Title
Impacts and Economics of Wildlife Browsing on Tasmanian Pastures

Journal
Proceedings of the Vertebrate Pest Conference, 24(24)

ISSN
0507-6773

Author
Smith, Rowan

Publication Date
2010

DOI
10.5070/V424110624

Impacts and Economics of Wildlife Browsing on Tasmanian Pastures

Rowan Smith
Tasmanian Institute of Agricultural Research, University of Tasmania, Kings Meadows, Tasmania, Australia

ABSTRACT: The clearing of land for agriculture and the establishment of forestry plantations in Tasmania has led to changes in the distribution and population density of mammalian wildlife species. Populations of Bennett's wallaby, Tasmanian pademelon, and common brushtail possum appear to have significantly increased over the past 50 years. Management of these and other species, including Forester kangaroo and introduced fallow deer on private land, is a contentious issue for landowners, animal welfare groups, and the government. Many farmers believe that browsing by native wildlife on pastures is significant and results in a considerable financial impost. However, limited research has been undertaken to quantify this wildlife browsing. The main control methods for these wildlife species include exclusion fencing, shooting, trapping, and poisoning. In 2005, the use of the poison 1080 (sodium monofluoroacetate) to kill wildlife was banned from use on public lands, and the Tasmanian Government plans to cease all use by 2015.

This study investigated the effects of browsing wildlife on pasture within this region. We used a split plot design, consisting of 2 main treatments with 9 sub-plot treatments, to determine browse impact. Significant reductions in pasture biomass were recorded. The severity of browsing was affected by distance from native vegetation and also varied seasonally. Browsing damage declined with distance from native vegetation edge and was best explained by a logistic relationship. Browsing damage was severe during winter 2008 and varied between 100% at 25 m and 68% at 800 m from native vegetation edge. Browsing wildlife had the least impact during spring 2009 and reductions varied between 64% at 25 m and 0% at 800 m from native vegetation edge. The availability of pasture was found to be a determining factor in the distance and direction that wildlife would travel to browse. Browsing by wildlife also resulted in a reduction in ground cover.

KEY WORDS: Australia, exclosures, forage loss, landscape management, pasture loss, seasonality, Tasmania, wildlife browsing

Proc. 24th Vertebr. Pest Conf. (R. M. Timm and K. A. Fagerstone, Eds.)
Published at Univ. of Calif., Davis. 2010. Pp. 384-388.

INTRODUCTION

Browsing wildlife species in Tasmania have long been implicated in causing significant damage to crops, pasture, and tree plantations. Bennett's wallaby (*Macropus rufogriseus*), Tasmanian pademelon (*Thylogale billardierii*), and brushtail possum (*Trichosurus vulpecula*) are believed to be the species causing the most damage (Coleman et al. 1997); however, species such as Forester kangaroo (*Macropus giganteus*) and the introduced fallow deer (*Dama dama*) are also responsible for damage in some areas (Coleman et al. 1997). In 1990, the Tasmanian Farmers and Graziers Association estimated the damage to crops and pastures was worth between A$4.5 and A$6.0 million per annum (Coleman et al. 1997). In addition, Forestry Tasmania estimated damage to tree plantations of A$2.8 million per annum (Coleman et al. 1997). In the 2006-07 financial year, Forestry Tasmania spent more than A$1M on browsing management in eucalypt plantations in state forests alone (Wardlaw and Burton 2008). In addition, private forestry companies appear likely to have spent a significant amount on controlling browsing wildlife.

Spotlight surveys of wildlife are conducted by the Tasmanian government Department of Primary Industries, Parks, Water and Environment along 10-km transects at more than 130 roadside locations annually. Since 1975, these surveys have provided monitoring of long-term population changes and assist in the management of these species (Driessen and Hocking 1992). Population trends since the early 1980s have indicated significant increases in the numbers of Bennett's wallaby, Tasmanian pademelon, and brushtail possum. Land clearing, improvement of pastures, plantation development, and a decrease in hunting are factors that may have led to an increase in wildlife numbers (Driessen and Hocking 1992, Coleman et al. 2006). It is likely that previous economic estimates of damage are now not only outdated, but underestimated.

Following increased community concern about animal welfare, in 2004 the Tasmanian Government announced that from December 2005 the use of 1080 would be banned on public land (Coleman et al. 2006). The 'Tasmanian Community Forest Agreement' (TCFA) was jointly announced by the Tasmanian and Federal Governments in May 2005 (Coleman et al. 2006).

Within the agreement, A$4 million was dedicated to research, field testing, and demonstration of alternative measures for control of browsing animals. The intention is to phase out the use of 1080 poison as a wildlife control measure in Tasmania by 2015 (Community Leaders Group 2001).

While some studies have assessed the influence of wildlife on pastures in Tasmania (Statham and Rayner 1995, Statham 2000, Donaghy and Tegg 2001), further research was required to quantify wildlife browsing. A review of research on browsing damage by mammals in Tasmania identified a lack of scientific data on wildlife browsing in forestry and farming systems (Coleman et al. 2006). The absence of adequate data restricts the development of science-based management techniques (Coleman et al. 2006).

