Managing fence damage by bare – nosed wombats (*Vombatus ursinus*) at the agricultural-riparian interface

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Abstract

Fence damage by bare-nosed wombats (*Vombatus ursinus*) can be a serious problem for farmers. Fence damage can cause many management problems, for example it may allow predation by herbivores on valuable crops. This study investigated the effectiveness of exclusion fencing and a simple ‘swinging wombat gate’ to reduce wombat fence damage.

We also examined the patterns of wombat behaviour towards exclusion fencing and swinging gates over time. The ten-month study took place on the interface between natural riparian vegetation and a 22-ha blueberry (*Vaccinium corymbosum*) orchard in south eastern Australia.

Following the testing of exclusion fencing (footing wire and flexible fence), six swinging wombat gates were installed at existing breach points within the exclusion fencing. Wombat gates were on average 600 mm high by 500 mm wide and constructed with 200 x 100 x 6mm galvanised steel material. The response of wombats to both exclusion fencing and wombat gates were continually observed throughout the study period using heat and motion sensor digital cameras. A total of 1,228 wombat detections were made in the study area between August 2007 and June 2008 with a peak in activity over the autumn months. The swinging wombat gate phase of our study showed a clear pattern of adaptation to its use by wombats over the first month, with an average exclusion rate of 48% in the first month after there installation. For the final six months of the project, the number of wombat detections showed an exclusion rate of approximately 25 %. The results of this study showed that swinging wombat gates were more effective than exclusion fencing at regulating wombat access while excluding other unwanted animals.

Key words: wombats, exclusion fencing, swinging gates, human–wildlife conflicts, exclusion rate.

Introduction

Bare- nosed wombats (*Vombatus ursinus*) are widely distributed throughout south-eastern Australia (McIlroy 1973). In temperate forest landscapes adjoining grasslands wombat densities can be 0.3 individuals per hectare (McIlroy 1973), however, in agricultural riparian landscapes, wombats often occur in high density populations (1.9 individuals per hectare) (Skerratt *et al.* 2004). In these environments’ wombats use the sloping streambanks for burrow sites, with adjoining agricultural pastures providing an abundant food source (Skerratt *et al*. 2004; Borchard *et al.* 2008). Unfortunately, the movement of wombats between their burrow sites and grazing areas often results in damage to rural fencing and as a consequence, conflict with humans (Borchard and Collins 2001), with many complaints being received by wildlife management agencies. With a common perception by rural landholders that wombats are increasing in number (Borchard and Collins 2001, Marks *et al.* 1989) the human – wildlife conflict is likely to worsen.

Historically, wombats have been culled by farmers in many parts of their range because of damage to fencing (Matthams, 1921); in New South Wales permits for their destruction may be issued for the purposes of damage control (Temby, 1998). Wire netting fences, often installed at the riparian interface to exclude cattle from entering the riparian zone and prevent wombats from accessing agricultural land, provide no barrier to wombats, which are able to scratch and lift under the base of the fence and lift it to access grasses for forage on the other side. These activities create permanent holes and access points not only for wombats, but also for many other species including red foxes (*Vulpes vulpes*) and swamp wallabies (*Wallabia bicolor*). In rural Australia, foxes kill native animals and lambs and spread noxious weeds (Adams, 2009). Wallabies are generalist browsers (Hollis et al., 1986; Osawa, 1990) and considerable losses of pasture and crop production have also been attributed to wallaby foraging (Statham and Statham, 2009).

In rural south-eastern Australia few non – lethal wombat management options are available to landholders and only two, electric fencing and wire netting, have been tested (Marks, 1998). Swinging gates have been used successfully to prevent fence damage by badgers (*Meles meles*) in pine plantations in the United Kingdom (Ratcliffe, 1974) and have been generally recommended for the prevention of fence damage by wombats in Australia (Breckwoldt, 1983; Platt and Temby, 1999; Triggs, 2009). The recommended design of swinging gates traditionally follows a timber construction that may require regular maintenance (Breckwoldt, 1983). Recently, however, heavy duty steel wombat gates were demonstrated to protect wallaby-proof fencing from wombat damage (Statham and Statham, 2009). Once through a fence opening wombats spend many hours grazing on native and introduced grasses (Triggs 2009). Not all property managers, however, readily accept the concept of swinging gates and of subsequently allowing wombats to access their properties (Borchard and Collins, 2001). Rather, they continue to focus on attempts to totally exclude them. Consequently, the success of wombat gates as a means of allowing wombats free access while excluding unwanted predators of resources and crops needs to be measured on two levels. At a practical level the effectiveness of wombat gates remains to be rigorously tested, while at a human level the acceptance of wombat gates by property managers also needs to be evaluated.

