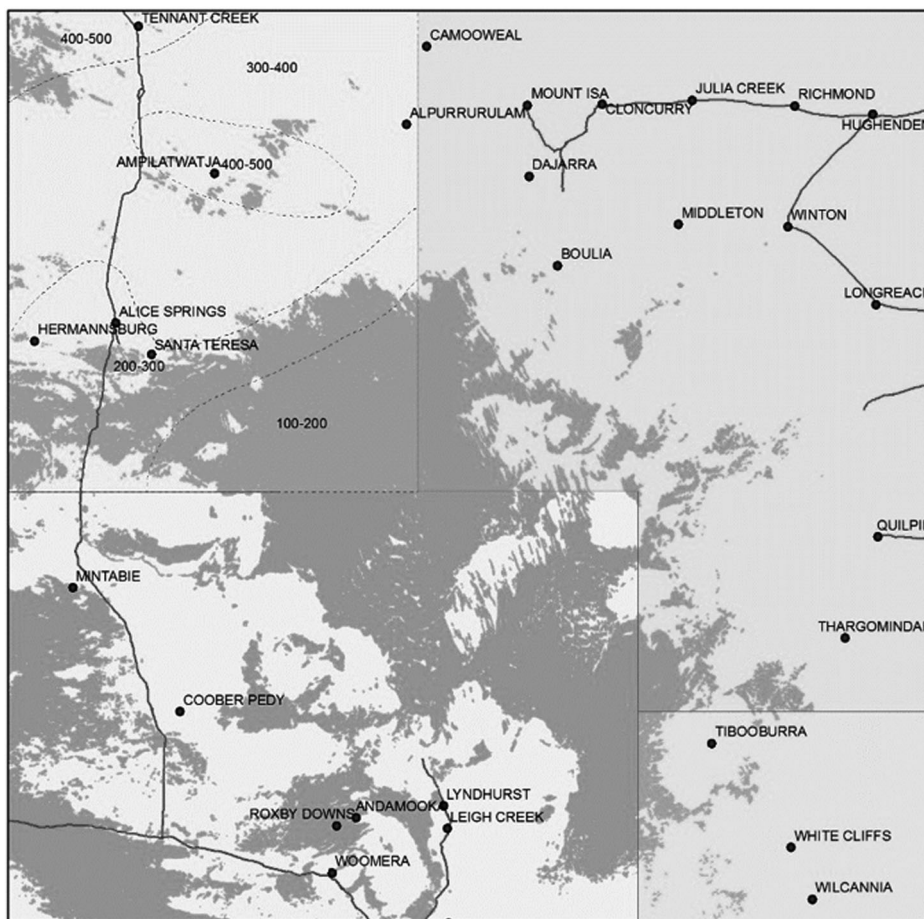


Figure 1. Study area in Australia showing state and territory boundaries and relatively large towns.

and medium term?” indicated voluntary intention, as did the seven-point Likert items in Table 1. These same items plus a financial incentive were used to assess the role of financial constraints in the potential uptake of proenvironmental behaviors. Respondents were also asked to note the presence of different types of barriers (time, labor, finances, information, and other, an open category that respondents could complete as they wished) present during respondent-defined good, bad, and average climatic years. Seven-point Likert items around trust in NRM organizations were included to explore relational barriers. Three open-ended questions about previous experiences with conservation-related projects and suggestions for change in the future were also included to explore other

barriers that may have been excluded by the design of other closed-ended questions.

We used descriptive statistics to create the demographic summary (Table 2) and to display Likert item results in SPSS 12.0.1. The Shapiro-Wilk test for normality showed that none of the Likert item variables were normally distributed; thus, we used nonparametric methods. Ordinal Likert-item data were analyzed together with the Kendall rank correlation coefficient to explore the relationships between them (e.g., the stated value of small mammals with willingness [intention] to manage for them). We used paired *t*-tests to examine whether financial incentives would induce uptake of management actions compared with voluntary behaviors. Each

Table 1. Relationship between management options that may benefit small mammals and related Likert items used in surveys of pastoralists.

