Do collars and ear tags affect the behaviour of Eastern Grey Kangaroos?

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Abstract

A population of eastern grey kangaroos (*Macropus giganteus*) in the coastal town of Anglesea has been the subject of an ongoing research program, and a large number have been marked with ear tags and neck collars for identification purposes. Concerns have been raised by the local community regarding the use of the markers and whether they affect the behaviour of the kangaroos. I conducted focal observations of marked and unmarked kangaroos at Anglesea Golf Club to determine if the ear tags and collars altered proportions of time spent in different behavioural states (e.g. foraging, resting, alert, grooming) during their active (foraging) and inactive (resting) periods. There was no difference between marked and unmarked kangaroos in the proportion of time spent foraging during their active period or resting during their inactive period. Kangaroos were more likely to shake their heads during the inactive period, although there was no significant difference in the number of head shakes observed between marked and unmarked kangaroos. The use of ear tags and collars does not alter the behaviour of kangaroos at Anglesea and the use of these markers is suitable for ongoing ecological research of this population.

Introduction

Many ecological studies rely on the use of markers to identify individuals or groups of animals. The use of markers allow researchers to study ecological parameters such as behaviour, population demographics, habitat use, home range, dispersal, and rates of reproduction and survival (Murray and Fuller 2000; Mellor *et al.* 2004). Marking techniques have been used for many years on a range of vertebrate species (Murray and Fuller 2000). The types of marking methods used can be classified as temporary (e.g. hair removal, paints, dyes, fluorescent powders), semi-permanent (e.g. tags, collars, bands, radio-transmitters, harnesses), or permanent (e.g. tissue mutilation or removal, implants) (Mellor *et al.* 2004).

The use of external ear tags and neck collars are widely used, as they are often cheap, readily available, easy to fit, applicable to a variety of species, and allow easy identification (MacInnes *et al.* 1969). Ear tags are used in agriculture to allow close monitoring of animals for stock control, management of disease and to guard against fraud (Johnston and Edwards 1996). Collars provide an easy way to distinguish individuals in a population and they are often large enough to be viewed from a distance (MacInnes *et al.* 1969). The use of collars fitted with radio-transmitters can further improve the detail and quality of studies in animal behaviour (Brooks *et al.* 2008). An additional benefit of collars and other easily identifiable tags is that they can allow the involvement and assistance of the general public for certain studies, and increase public awareness and knowledge of research that is being undertaken.

Despite the benefits and wide use of markers, research into the potential negative effects caused by the various techniques is limited. Impacts associated with the use of markers such as ear tags and collars include tissue damage at the insertion point or by chafing; infection of tissue damage; injury resulting from the marker becoming snagged; issues resulting from collars being too tight; physical impairment that can lead to increases in energy use (e.g. hydrodynamic drag); and alteration in natural behaviours associated with feeding or attempting to remove the marker (Mellor *et al.* 2004). When conducting research of marked animals, it is important to ensure that the marking method used does not adversely impact on the parameters being measured, otherwise data collected can be inaccurate (Murray and Fuller 2000).

Many studies using marked animals make the assumption that the use of markers does not alter the outcome of their research, despite not explicitly testing for potential negative effects. In addition to the potential effects markers have on certain species, the process involved in capturing and marking animals also warrants consideration, as animals that are handled while markers are attached can become stressed, which can negatively impact the animal and the outcome of the study (Mellor *et al.* 2004).

A review of the effects of marking by Murray and Fuller (2000) found that of the vertebrate groups considered, few studies have evaluated the effects of markers in mammals, particularly in the use of tags and identification collars (with the exception of radio-collars). Of the limited literature available on the effects of ear tags used in mammals, research has generally focused on the physical impacts caused by the markers, such as the incidence and severity of ear lesions in cattle and sheep (Johnston and Edwards 1996; Edwards and Johnston 1999). Causal effects such as the increased rates of larval tick infestation around ear tags fitted to white-footed mice (*Peromyscus leucopus*) has also been reported (Ostfeld *et al.* 1993). Very few studies have tested for behavioural effects associated with this ear tags.