The current project was developed to provide scientific information about options to manage native wildlife involved in pasture browsing as the use of 1080 poison is removed. The study aimed to quantify both the influence of wildlife browsing on pasture production, and the indirect affect of browsing such as changes in the botanical composition of pasture species. The study examined how browsing damage varies both spatially and temporally across different landscape contexts.

METHODS

Experimental Site

The study was undertaken at Fosterville (41.6°S, 147.3°E), a wool producing property in the Midlands region of Tasmania. Annual rainfall for the Fosterville property is 450 mm (Johnson et al. 2006). Fosterville was chosen for the diversity and large numbers of wildlife known to be grazing pastures (S. Foster, property owner, pers. commun.). The property has a relatively long perimeter boundary between the native vegetation and introduced pastures. In February 2008, a 7-strand plain wire fence was erected to give the experimental site the dimensions of 900 m long × 50 m wide. The soil type varied from a black vertosol on the flats to a brown dermosol adjacent to the native vegetation. The site has a slope of around 3%. Sheep were excluded from the site, but the fence allowed wildlife to enter and graze without impediment.

Experimental Design

A split plot design was implemented, consisting of 2 main treatments with 9 sub-plot treatments. The 2 main plot treatments were: 1) exposed to browsing, and 2) exclusion from browsing. The sub-plot treatments were 9 differing distance boundaries running out from the native vegetation/pasture edge. Distances were 25 m, 50 m, 100 m, 150 m, 250 m, 350 m, 500 m, 650 m, and 800 m from native vegetation cover. Each sub-plot contained 4 (0.55 × 0.55 × 0.55-m) exclusion cages and paired non-caged areas that were used for pasture assessment. Paired exclusion areas were determined by first identifying two areas similar in botanical composition within 2 m of each other. The cage was then positioned randomly on one of the two areas.

Pasture Assessments

Pasture growth and biomass accumulation were measured using the paired quadrat technique ('t Mannetje 1978). Paired quadrats (0.5 × 0.5 m) of pasture were periodically harvested to a height of 2 cm to mimic grazing when the majority of caged areas had reached 5 - 10 cm in height. All quadrats were cut with manual or mechanical hand shears. Pasture samples were oven dried at 60°C for 48 hours and weighed to determine dry matter (DM) yield. Following harvest, cages were placed over both paired areas and sheep were allowed to graze the remainder of the experimental site for short periods (generally less than 1 week), after which the cages were removed. This reset the experimental site for the subsequent growth period.

Botanical composition and ground cover were estimated visually prior to each harvest. The estimate included each species present (annual and perennial grasses, legumes, and broadleaved weeds) and how much the canopy of each species covered the bare ground. These were recorded as a percentage along with the percentage of bare ground/residue pasture remaining. This method was adapted from a method for canopy cover ('t Mannetje 2000). Hand separation of harvested samples was also conducted in the laboratory prior to drying to measure DM accumulation of individual species.

Wildlife Assessments

Daytime and spotlight observations were employed to identify species grazing/browsing on the experimental site. Infrared digital scouting cameras (ScoutGuard SG550, HCO, Norcross, GA, USA), and the presence of faecal pellets and tracks were also used to identify species browsing within the experimental site. Faecal pellet count plots (5 m × 5 m) were established at each sub-plot distance boundary. These plots were first cleared of existing faecal pellets with a light leaf rake, avoiding excessive disturbance of the existing pasture and exposed soil. Plots were surveyed on a monthly basis from February 2009 and pellets were identified to wildlife species. Pellets were then dried at 60°C for 48 hours, after which they were counted and dry weights recorded. The dry weights were summed for the boundary and period, and a rate in g/day was calculated. This figure was then used as a measure of relative feeding time.

Data Analysis

Means of pasture loss were analysed as a split plot design. Statistical analyses were performed using the statistical package SPSS (Version 11.5, SPSS Inc., Chicago, IL, USA). A logistic regression relationship between pasture reductions and distance from native vegetation edge were parameterised using PROC NLIN (SAS 2004). The estimated cost of 1,000 kg of DM for this area was A$200 (S. Foster, pers. commun.). SGS Pasture Model (Grains Research & Development Corp., Australian Government, Barton, ACT, Australia) was used to predict pasture growth rates for the Fosterville property (Johnson et al. 2003).