<i>Management option</i>	<i>Details of management option</i>	<i>Assumed benefit to small mammals</i>	<i>Strength of evidence of benefit to small mammals</i>	<i>References</i>	<i>Related Likert item</i>
Control of cats and foxes	effective control of cats and foxes in dryland Australia remains difficult; range of approaches advocated, but effective control methods, especially for cats, are not yet commercially available; several methods are under development; targeted shooting, sometimes in combination with trapping, undertaken in areas of high conservation value within the conservation reserve system; pastoralists usually control cats and foxes by shooting opportunistically or by focusing on areas of high density; pastoralist methods a reasonable approach for local control	reduction of direct predation of mammals by cats and foxes	cats and foxes currently considered primary cause of ongoing mammal decline; supported by modeling and field evidence across multiple sites	Kinnear et al. 2002; Johnson 2006; Kutt 2012; Woinarski et al. 2015	I would voluntarily control fox and cat numbers to help conserve small mammals. With adequate financial incentives, I would control fox and cat numbers to conserve small mammals.
Control wild dogs	wild dogs considered by many pastoralists and jurisdictions a pest that injures or kills calves; dogs are either shot opportunistically or poison baits are placed around properties; debate around what constitutes a wild dog versus a dingo and whether it is appropriate to control dingoes; some pastoralists shoot what they believe is a wild dog based on morphological features and do not shoot dingoes	culling of wild dogs may remove a predation pressure; dingoes and wild dogs are likely to present the same predation pressure on small mammals; wild dogs and dingoes are relatively large and thus consume fewer small mammals than foxes or cats	culling of wild dogs and dingoes is not universally considered advantageous to small mammals; wild dogs and dingoes may benefit small mammals by controlling fox and cat numbers and activity	Allen & Fleming 2012; Letnic et al. 2012; Kutt 2012	I would voluntarily start controlling wild dogs to help conserve small mammals if I wasn't already controlling them. With adequate financial incentives, I would start controlling wild dogs to conserve small mammals if I wasn't already controlling them.
Cease control of wild dogs	no known cases where control of wild dogs has deliberately ceased; ceasing control would likely involve no longer laying baits or shooting dogs	not controlling wild dogs may promote them as an apex predator; presence of wild dogs may decrease the number of cats and foxes which are more reliant on small mammals as a food source	substantial literature suggests wild dogs and dingoes benefit small mammals by controlling fox and cat numbers and their activity; idea is still actively debated in the literature	Johnson 2006; Letnic et al. 2012; Moseby et al. 2012; Allen et al. 2013	With adequate financial incentives, I would stop controlling wild dogs to conserve small mammals if I were already controlling them. I would voluntarily stop controlling wild dogs to help conserve small mammals if I were already controlling them.

*Continued*

Table 1. Continued.

<i>Management option</i>	<i>Details of management option</i>	<i>Assumed benefit to small mammals</i>	<i>Strength of evidence of benefit to small mammals</i>	<i>References</i>	<i>Related Likert item</i>
Reduce grazing pressures	option involves reducing the number of cattle grazing in some areas; reduction could be achieved by, for example, periodic destocking or maintenance of conservative stocking rates	removal of cattle may increase ground cover and improve habitat quality, thus increasing food availability and reducing hunting efficiency of predators such as cats	link between cattle grazing and declines in small mammal populations frequently made in the scientific literature but there are limited data directly linking the 2; grazing may indirectly have a negative impact on small mammals; threshold livestock density at which it becomes an issue requires further research because, for example, moderate stocking rates may have limited impacts on small mammals	Johnson 2006; Kutt 2012; Woinarski et al. 2015; Waudby & Petit 2015	I would voluntarily reduce grazing pressure in less productive country to conserve small mammals. With adequate financial incentives, I would reduce grazing pressure in less productive country to conserve small mammals. I would voluntarily reduce grazing pressure in productive country to conserve small mammals. With adequate financial incentives, I would reduce grazing pressure in productive country to conserve small mammals.
Changing water point placement	change in water-point placement may involve reconsidering the location of new dam or bore construction so that it is further away from prime small mammal habitat (e.g., refuges)	water points remote to small mammal populations should reduce grazing pressures (and thus defoliation and soil disturbance) and predation pressure because cats, foxes, and dogs are often at higher densities around water points	little data directly linking water-point placement with small mammals, but because water-point placement is a surrogate of exposure to predation and habitat quality, the strength of evidence should be similar to the management options of reducing grazing pressures (see above)	Brawata & Neeman, 2011; see above references	I would change water-point placement to help conserve small mammals.
Livestock exclusion through fencing	excludes livestock from prime small-mammal habitat	would not exclude predators; would reduce defoliation and soil disturbance, thus ensuring better habitat for small mammals	evidence as for reduce grazing pressure (see above)	see references for reduce grazing pressure	I would fence off a few hectares to help conserve small mammals.

**Table 2. Demographics of pastoralists participating in a survey relevant to their values regarding small mammals, uptake of actions that may provide benefit to small mammals, and potential perceived barriers to their uptake.**

Variable	Measure	%
Gender	male	45
	female	40
	not stated	5
Education	middle school	17
	high school	26
	vocational training	14
	university degree	26
	not stated	17
Age	18–30 years	12
	31–40 years	17
	41–50 years	10
	51–60 years	38
	more than 60 years	12
Area	not stated	12
	southwestern Queensland	36
	central Australia	26
	western New South Wales	14
	northern South Australia	10
Length of time on property	not stated	14
	<5 years	10
	5–10 years	12
	11–20 years	14
	>20 years	45
Management	not stated	20
	own (freehold) and manage property personally	33
	lease (leasehold) and manage property personally	17
	manage the property on behalf of another individual	21
	manage the property on behalf of a company	12
Method of acquisition	own or lease but still paying it off	24
	inherited property outright	14
	purchased property with a loan but now own it outright	5
	do not own or lease the property	7
	no answer or other	50
Membership in industry or NRM* group	land care	26
	pastoralist representative body	24
	NRM group	21
	rural support group	7
	other	7

\* Natural resource management.

pastoralist's qualitative responses were coded to inform analysis and help identify representative quotations.