Previously, using the methods described here we were able to report a high level of success in both "educating" wombats to use swinging gates and to exclude unwanted animals (Borchard and Wright 2010a). In this study we focus more on the patterns of movement and diurnal behaviour of wombats at both exclusion fencing and swinging gates. This was achieved by using motion sensing camera techniques developed in a recent study of wombats and cattle (Borchard and Wright 2010b). At the conclusion of the project, we informally reviewed the property managers response to managed wombat access to his blueberry orchard.

Methods

Study area

The study took place between August 2007 and June 2008 in a 22-ha blueberry

(*Vaccinium corymbosum*) orchard situated 250 km south of Sydney (35°50‟S, 150°21‟E) in the Shoalhaven region of New South Wales. The orchard is bounded on one side by eastern riverine forest (Keith, 2004) dominated by river oak (*Casuarina cunninghamiana*), river peppermint (*Eucalyptus elata*), black wattle (*Acacia mearnsii*) and water gum (*Tristaniopsis laurina*). Dry sclerophyll forest habitat containing white stringy bark (*Eucalyptus globoidea*), large fruited red mahogany (*E. scias*), grey ironbark (*E. paniculata*), rough-barked apple (*Angophora floribunda*), tick bush (*Kunzea ambigua*), hair pin banksia (*Banksia spinulosa*), and prickly shaggy pea (*Oxylobium ilicifolium*) surrounds the other three sides. Introduced grasses such as kikuyu (*Pennisetum clandestinum*) and narrowleaf carpet grass (*Axonopus affinus*) occur as a narrow buffer on the outside of the orchard and between the rows of blueberry shrubs within the orchard. Wombat burrows are broadly distributed across the surrounding general landscape but, as in other agricultural riparian landscapes, occur in high abundance on the surrounding streambanks (Borchard et al., 2008). The blueberry orchard is enclosed by a 2-m high deer fence and is entirely covered by bird netting. At the time of commencing the study 17 wombat breaches of the existing deer fence were recorded around the entire farm, with 14 of these located along the riparian interface. Several of these breaches appeared to be more well-used than others as identified by deep, hemispherical excavations of soil under the fence and the raised nature of the lower part of the netting (Marks, 1998; Marks et al., 1989). Wombat breaches and subsequent damage to fencing had been repaired and re–repaired by the property owner over many years.

Trial 1. Exclusion fencing (Foot netting wire and flexible fencing)

Two types of exclusion fencing were tested for excluding wombats as well as foxes and wallabies. Firstly, at the farm/riparian interface, a 100 m long section of foot netting using wire mesh (8 lines, 80 cm wide x 15 cm spacings (Hinged Joint wire); Whites Wires Australia Pty. Ltd.) was strained flat along the ground and secured to the outside of the existing vertical deer fence (Figure 1). Hinged joint wire was attached to the existing fence at 1 m intervals using ring fasteners and secured to the ground using tent pegs also at 1 m intervals. Patches of hinged joint wire were also secured in the same manner on the inside of the existing fence at the five existing wombat breach points within this section. Secondly, at another 30-m section of existing fence along the riparian interface located on steep rough ground and containing four wombat breaches, each breach was patched with hinged joint wire on both sides of the existing fence as previously described. The hinged joint wire footing wire was tested from 29 August 2007 to 10 October 2007. Our approach to flexible fencing was based on alternative materials used for excluding Tasmanian pademelons (*Thylogale billardierii*) from blackwood (*Acacia melanoxylon*) plantations in Tasmania (Jennings, 2003). A 100-m long section of woven nylon material (770 mm wide (Silt Fence) Rally Products Australia) was secured at a height of 30 cm to the existing fence at 30 cm intervals and secured outwards by tent pegs along the riparian interface (Figure 2). The flexible fence spanned five existing wombat breach points which were also patched on the inside with hinge joint wire as previously described. The flexible fence material was tested from 5 September 2007 to 26 September 2007.