Collars for identification purposes have been used on large mammals for many years (Progulske 1957; Fashingbauer 1962; Hamilton 1962). Some of the earliest designs were trialled on euros (*Macropus robustus cervinus*) and quokkas (*Setonix brachyurus*) in Australia (Ealey and Dunnet 1956). Ealey and Dunnet (1956) did not observe any noticeable changes in behaviour of quokkas wearing collars, although specific research into behavioural impacts was not undertaken. It was also reported that euros appeared unaware of the collars and did not attempt to remove them (Ealey and Dunnet 1956). At the same time, studies on collared ungulates such as deer mostly reported on issues relating to physical limitations, such as the collars becoming too tight as the animal grew (Progulske 1957; Harper and Lightfoot 1966). Of these early studies involving collars, few tested for the potential impact of death or injury (Keister *et al.* 1988), however, there appears to be no research into behavioural affects associated with their use.

The use of collars on mammals has evolved over the years from functioning as another means of identification, to expanding designs catering for animals as they grow, and more recently and now most commonly as the device to which radio-transmitters are attached. Unlike tagging or conventional collars, the effects of radio-collars are more widely researched, mostly due to the size and weight of radio-transmitters which have potential to increase energy demands on animals and affect their behaviour (Murray and Fuller 2000; Brooks *et al.* 2008). Despite this, many researchers have found no significant changes in parameters tested for a range of radio-collared mammals, including 'normal' behaviours or activity levels in the giant panda (*Ailuropoda melanoleuca*) (Durnin *et al.* 2004); foraging ability in meerkats (*Suricata suricatta*) (Golabek *et al.* 2008); daily expenditure of energy in meadow voles (*Microtus pennsylvanicus*) (Berteaux *et al.* 1996); or higher mortality in root voles (*Microtus oeconomus*) (Johannesen *et al.* 1997).

By comparison with mammals, research into the use and effects of markers on birds is extensive. Coloured markers and collars have been used in studies of waterfowl since the late 1940s (Taber 1949; Gullion 1951; Craighead and Stockstad 1956). At the time, concerns were raised over the potential impacts to the birds (Aldrich and Steenis 1955; Lensink 1968; Ankney 1975). Early research into their use found various negative effects, such as the accumulation of ice around collars, which resulted in the necks of some geese becoming raw and bleeding from the ice rubbing and removing the feathers (MacInnes *et al.* 1969). It was also found that certain species of geese were irritated by collars and constantly pecked and scratched at the collar, resulting in loss of feathers and injury to the skin of the neck, or bills being caught causing further injury to the birds (MacInnes *et al.* 1969). Ankney (1975) suggested that the time spent by lesser snow geese (*Chen caerulescens*) attempting to remove the collars impacted on their foraging time and thereby contributed to starvation. Many investigations of collared geese have reported negative impacts on other biological parameters, such as breeding and reproduction (Lensink 1968; Schmutz and Morse 2000; Demers *et al.* 2003; Reed *et al.* 2005), and survival rates (Schmutz and Morse 2000; Alisauskas *et al.* 2006).

Behavioural studies on greater white-fronted geese (*Anser albifrons frontalis*) (Ely 1990) and black swans (*Cygnus atratus*) (Guay and Mulder 2009) have noted excessive preening of the neck region directly after the birds were fitted with collars. Demers et al. (2003) also observed female greater snow geese (*Anser caerulescens* *atlanticus*) walking backwards immediately following attachment of collars. These abnormal behaviours were shown to diminish over time as the birds became habituated to the collars (Ely 1990; Demers *et al.* 2003; Guay and Mulder 2009). Once accustomed to the collars, Ely (1990) did not record significant differences between the behaviour of marked and unmarked geese. Similarly, Guay and Mulder (2009) found body condition and the proportion of time spent preening to be the same for unmarked black swans and those that had worn collars for over four months. These studies suggest that behavioural responses to markers such as collars can be obvious immediately following attachment; however, the long-term effects become negligible as the animals become habituated to the collar's presence.

In the small Victorian coastal tourist town of Anglesea, a population of eastern grey kangaroos (*Macropus giganteus*) is the subject of an ongoing research program, so that a large number of the kangaroos have been marked with ear tags and collars for specific research projects. Individuals from the population of kangaroos centred on the Anglesea Golf Course were first marked in 2007 as part of a study of the ecology of urban kangaroos (Mulder *et al*., *in review*). This research evolved from a community-based kangaroo management plan that was developed in response the increasing issue of human-kangaroo conflicts occurring within the town (Inwood *et al.* 2008).