## Results

### Value-Action Gap

Respondents placed high levels of value on good natural resource management and small mammals on their

property (e.g., “Most landholders actually like their critters and their plants” [respondent 11, Queensland]).

Many respondents believed livestock production and small mammals are compatible (Fig. 2). Key demographic variables significantly and positively correlated with value placed on small mammals included respondent age ( $r^2 = 0.400$ ,  $p = 0.001$ ,  $n = 43$ ), increasing length of time on property ( $r^2 = 0.513$ ,  $p = 0.000$ ,  $n = 43$ ), and relatively high level of education ( $r^2 = 0.386$ ,  $p = 0.002$ ,  $n = 43$ ). All respondents who planned to purchase additional properties ( $n = 2$ ), increase off-farm income ( $n = 7$ ), diversify ( $n = 7$ ), borrow money to improve capital ( $n = 1$ ), and reduce debt ( $n = 9$ ) strongly agreed that they valued small mammals. One of the 11 respondents who planned to sell or pass their lease to their children did not agree that they valued small mammals. Of the 12 respondents who did not answer questions about future intentions for their property but answered the question about valuing small mammals, 4 stated they valued small mammals.

Some respondents provided a rich and contextually nuanced understanding of ecological dynamics on their property. The complexities of resource pulses driving irruptive population dynamics and subsequent implications for predator-prey relationships inherent in a climatically variable landscape were particularly well articulated. For example,

“The hyperpredation that can occur with the boom, makes it hard for these little critters to get through that repopulating thrust with enough numbers and fast enough to then survive the next dry period [respondent 11, Queensland].”

“I've been here 25 years and have only seen 1 or 2 foxes. It's very dry at the moment, there's very few predators, no wild dogs and not many cats. There were lots of mice after the big rains, and then there were cats, but they've eased back now [respondent 52, Northern Territory].”

Species-level accounts also revealed nuanced understanding of the spatial and temporal dynamics of small mammals and how these dynamics relate to pastoralists' individual properties (e.g., “The rats plagued from the Diamantina [River] area during the last boom, but we didn't get any on our property” [respondent 31, Queensland]).

Stated voluntary willingness to engage in a range of behaviors that may benefit small mammals was high but depended on the behavior (Fig. 3). Stated willingness to engage in managing predators, cats and foxes, was particularly high. Preparedness to reduce grazing pressures for small mammals was considered reasonable if this reduction would occur in less productive grazing country. Low levels (21% and 26% slight to strong agreement for voluntary and incentivized cessation, respectively) of willingness to cease wild-dog control for the benefit of small mammals suggests strong constraints to this behavior.