Trial 2. Wombat gates

Following the testing of exclusion fencing (footing wire and flexible fence), six swinging wombat gates were installed at existing breach points within the exclusion fencing that either continued to be breached or were heavily impacted by breach attempts. Another two wombat gates were also installed at other locations around the orchard, but frequency of use was only monitored at the riparian interface. Wombat gates were on average 600 mm high by 500 mm wide and constructed with 200 x 100 x 6 mm galvanised “Weldmesh” steel material (Figure 3). When cutting out the gate from the larger sheet of steel mesh, the top run of wire was allowed to protrude approximately 50 mm on each side. These tabs formed the swinging pivot point when installed. The installation of the gates required the excision of a section of deer fence above the hemispherical wombat excavation in the soil below the fence. Two steel posts were rammed into the earth at each side of the hole ensuring that the holes in the posts were aligned so that the two protruding tabs could be inserted in the holes. Two bushes were placed over the tabs and were pushed hard against the steel posts to prevent the gate from slipping to one side and jamming. A threaded rod within a steel tube was attached to both steel posts above the gate to form a strong rigid frame that could be then secured to the surrounding deer wire. Finally, two treated pine half logs weighing about 2 kg were attached to each side of the lower section of the gate. This aimed to allow access by wombats while preventing access by wallabies and foxes (Figure 4). To avoid wombats scratching the soil under the gates, care was taken to ensure the swinging action of the gate followed the hemispherical shape of the existing excavation.

Monitoring animal activity using camera traps

The response of wombats and other animals to both the exclusion fencing and wombat gates were observed continually throughout the study using 4 Moultrie Game Spy I40 heat and motion sensing digital cameras (Moultrie Feeders, Alabaster, USA). The cameras were powered by 12-volt Panasonic external rechargeable batteries. With a service interval of approximately 1-2 weeks battery power was not compromised. Cameras were secured to permanently positioned steel posts 30 cm above ground level and 1 m away from the wombat breach points. The cameras were positioned at the four most heavily used breach points to test the exclusion fencing first and then the swinging gates. These were approximately 50 m apart. The images were downloaded every 1-2 weeks and at this time the serviceability and time and date functions were checked. The cameras were set to capture 15- second videos, after being triggered by motion, followed by a still image that contained the time and date. An image delay of one minute, as used in other studies (Bowkett et al., 2007; Otani, 2002), determined the number of pictures taken of a detected animal remaining in range. We therefore, used the number of animal detections to estimate the difficulty faced by an animal to breach an exclusion fence or gate, and use the term exclusion rate as a measure of effectiveness. Figure 3 shows how the Moultrie cameras were positioned at a wombat gate.

Species identification and data preparation

After images were downloaded, videos and photographs were examined first for falsely activated images such as those taken of moving grasses during high winds, then for images of animals. All species recorded were identified after comparisons with descriptions provided by Strahan (1988). The time and date of every video/ photograph were automatically recorded. At each recorded event, a wombat entering a breach point (of exclusion fences, or a gate from outside the orchard was given a code of 1. Wombats exiting the farm through a breach point (or gate) were given the code of 2, while wombats that were unsuccessful in their attempts to either enter or exit a breach point (or gate) were given the code of 3. For the purposes of this manuscript, we only focused on whether or not a wombat had breached an exclusion fence or gate and therefore direction of travel was not assessed. Results were expressed as “wombat detections” per day (24 h), with mean results compared between species on a monthly basis. Detections of wombats passing through the

fence (or gate structure) was compared with the numbers of that wombats detected in each 24 h period, thus enabling calculation of exclusion rate for wombats. For example, if there were 10 "detections" of a wombat and 2 were of a wombat breaching the fence, in either direction over a single 24 h period, it gave a wombat fence exclusion rate of 80 %, for that day. A one-way analysis of variance (ANOVA) was used to temporal variation of wombat detections, grouped according to month, season and to time of day of detection over the 24 hour period (1200 – 1859 hours; 1900 – 0059 hours; 0100 – 0659 hours; 0700 – 1159 hours).
All data were logarithmically (base 10) (X +1) transformed to approximate a normal distribution.