Since the kangaroos were fitted with the collars and tags, residents and visitors have raised concerns over their use. Some people have expressed concern that the collars are too tight or that their presence affects the behaviour of the kangaroos. The purpose of this study is to address some of these concerns. Through behavioural observations of kangaroos at the Anglesea Golf Club, I aimed to determine if marked kangaroos shake their heads more often, or scratch/groom their necks and ears more frequently than unmarked kangaroos; and whether activity budgets during resting and foraging are different for marked kangaroos and unmarked kangaroos.

Methods

Study site

I conducted my study within the grounds of the Anglesea Golf Club, located in the small coastal town of Anglesea, approximately 100 km south west of Melbourne, Victoria. The 18-hole golf course covers an area of 73 ha and is bounded to the north by Alcoa freehold land, to the west by Anglesea Heath (managed by Parks Victoria), and to the east and south by residential areas. The vegetation within the golf course is dominated by couch grass (*Cynodon dactylon*) on the fairways and remnant linear patches of woodland separating the holes.

Eastern grey kangaroos are resident in Anglesea and spend a large proportion of their time within the grounds of the golf course. The abundance of kangaroos on the golf course fluctuates from highest numbers during the morning and evening (approximately 300 kangaroos) to lowest numbers recorded during the middle of the day (approximately 200 kangaroos) (Inwood *et al.* 2008). The abundance of kangaroos on the golf course is higher during the summer months and is generally lowest over winter (Inwood *et al.* 2008).

Kangaroo capture and marking

Between November 2007 and October 2009, 162 kangaroos (120 female and 42 male) at the Anglesea Golf Course (or nearby Camp Wilkin) were captured and marked by researchers from the University of Melbourne (Mulder *et al.*, *in review*). Kangaroos were captured by use of a pole syringe, as described by Allen (2008). Once caught, coloured Allflex ear tags were inserted into each ear to give individuals a unique marking. Ear tag combinations consisted of one tag in the right ear and either one or two tags in the left ear. Of the kangaroos marked with ear tags, 142 were also fitted with a neck collar displaying the individual's name (M. Wilson *pers. comm.*). Females and small males were fitted with vinyl collars cut to a width of 80 mm. The vinyl material was doubled over and glued together (Allen 2008). The collars were permanently fastened with four ratchet rivets after being measured in the field to the appropriate length for the individual. Large male kangaroos were fitted with silicon belt collars, which were also individually measured in the field and then fastened with two zinc-plated steel bolts, nuts and washers (Allen 2008).

Behavioural observations

I conducted behavioural observations of marked and unmarked kangaroos over four days between 15 March and 9 April 2010. To compare the behaviour between marked and unmarked kangaroos, I used focal animal sampling with continuous recording (Martin and Bateson 1986). As I walked around the golf course, I haphazardly selected a pair of focal kangaroos, comprising a marked and unmarked individual of the same sex, age class (adult or sub-adult) and reproductive status (e.g. with or without a pouch young or young at foot) within 30 m of one another.

I made observations from the edge of the woodland areas at a distance of approximately 50-200 m from the focal animal. Depending on the distance, I observed either with the unaided eye or with the use of binoculars (Nikon, 8 x 42). Because the kangaroos were habituated to golfers and ground staff, my presence at this range generally did not affect their natural behaviour. If the kangaroos were alerted to my presence, I would wait until they resumed their original activity before beginning the observation. If the focal individual moved out of view or further than 30 m from its test/control counterpart, I ceased sampling for that focal pair of kangaroos and selected a new pair.

I sampled two distinct behavioural periods: active (foraging) and inactive (resting). The active period was defined as the kangaroos foraging and/or actively searching for food, which generally occurred during the morning and early evening. The inactive period was defined as the behavioural state not associated with foraging. These rest periods occurred throughout the day, when the kangaroos would seek areas within or adjacent to the remnant woodland patches to rest, groom and sleep. In total, I obtained 76 focal observations during the active period and 78 observations for the inactive period, totalling 462 min. I completed paired observations within 10 min of one another, and separated repeat observations of marked individuals by at least 2.5 h. Due to the large numbers of kangaroos available to sample, only a small number of repeat observations of the same marked individual occurred on the same day.