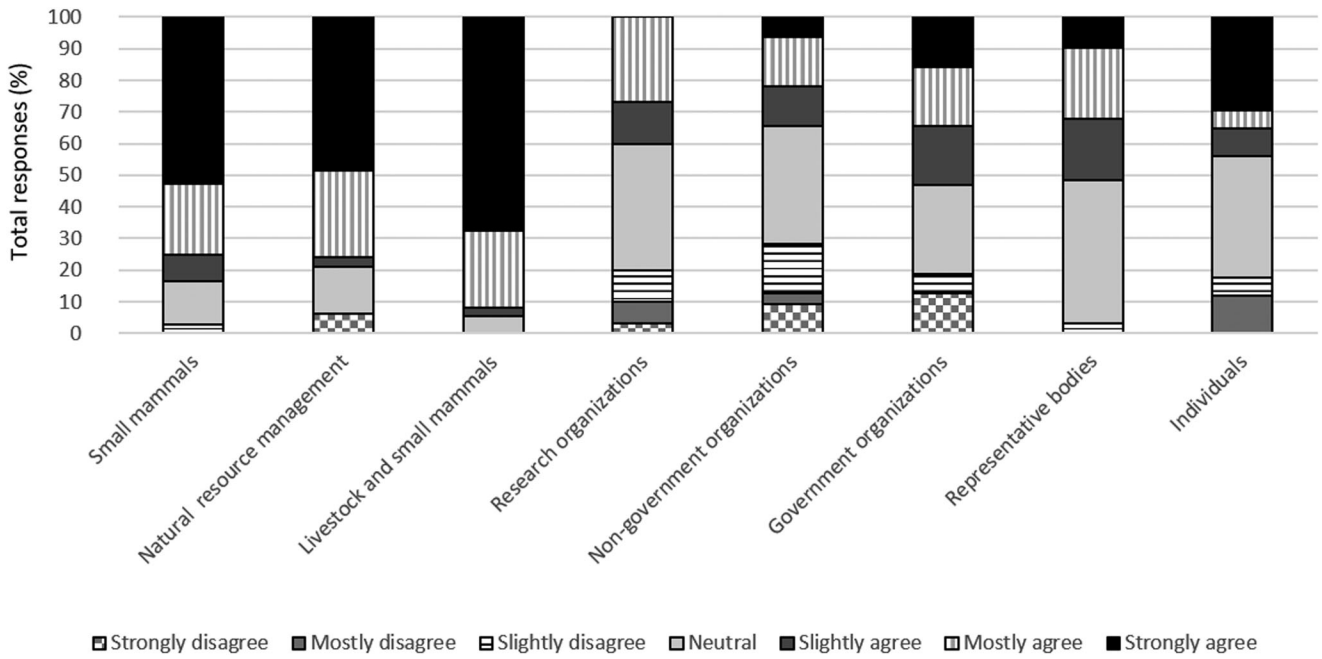


Figure 2. For surveyed pastoralists, level of value placed on small mammals and natural resource management, perceived compatibility of small mammals with livestock production, and levels of trust of different entities that may implement small mammal conservation programs.

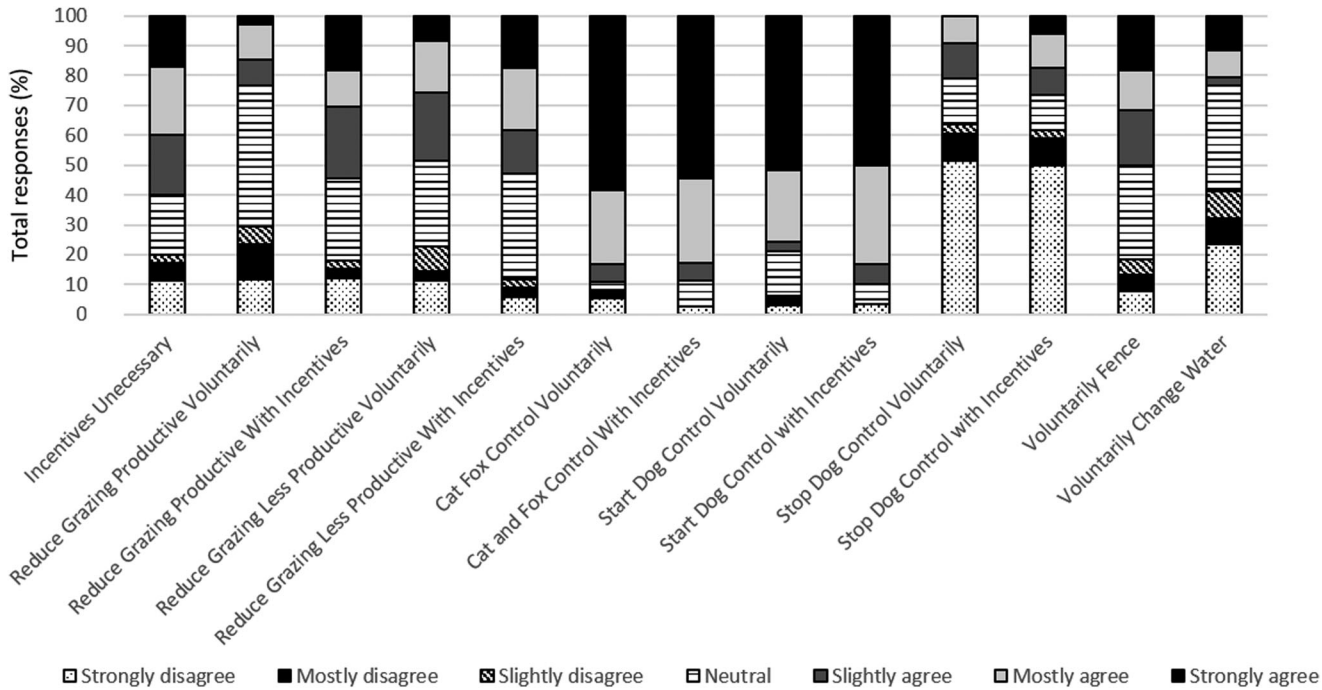


Figure 3. Willingness of surveyed pastoralists to engage with management that benefits small mammals with and without financial incentives.

The level of value placed on small mammals was a good predictor of willingness to manage for them. The correlation between responses to the statements “I value small mammals.” and “I would voluntarily control cats and foxes.” was high, positive, and significant and had a

large effect size ( $r^2 = 0.558, p = 0.000, n = 43$ ). Of all the specific management options presented to pastoralists, including voluntary and incentivized options for cat and fox control, fencing, and wild-dog control, only the voluntary ( $r^2 = 0.187, p = 0.142, n = 43$ ) or incentivized



( $r^2 = 0.051$ ,  $p = 0.685$ ,  $n = 43$ ) cessation of wild-dog control was not significantly correlated with the level of value that pastoralists placed on small mammals. In general, the qualitative data set revealed such a tangible dislike of wild dogs because of their perceived negative impact on calves and, ultimately, pastoral livelihoods that even a financial-compensation management option was not strongly supported.