Results

A total of 1,228 wombat detections were made across all fencing and swinging gate trials between August 2007 and June 2008, with wombat activity ranging from 52 detections in December 2007 to 219 detections in May 2008 (Table 1). The daily level of wombat activity appeared to be highly variable, with wombats frequently undetected over many 24-h periods (Table 1). The mean monthly activity level for wombats ranged from 2.7 detections per day in August 2007 to 7.1 per day in May 2008 (Figure 5). The maximum level of activity was recorded on 29 April 2008 with 22 wombat detections. Wombats were successful at breaching exclusion fences over the entire 10-month study. Averages of 78.6 % of wombat detections were associated with successful exclusion fence breaches, or passage through swinging gates. The exclusion fence trial (footing wire and flexible fence) in September/October 2007 resulted in a mean wombat exclusion rate of 35 % for that period.

The second trial was the "swinging gate treatment". The first month of this treatment (October 2007) resulted in fewer successful fence breaches by wombats, with an average detection rate of 48 %. Wombats became more successful at using the swinging gates over the next three months, with exclusion rate dropping to 21.3%, 2.4 % and 23.3 % over November 2007 to January 2008, and exclusion rate remained lower than 23 % for the remaining 5 months of the trial.

Monthly wombat detections varied highly significantly ($F_{10,317} = 9.8$, $p < 0.0001$) from month to month, ranging from 1.7 detections per day in December to a peak of 7.1 detection per day in May (Figure 5). Wombats attempting to enter fencing structures were detected more often in the periods 1900- 0059 hours and 0100-0659 hours than between 1200 – 1859 hours and 0700 – 1159 hours ($F_{3,1332} = 238.5$, $p < 0.0001$). Seasonal activity during the autumn months was significantly greater ($F_{3,1468} = 39.3$, $p < 0.0001$) than spring, winter and summer months (Figure 6).

Discussion

Wombat activity

Wombats had highly variable activity levels (measured as detections per day, per month) during the study period with the lowest activity in December 2007, two months into the swinging gate monitoring. From December 2007 to May 2008 there was a steady increase of wombat activity at the swinging gates then a sharp decline between May 2008 and June 2008. Possible explanations for highly variable activity levels, particularly for the sharp decline between May 2008 and June 2008, may be the impact of mange (*Sarcoptes scabiei*) throughout the local population which may have reduced wombat numbers at this time. It is also possible that native grasses such as *Poa labillardieri* and *Microlaena stipoides*, which are favoured by wombats (Evans et al., 2006) and available in the surrounding landscape, may have provided alternative forage when introduced grass species in the orchard were dormant.

Differences in activity throughout the year at the monitoring sites, particularly at the swinging gate stage, could also be an artefact of the sampling method. Since cameras were placed at fixed locations during this period, wombats may have kept the same activity from month to month but changed gate access to either or both of the other two gates installed around the orchard. A photographic survey of vegetation and soil disturbance at all past and present access points throughout the study period showed, that the four monitoring points used, selected for heavy usage, remained the most devoid of ground cover vegetation throughout the study, suggesting a greater level of wombat trampling impact.

Exclusion fencing

In the exclusion phase of our study 35% of wombat detections were associated with a successful breach of the fence. Once again, more wombat detections were associated with repeated attempts to establish entry. Once a hole was reopened, unobstructed entry allowed for quicker entry of wombats and therefore fewer recorded detections. In a study of the use of electric fencing to exclude wombats, Marks (1998) noted that wombats learned to avoid contact with energized wires over three nights to avoid electric shock. In contrast, the exclusion rate of exclusion fencing by wombats in our study suggests that, in the absence of aversive stimuli, physical obstruction is insufficient to modify behaviour. Rather, exclusion fencing provided only an engineering challenge and another problem to solve (McFarland, 1982) on a travel path probably established over many years. Video data showed that wombats tried biting and digging through the hinged joint wire but if they were able to find the leading edge of the exclusion wire, they quickly utilized the scratch-and-lift method to gain access. Although anecdotal evidence suggested that wombats are deterred by "flexible" material, our flexible exclusion fencing was breached by wombats, which were able to chew through it with relative ease.