I made observations on a total of 49 marked kangaroos. A database detailing the dates Anglesea kangaroos were captured, marked and recaptured for subsequent research was provided by M. Wilson (*pers. comm.*). Taking into account repeat observations of individuals, observations of kangaroos included 55% marked with three ear tags (two in one ear and one in the other) and a collar; 36% with two ear tags and a collar; 8% with two ear tags (no collar); and 1% with one ear tag only. Database records for the marked kangaroos also showed that a large proportion of observations were of kangaroos that had been captured and handled either once (34%) or twice (45%), and that a smaller number of focal kangaroos had been captured and handled three times (17%) or four times (4%).

A total of 98% of the observations included kangaroos that had been marked for over 12 months. Of these, 23% of observations included kangaroos that had been marked in December 2007, and 75% of observations were of kangaroos marked in 2008. One kangaroo was tagged in September 2009 and one additional observation was of a kangaroo that could not be identified and therefore it is unknown when it was marked. Of the kangaroos at the golf course, the most recent markings were fitted to kangaroos in September 2009.

I conducted focal samples of individuals for 3 min. During each observation, I recorded all relevant behavioural events and states (Martin and Bateson 1986) using an MP3 voice recorder (iRiver, Reigncom, China). Behavioural events were defined as individual body movements of short duration; a single head scratch; a single body scratch (scratch of any area of the body other than the head or neck region); head shake (or flick of ears); and dirt flick (the action of flicking dirt on themselves when lying down). Behavioural states were defined as an activity or posture over a prolonged duration of time; foraging (continuously grazing/chewing, actively searching for food); resting (at ease, sleeping); alert (ceases all other activities while focusing on an object/disturbance); locomotion (hopping movements not associated with foraging); cruising (slow steps not associated with foraging); social interactions (interactions with kangaroos which cause them to cease other behaviours); and grooming. I further classified grooming as head grooming (grooming occurring anywhere on the head, ears or neck) or body grooming (anywhere on the body other than the head or neck region). During each focal sample, I recorded events as a frequency of occurrence and states as their duration.

Data analysis

The proportions of time kangaroos spent on each behavioural state were calculated using JWatcher 0.9 (http://galliform.psy.mq.edu.au/jwatcher/). I averaged the proportions of time for behavioural states for any marked individuals that were observed more than once during each behavioural period. Averages were also calculated for the corresponding unmarked individuals. Due to the small times observed for head grooming and body grooming, I combined the times to include a category of general 'grooming'.

All statistical analyses were carried out using GenStat 12 Edition (www.genstat.co.uk). Log_e and square-root transformations were carried out in an attempt to normalise the data; however, as this did not improve normality the raw data was used for statistical analyses. To investigate the relationship of each behavioural state and event for both the active and inactive periods for marked and unmarked kangaroos, I conducted two-way analyses of variance (ANOVA). Effects were considered to be significant if $P < 0.01$.

Results

During the active period, both marked and unmarked kangaroos spent an average of 87% of their time foraging. When comparing marked with unmarked kangaroos, there was no significant difference in the proportion of time spent foraging during the active period ($F_{1,122}=0.55$, $P=0.459$). During the inactive period, kangaroos spent an average of 93% of their time resting. There was no difference between marked and unmarked kangaroos in the proportion of time spent resting during this period ($F_{1,122}=0.12$, $P=0.73$).

Very small proportions of time were spent on the other behavioural states in both the active and inactive periods (Table 1). Of these, marked kangaroos spent slightly more time grooming than unmarked kangaroos, however, a significant difference between groups was not detected ($F_{1,122}$=1.7, P =0.195).

Table 1. Mean percentage proportion of time (±s.e.) eastern grey kangaroos were observed in behavioural states for active and inactive periods

Behavioural	Active Period		Inactive Period	
State	Marked	Unmarked	Marked	Unmarked
Foraging	86.0±7.0	88.6±6.6	0.0	0.0
Resting	0.0	0.0	92.6±6.3	93.7±6.2
Alert	9.9±6.4	8.9±6.9	3.7±5.3	5.2±5.5
Locomotion	0.3±1.8	0.2±1.7	0.1±1.3	0.0
Cruising	0.0	0.0	0.1±1.1	0.0
Interactions	0.2±1.9	0.0	1.0±4.2	0.0
Grooming	3.5±5.7	2.0±3.3	2.6±4.4	1.0±3.8
Head Groom	0.7±2.4	0.5±2.4	0.1±1.6	0.8±3.8
Body Groom	2.8±5.6	1.5±3.1	2.4±4.4	0.2±1.6

Overall, marked kangaroos shook their heads a similar number of times as unmarked kangaroos ($F_{1,122}$=0.27, P =0.605). Kangaroos were more likely to shake their heads during the inactive period than the active period, although there was no significant difference between marked and unmarked kangaroos ($F_{1,122}$=0.32, P =0.574). There were few observations of kangaroos scratching their heads, which did not allow for formal analysis of these events. Head scratching in marked kangaroos was observed only four times (three of these during the inactive period) during the behavioural observations. By comparison, unmarked kangaroos scratched their heads a total of three times during observations, all within the active period.