In terms of actions, 60% of respondents ( $n = 43$ ) stated that they self-initiated control of cats and foxes, 48% used conservative stocking rates, and 35% deferred grazing. Some respondents engaged in cat and fox control had monitored the outcomes of their predator control attempts. For example,

“In 2012 the feral cat numbers were huge, probably due to the mouse plague in 2011. We found that our routine dog baiting culling killed a lot of cats too. Thank goodness as they were killing lots of birds at troughs [respondent 7, Northern Territory].”

Of the 30% ( $n = 32$ ) of respondents who stated that they agreed to very strongly agreed that they would voluntarily control cats and foxes for small mammals, half stated they were currently managing them. Of the 4 respondents who did not agree to strongly agree that they would voluntarily control cats and foxes for small mammals, one stated she or he was currently managing them.

### Reasons for the Value-action Gap

Labor, time, and finances were all perceived to be constraints to engaging in proenvironmental activities for the benefit of small mammals; information constraints were not perceived as a discernible barrier. On average labor was considered by respondents to be the biggest constraint in climatically good (count = 37) and average (count = 40) but not bad years (count = 37) when financial constraints were considered more important than labor constraints. In general, time constraints were lowest across all periods. Financial constraints appeared to be weakly related to climatic phases; financial constraints (40) in bad years were cited more frequently than in financially average (37) and good years (33). Two respondents believed financial incentives may overcome constraints to further conservation activities. For example,

“Most landholders are good conservationists. The problem for not doing more land management activities is money, not time or attitudes. With financial incentives, pastoralists would be more than willing to do more land management [respondent 28, Queensland].”

Despite this perception by some, there was no significant difference between total stated constraints (informational, financial, labor, and time) and the uptake or not of the specific environmental action of cat/fox control ( $p = 0.237$ ,  $n = 43$ ). There was also no significant difference between voluntarily and incentivized willingness to engage in: cat/fox control ( $p = 0.862$ ,  $n = 43$ ), reduction of grazing pressures in less productive country ( $p = 0.358$ ,  $n = 43$ ), reductions of grazing pressures in more productive country ( $p = 0.068$ ,  $n = 43$ ), cessation of wild-dog control ( $p = 0.480$ ,  $n = 43$ ), and initiation of wild-dog control ( $p = 0.307$ ,  $n = 43$ ). All 3 pastoralists interviewed on their property found it difficult to estimate a reasonable level of payment for proposed actions, trade-off between potential payments, and contract length and to determine activity attributes and frequency for a hypothetical cat and fox management program.

Perceived poor program design was considered a sizable constraint to engaging in formal conservation programs. Pastoralists thought good relationships, appropriate program design, and contextual appropriateness positively affected their involvement in conservation programs. Relationship factors were cited as being the most important factors affecting their involvement in conservation programs, and respect for pastoralist knowledge by program implementers was the most commonly cited variable. On the whole, pastoralists expressed dissatisfaction with the framing of conservation that represented them as having a negative impact on conservation outcomes. For example,

“... with better communication and a less aggressive belief of conservationists to listen and work with landholders and give a little credit and respect to our knowledge and ideas, we could have a lot more involvement [respondent 15, unknown postal code].”

Instead, respondents self-identified as “dirt scientists” (respondent 11, Queensland) who sometimes had “more conservation experience than nonpastoralists” and “more knowledge of their land than anyone else” (respondent 20, Northern Territory). This perceived experience and local knowledge translated into an appreciation for spatial and temporal biophysical complexity and a desire to engage with programs that recognized this complexity. Some pastoralists thought that programs were not always appropriate for their individual household or their particular property. The appropriate timing of conservation programs to align with appropriate climatic conditions (as opposed to funding or annual reporting timelines) was also considered important. Nuanced projects that recognized complexity and variation were deemed desirable.

“One of the main reasons many projects are not easily or readily taken up in the central Australia region is due to the fact that the project was created for a different land type, and it is simply not compatible with our environment [respondent 3, Northern Territory].”

“... I think the conservation effort needs to not make easy “obvious” assumptions about the complexity of [ecological] processes... Never assume, never average out, landholders like to be seen as individuals and that their properties are unique [respondent 11, Queensland].”

Good technical support through a sufficiently long program for outcomes to be realized was also considered desirable by pastoralists:

“... timeframes to deliver such programs... need to be long enough with short politically driven projects simply a real turn-off [respondent 11, Queensland].”

Values and subjective norms, the latter indicated by relationships with NRM organizations, were only weakly related. Membership levels in NRM organizations were reasonably high, at 26% for a Landcare group and 21% for a NRM group. Of the 18 respondents who were members of a Landcare or NRM group, 89% agreed to strongly agreed that they valued small mammals, whereas 80% ( $n = 20$ ) of those who were not members felt similarly. Only one respondent stated he or she disagreed with the statement that they valued small mammals (as opposed to agreeing or being neutral). This respondent was a member of an NRM organization. Value placed on small mammals was more strongly and positively related to trust in nongovernmental organizations ( $r^2 = 0.555$ ,  $p = 0.000$ ,  $n = 43$ ), government ( $r^2 = 0.517$ ,  $p = 0.000$ ,  $n = 43$ ), research organizations ( $r^2 = 0.623$ ,  $p = 0.000$ ,  $n = 43$ ), and pastoralist representative bodies ( $r^2 = 0.642$ ,  $p = 0.000$ ,  $n = 43$ ). Of those who stated they would voluntarily control cats and foxes ( $n = 32$ ), half were in a NRM group and half were not. Almost one-third (30%,  $n = 32$ ) of respondents who stated they would voluntarily control cats and foxes stated that nothing constrained their ability to do so in financially good, average, or bad years. Half of those ( $n = 6$ ) who would not voluntarily control cats and foxes stated that nothing constrained their ability to do so in good, average, or bad years.