Swinging gates

The swinging gate phase of our study showed a clear pattern of adaptation by wombats over the first month (October 2007), with an average detection rate of 48 %. From January 2008 to June 2008 the number of wombat detections were reduced to an average of 25 % as the gates led to easier passage and therefore less time spent within camera range. The swinging gates were equally consistent in excluding foxes and wallabies. On one occasion, however, video showed a wallaby rocking a gate with its fore paws while balancing on its hind legs. The wallaby was able to gain access when the gate was swung far enough to squeeze its head under. We determined that the combined weight of the half logs used to weigh this particular gate down were less than 3 kg. The problem was therefore rectified by increasing the weight of the gate to approximately 3 kg. Similar success was reported by Statham and Statham (2009), who described a wombat gate weighing 2 - 3 kg that was able to exclude Bennetts wallabies (*Macropus rufogriseus*) and Tasmanian pademelons. Video footage showed variable patterns of wombat passage through the gate. In some instances, similar to Marks' (1998) study of wombats at electric fencing, some wombats used a charging strategy to enter the gates. At other times wombats pushed halfway through the opening, paused, and balanced the gate on their head or back before continuing through. This approach was particularly apparent where deep hemispherical excavations (prior to gate installation) necessitated steep access and egress, therefore resulting in more challenging progression through the openings.

Property managers' response to managed wombat access

Initially, the property manager wished to totally exclude wombats, but as the exclusion fencing phase of this project was undertaken before the installation of wombat gates, this allowed us to review its success. With 35% of wombat detections associated with a successful breach of the fence, and a subsequently high rate of wallaby entry via the breaches made by wombats, the property manager became open to the notion of managed wombat access via swinging gates as a potential solution to the problem. When the success of the wombat gates excluding unwanted animals became apparent, the property manager readily accepted wombats moving in and out of the blueberry orchard as a trade - off. The increased blueberry productivity over the study period reported by the property manager may have been partly due to a reduction of predation by wallabies.

Conclusions

The results of this study showed that swinging wombat gates were more effective than exclusion fencing at selectively regulating access by wombats. However, both methods together probably contributed to managing wombats and other unwanted species on a whole farm basis. Wombats can make numerous breaches in fencing and the installation of gates at every breach point may be impractical. Therefore, gates should always be installed at the most well–used breaches. Exclusion fencing as described here over minor fence breaches (indicated by less fence damage and soil disturbance) should serve to 'train' wombats to use the gates over time by forcing them to utilize an easier access option provided by a swinging gate (Breckwoldt, 1983). According to Triggs (2009), anecdotal evidence suggests that wombats will use gates placed up to 800 m apart without making new holes. The decision to use wombat gates alone or a combination of both wombat gates and exclusion fencing will depend on the extent of the problem, the cost of the damage and the cost to purchase, erect and maintain the length of fence protection required. The success of swinging gates in this study shows potential for assisting with the alleviation of the strong landholder-wombat conflict that continues to exist in parts of rural Australia. By individually testing exclusion fencing then swinging gates, then a combination of both methods allowed us to demonstrate to the property manager how it is possible to reduce wildlife conflict while possibly improving agricultural productivity at a relatively small scale. The challenge remains however, to apply similar strategies at a larger scale.

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TABLE

Table 1. Detections of wombats (by camera) throughout the survey at the study area between August 2007 and June 2008. Statistics are given for total number of detections of wombats per month, mean detections per day (by month) and the minimum and maximum detections per day (by month).

Wombat detections	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	Total
Total detections/month	78	103	90	88	52	72	119	175	147	219	85	1228
Mean detections Per 24 hours	2.7	3.4	2.9	2.9	1.7	2.3	4.1	5.6	4.9	7.1	2.7	-
Minimum/maximum detections per 24 hours	0-17	0- 8	0-10	0-15	0-4	0-5	0-14	0-18	0-12	0-15	0-8	-

FIGURES

Figure 1 Wire mesh (hinge joint wire) strained flat across the ground and attached to the existing deer fence.

Figure 2

Flexible woven material (Silt fence) attached to the existing deer fence and secured to the ground using tent pegs.

Figure 3 Installation of a swinging gate with parts described

1. Steel posts rammed into earth.
2. Threaded rod within a steel tube to add strength to the structure.
3. Bushes covering protruding tabs (pivot points) preventing gate from jamming on steel posts.
4. Galvanised steel mesh 'Weldmesh' 200x100x6mm.
5. Half logs to add weight to gate to prevent the access of unwanted animals.
6. Rechargeable battery in protective cover.
7. Moultrie camera.
8. Hemispherical excavation caused by wombats scratching to access under the original fence.

Figure 4 Wombat utilising swinging gate

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