Discussion

At Anglesea, the eastern grey kangaroos marked with ear tags and collars did not display any differences in behaviour when compared to unmarked kangaroos. If kangaroos were irritated by the markers, they would be expected to spend more time attempting to physically remove them, shake their heads more frequently, or spend more time grooming at the sites where they are attached. If so, this time spent in response to the markers could detract from normal activity, particularly foraging or resting, which could in turn have a negative impact on the animal's overall health and condition (Ankney 1975; Ely 1990; Mellor *et al.* 2004).

Marking methods that involve tissue damage, such as ear tagging, can lead to infections or prolonged healing times, causing pain to the animal for long periods and ultimately affecting its natural behaviour and energy use (Mellor *et al.* 2004). In the ongoing research of the marked kangaroos at Anglesea, there have been no reports of lesions within the ears of tagged animals (M. Wilson *pers. comm.*; *pers. obs*), although some individuals have torn ears where tags were fitted in the past. Of the marked kangaroos that have been recaptured, there has been no indication that collars increase flea infestation, and rubbing of the hair or skin underneath the collars has not been detected (M. Wilson *pers. comm.*).

Other presumed effects associated with markers, such as increased energy demands due to thermoregulatory, aerodynamic or hydrodynamic factors (Schmutz and Morse 2000; Mellor *et al.* 2004) are not applicable to kangaroos. However, Brooks *et al.* (2008) noted that even a slight increase in the weight of radio-collars used on plains zebra (*Equus burchelli antiquorum)* could alter their foraging behaviour and increase overall energy costs. Brooks *et al.* (2008) also suggested that the presence and weight of a collar sliding up and down the neck during foraging may limit the number of times zebra raise their head, so that they graze only on tufts of grass closest to their last bite, rather than higher quality tufts further away, thereby reducing energy intake. This type of impact is unlikely to be an issue for the kangaroos at Anglesea as the collars are light-weight and are not fitted with radio-transmitters. Each collar has been individually fitted to ensure they are loose enough for the animals to feed uninhibited and tight enough to avoid the incidence of snagging or excessive movement.

In some studies on waterfowl, abnormal behaviour noted immediately after being fitted with collars has been found to decrease with time as the animal became accustomed to the marker (Ely 1990; Demers *et al.* 2003; Guay and Mulder 2009). The majority of kangaroos in this study had worn their ear tags and collars for over 12 months, allowing time to become habituated to their presence. When first fitted with the tags and collars, the kangaroos at Anglesea may have been irritated and displayed abnormal behaviour, such as excessive head shaking or grooming at the point of attachment. However, I found no evidence of long-term behavioural impacts associated with the ear tags and collars used in this study. My study showed that kangaroos with ear tags and collars did not shake their heads more often than unmarked kangaroos. Furthermore, they did not spend a greater proportion of their time grooming their head and neck region, nor were any kangaroos observed trying to physically remove their markers. More specifically, the presence of collars and ear tags did not have a significant effect on the proportion of time kangaroos spent foraging during their active period or resting during their inactive period. These results provide evidence that ear tags and collars do not cause the kangaroos to alter their normal behaviour when foraging and resting, and are a suitable method of marking for studies on behaviour.

The use of markers is important for many ecological studies, provided that the type of marker used does not impact negatively on the animal or alter its natural behaviour. In urban environments there can be benefits in using conspicuous markers such as brightly coloured ear tags or collars with names, as it can spark public interest, encourage community involvement in research, and improve the extent of data received for particular scientific studies (Mulder *et al., in review*). It can, however, also alert the community to the various research techniques used in such studies and raise concerns over animal welfare issues. Therefore, it is important that benign marking methods are used in animal research and that any potential negative effects are tested for, not only to avoid potential errors in the quality of data collected, but to also ensure the welfare of the animals being studied. Once marking methods have been tested and found to be harmless, this information can be conveyed to the public, resulting in increased education and awareness of ecological research.

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