Despite the strong trust and small-mammal value relationship among respondents, qualitative data suggest that some pastoralists who do not trust external organizations enough to participate in research surveys or formal conservation programs may still place value on small mammals. Some respondents, although willing to engage with this research themselves, attempted to explain the perspectives of others who chose not to. For example,

“[Pastoralists and graziers] have been “bitten” by agencies or organizations [that] have usually used and abused [us]

over the years. The information provided by pastoralists has often been misinterpreted or used to punish [us] [respondent 20, Northern Territory].”

## Discussion

Active management for small mammals in the drylands, particularly that which reduces the impact of introduced predators on populations, is urgently needed. In the absence of effective broad-scale management options for these predators, targeted control is needed at sites of high conservation importance. Drought refuges are small in area, occur widely across the landscape, and are species specific (Pavey et al. 2015). Consequently, the classical approach to land sparing—to spatially separate conservation and agricultural production (e.g., Fischer et al. 2014)—is unlikely to ensure that enough drought refuges are included in the conservation-reserve system given current investment patterns. Private landholders need to be more strongly engaged.

We established that land sharing, with pastoralists taking primary responsibility for small mammal conservation, is a potentially socially viable alternative for conservation in dryland Australia. It may also be financially viable due to the strong willingness of pastoralists to voluntarily engage in cat and fox control. Our hypotheses that there is a value-action gap between the valuation of small mammals and uptake of key proenvironmental behaviors and that financial constraints may be the main barrier to the uptake of these behaviors were not strongly supported. A substantial percentage of pastoralists are managing cats and foxes in some form despite there being little legislative requirement for them to do so and despite a lack of financial or technical support or incentives. In general, this finding concurs with research results elsewhere (Herzon & Mikk 2007), where expressed interest in wildlife positively correlates with stated willingness to manage for them. That said, the specific reasons only half the respondents who stated that they would voluntarily control cats and foxes for small mammals were actually doing so were not clear, particularly given that stated information, time, financial, and labor constraints did not appear to differ between those who controlled these predators and those who did not.

The value-action gap can be more accurately described as the values-intention-action gap. A close relationship between values and intentions has been found among many agriculturalists, including those in the drylands (e.g., Holmes & Day 1995). The gap between intention and action is often larger; some assessments show a general lack of relationship between sense of stewardship and adoption of land-management activities (e.g., Curtis & De Lacy 1996; Pannell et al 2006). Our results suggest the exact nature of the land-management activity in question is important. Different land-management activities

variously support or challenge agrarian values such as income generation and pride of ownership. Adoption of novel practices is more likely to occur if that particular practice provides a comparative advantage for achieving these livelihood goals (Pannell et al. 2006). Cat and fox control is not mutually exclusive with production and identity values, which may explain the positive attitudes respondents had to cat and fox control for small mammals. In contrast, the cessation of wild-dog control and reduction of grazing pressures in productive country may challenge with production and identity values. Self-identity and norms can also be related to the intention to perform nonsubsidized proenvironmental actions (Lokhorst et al. 2011), which may explain the lack of meaningful difference between many incentivized and nonincentivized proenvironmental actions we examined. As noted by Gill (2014), linking specific events, activities, or values with overall sense of stewardship can be somewhat fraught.

Trust in the source of information has significant influence over which types of information are accepted and subsequently incorporated into decision-making processes (Gilmour et al. 2015). However, our data suggest that many pastoralists have been involved in conservation programs despite their beliefs that program designs were inappropriate, as has been noted elsewhere (e.g., Lédée et al. 2012). Although they did not always distrust NRM organizations per se, many pastoralists believed they had greater knowledge of their properties, their landscapes' inherent ecological complexity, and the best way to act as environmental stewards on their properties than the facilitators of NRM programs. This belief is recognized from other social-ecological systems (Robins & Dovers 2007; Kelemen et al. 2013), but the strength of this perception and resulting self-reliance by pastoralists may be stronger in drylands given the significant length of time most pastoralists have spent on their property, the remoteness of properties, high levels of landscape heterogeneity, and the relatively thin and short-lived research and extension pool that characterizes these areas (Stafford Smith 2008). A lack of perceived legitimacy in policy and of program implementers has implications for the design and outreach strategies of such programs. As has been found elsewhere (e.g., Blake 1999), a model of engagement that assumes an information deficit is unlikely to gain traction.

The relationship between personality traits and decision-making styles used by landholders has largely been overlooked in relation to NRM (Pannell et al. 2006). Self-reliance runs the risk of being negatively framed as disengagement, but autonomous motivation (self-reliance) has an internal locus of causality (Ryan & Deci 2000). Individuals with this type of motivation may be more likely to fulfil their intentions than those with strong controlled motivation. Survey responders and, presumably, participants in community NRM projects tend to have higher levels of agreeableness and extraversion

than nonresponders (Carlo et al. 2005). Autonomous motivation and agreeableness may be negatively linked. The implication here is that the cohort of pastoralists that values small mammals but does not interact with conservation-related organizations or indeed choose to respond to survey invitations may potentially be as strong or stronger long-term environmental stewards than those who do engage. Our qualitative data lend some weight to this hypothesis. If true, this problematizes the tendency of quantitative social surveys to link proenvironmental values, actions, and outcomes with formal NRM engagement in rural and remote agricultural settings. It also provides challenges to the design of conservation policies or programs that may miss engagement with a proportion of conservation minded landholders, particularly when potential levels of trust between landholders and programs implementers are challenged by remoteness, sporadic interactions, and high staff turnover.

The confluence between the most pressing threat to dryland small mammals, cat and fox predation, and the high level of willingness of responding pastoralists to engage in their control is significant. Land sparing may be both unnecessary and prohibitively expensive given that value-based antecedents for pastoralist involvement in activities to benefit small mammals are present. However, pastoralists are unlikely to engage in activities that compete with livestock-production goals or challenge stewardship identities too strongly. Dryland pastoralists often position themselves as "knowledgeable and deep-rooted insiders in contrast to feckless and fickle outsiders" (Gill 2014:274). Trust, shared goals, collaboration between landholders and conservation authorities, and the inclusion of mechanisms facilitating mutual learning experiences between conservation stakeholders and landholders help overcome such barriers to conservation based engagement (Selinske et al. 2015). Processes that more deeply recognize the complexity of dryland social-ecological systems, acknowledge multiple legitimate perspectives, and promote decision making via shared understandings (Gilmour et al. 2015) may lead to better outcomes for small mammals. A specific focus on cat and fox control programs that incorporate these processes and principles, thus leveraging a sense of agency among pastoralists, should help address mammal declines in dryland Australia. Social-ecological research around the feasibility of such a program that focuses on small mammal refuges during key periods in boom and bust cycles may be a particularly cost-effective entry point.

## Acknowledgments

We thank the pastoralists who took the time to respond to our survey or to speak with us on the phone. We also acknowledge the Centralian Land Management Association, the Kingoonya NRM group, and others who provided

various forms of assistance. This research was funded by the CSIRO Land and Water and Territory NRM. We acknowledge and thank the 3 anonymous reviewers who provided very constructive feedback. We are grateful for early reviews by N. Gill and J. Goldberg that significantly improved the manuscript.

### Literature Cited

- ACRIS (Australia Collaborative Rangelands Information System). 2008. Rangelands 2008 - taking the pulse. National Land and Water Resources Audit, Canberra. Available from: <https://www.environment.gov.au/system/files/resources/a8015c25-4aa2-4833-ad9c-e98d09e2ab52/files/rangelands08-pulse.pdf> (accessed February 2, 2016).
- Ajzen I. 1991. The theory of planned behavior. *Organizational Behavior and Human Decision Processes* **50**(2):179-211.
- Allen BJ, Fleming PJS. 2012. Reintroducing the dingo: the risk of dingo predation to threatened vertebrates of western New South Wales. *Wildlife Research* **39**:35-50.
- Allen BJ, Fleming PJS, Allen LR, Engeman RM, Ballard G, Leung LK-P. 2013. As clear as mud: a critical review of evidence for the ecological roles of Australian dingoes. *Biological Conservation* **159**:158-174.
- Blake J. 1999. Overcoming the "value-action gap" in environmental policy: tensions between national policy and local experience. *Local Environment* **4**:257-278.
- Brawata RL, Neeman T. 2011. Is water the key? Dingo management, intraguild interactions, and predator distribution around water points in arid Australia. *Wildlife Research* **38**:426-436.
- Carlo G, Okun M, Knight G, de Guzman M. 2005. The interplay of traits and motives on volunteering: agreeableness, extraversion, and prosocial value motivation. *Personality and Individual Differences* **38**(6):1293-1305.
- CSIRO (Commonwealth Scientific and Industrial Research Organisation). 2003. Assessing the impact of landcare activities on natural resource condition. Review of the National Landcare Program. Australian Government Department of Agriculture, Fisheries and Forestry, Canberra.
- Curtis A, De Lacy T. 1996. Landcare in Australia: Does it make a difference? *Journal of Environmental Management* **46**(2):119-137.
- Fischer J, Abson D, Butsic V, Jahi Chappell M, Ekroos J, Hanspach J, Kuemmerle T, Smith H, von Wehrden H. 2014. Land sparing versus land sharing: moving forward. *Conservation Letters* **7**(3):149-157.
- Gill N. 2003. Environmental (re)education and local environmental knowledge: statutory ground-based monitoring and pastoral culture in Central Australia. *The Rangeland Journal* **25**:85-104.
- Gill N. 2014. Making country good: stewardship and environmental change in central Australian pastoral culture. *Transactions of the Institute of British Geographers* **39**(2):265-277.
- Gilmour P, Coffey B, O'Toole K. 2015. Trust and knowledge exchange in coastal settings. *Australian Journal of Maritime & Ocean Affairs* **7**(1):66-74.
- Hacker R, Jessop P, Smith W, Melville G. 2010. A ground cover-based incentive approach to enhancing resilience in rangelands viewed as complex adaptive systems. *The Rangeland Journal* **32**:283-291.
- Herzon I, Mikk M. 2007. Farmers' perceptions of biodiversity and their willingness to enhance it through agri-environment schemes: a comparative study from Estonia and Finland. *Journal for Nature Conservation* **15**(1):12-25.
- Holmes J, Day P. 1995. Identity, lifestyle, and survival: value orientations of South Australian pastoralists. *The Rangeland Journal* **17**(2):193-212.
- Hunt L. 2003. Opportunities for the future in Australia's grazed rangelands. *The Rangeland Journal* **25**:183-195.
- Johnson C. 2006. Australia's mammal extinctions: a 50,000 year history. Cambridge University Press, Cambridge.
- Kelemen E., et al. 2013. Farmer's perceptions of biodiversity: lessons from a discourse-based deliberative valuation study. *Land Use Policy* **35**:318-328.
- Kinnear J, Sumner N, Onus M. 2002. The red fox in Australia - an exotic predator turned biocontrol agent. *Biological Conservation* **108**:335-359.
- Kollmuss A, Agyeman J. 2002. Mind the gap: Why do people act environmentally and what are the barriers to proenvironmental behavior? *Environmental Education Research* **8**(3):239-260.
- Kutt A. 2012. Feral cat (*Felis catus*) prey size and selectivity in north-eastern Australia: implications for mammal conservation. *Journal of Zoology (London)* **287**:292-300.
- Law E, Wilson K. 2015. Providing context for the land-sharing and land-sparing debate. *Conservation Letters* **8**(6):404-413.
- Lédée EJL, Sutton SG, Tobin RC, De Freitas DM. 2012. Responses and adaptation strategies of commercial and charter fishers to zoning changes in the Great Barrier Reef Marine Park. *Marine Policy* **36**(1):226-234.
- Letnic M, Ritchie EG, Dickman CR. 2012. Top predators as biodiversity regulators: the dingo *Canis lupus dingo* as a case study. *Biological Reviews* **87**:390-413.
- Lockie S, Higgins V. 2007. Roll-out neoliberalism and hybrid practices of regulation in Australian agri-environmental governance. *Journal of Rural Studies* **23**:1-11.
- Lokhorst A, Staats H, van Dijk E, de Dnoo G. 2011. What's in it for me? Motivational differences between farmers' subsidized and nonsubsidized conservation practices. *Applied Psychology* **60**(3):337-353.
- Morton SR, Stafford Smith DM, Friedel MH, Griffin GF, Pickup G. 1995. The stewardship of arid Australia: ecology and landscape management. *Journal of Environmental Management* **43**:195-217.
- Moseby KE, Neilly H, Read JL, Crisp HA. 2012. Interactions between a Top Order Predator and Exotic Mesopredators in the Australian Rangelands. *International Journal of Ecology* **2012**:e250352 DOI:10.1155/2012/250352.
- Pannell D, Marshall G, Barr N, Curtis A, Vanclay F. 2006. Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture* **46**:1407-1424.
- Pavey C, Addison J, Brandle R, Dickman C, McDonald P, Moseby K, Young L. 2015. The role of refuges in the persistence of Australian dryland mammals. *Biological Reviews* DOI: 10.1111/brv.12247.
- Robins L, Dovers S. 2007. NRM regions in Australia: the "haves" and the "have nots." *Geographical Research* **45**(3):273-290.
- Ryan R, Deci E. 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist* **55**(1):68-78.
- Selinske M, Coetzee J, Purnell K, Knight A. 2015. Understanding the motivations, satisfaction, and retention of landowners in private land conservation programs. *Conservation Letters* **8**(4):282-289.
- Stafford Smith M. 2008. The 'desert syndrome' - causally-linked factors that characterize outback Australia. *The Rangeland Journal* **30**:3-14.
- Waudby H, Petit S, Robinson G. 2012. Pastoralists' perceptions of biodiversity and land management strategies in the arid stony Plains region of South Australia: implications for policy makers. *Journal of Environmental Management* **112**:96-103.
- Waudby HP, Petit S. 2015. Small Australian desert vertebrate responses to grazing intensity during La Nina. *Ecological Researches* **30**:715-722.
- Woinarski J, Burbidge A, Harrison P. 2015. Ongoing unravelling of a continental fauna: decline and extinction of Australian mammals since European settlement. *Proceedings of the National Academy of Sciences* **112**(15):4531-4540.