RESULTS

Significant ($P<0.05$) reductions in total pasture biomass were recorded between the exclosure and the exposed plots (Figure 1). Total biomass production in the exclosure plots decreased with distance from native vegetation. Browsing impact was measured as a percentage reduction in the amount of biomass harvested and is summarised for 2008 and 2009 in Figures 2 and 3, respectively. Pasture loss varied between 100% at 25 m in winter 2008 and no impact at 800 m in spring 2009. The reduction in biomass due to browsing decreased with increasing distance from the native vegetation edge. The relationship was best explained by a logistic regression, with the production loss equation $L = a/(1+EXP(b-c*DIST))$, where a, b, and c are constants. Changes to the parameters of the logistic regression were influenced by seasonality and availability of pasture. The cost of reductions in pasture DM may be between A$200-400

Table 1. Summary of the logistic relationships between reduction in pasture biomass (kg of dry matter (DM) per ha) and distance from native vegetation edge for the period autumn 2008 to spring 2009.

Time of harvest	Loss (L) equation	R^2	Distance at 50% reduction	Ave reduction (kg DM/ha)	Cost A$/ha
Early winter 08	L= 1.0043/1+EXP(-5.3778 - -0.00595*DIST)	0.827	905m	45.1	9.02
Early spring 08	L= 1.0239/1+EXP(-4.1012 - -0.00603*DIST)	0.959	688m	302.3	60.46
Late spring 08	L= 1.5967/1+EXP(-0.5643 - -0.00407*DIST)	0.988	332m	376.8	75.36
Mid summer 09	L= 0.715/1+EXP(-6.5055 - -0.00914*DIST)	0.714	619m	389.9	77.98
Late autumn 09	L= 1.0049/1+EXP(-4.6209 - -0.00663*DIST)	0.852	698m	273.1	54.62
Late winter 09	L= 0.9712/1+EXP(-6.0891 - -0.0091*DIST)	0.958	663m	698.8	139.76
Mid spring 09	L= 0.6291/1+EXP(-3.2587 - -0.01*DIST)	0.969	190m	567.9	113.58

Table 2. Ground cover measured as the percentage of canopy covered by individual plant groups and bare ground for exclosure (■) and exposed (□) plots.

Time of harvest	Improved perennial grasses		Legumes		Annual grasses		Broadleaf weeds		Bare ground / Residue	
	■	□	■	□	■	□	■	□	■	□
Early winter 08	29.8	23.0	13.1	9.9	7.6	3.5	6.9	9.1	42.6	54.0
Early spring 08	20.6	17.6	12.4	6.2	19.1	9.0	0.1	1.1	47.8	66.0
Late spring 08	26.9	19.6	13.3	10.8	34.1	26.2	0.1	0.1	25.7	43.4
Mid summer 09	13.7	7.2	0.6	1.0	18.4	13.7	0.1	0.6	67.1	77.6
Late autumn 09	31.9	19.1	6.9	9.3	19.2	11.9	2.4	2.8	39.6	56.9
Late winter 09	19.7	35.4	15.4	9.3	25.1	29.7	6.9	5.4	32.8	20.3
Mid spring 09	43.7	27.7	9.2	27.6	29.1	27.6	1.6	2.1	16.4	14.9

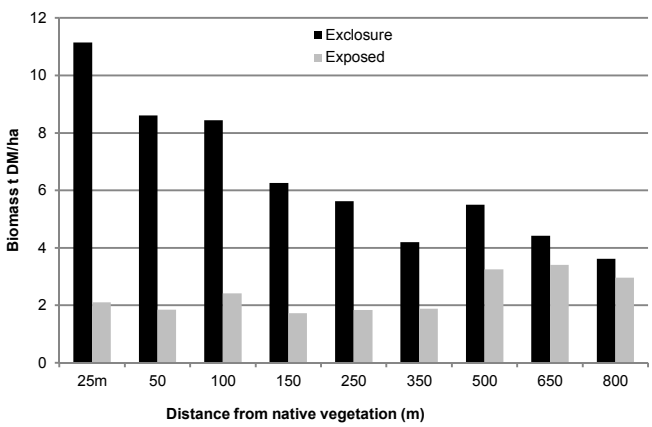

Figure 1. Harvested biomass (tonnes of dry matter (DM) per ha) from exclosure and exposed plots between February 2008 and October 2009.

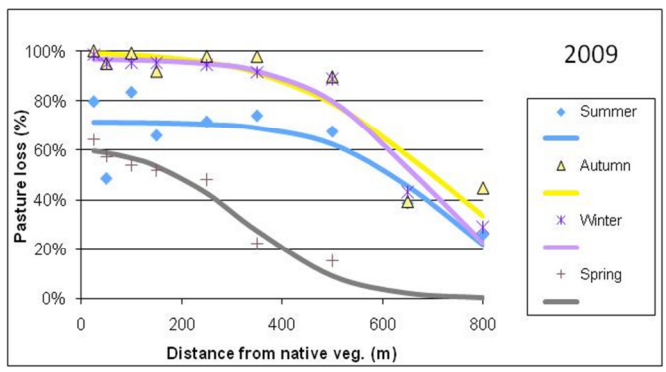

Figure 3. Percentage of pasture lost to wildlife browsing in mid summer, late autumn, late winter, and mid spring, at varying distances from the native vegetation edge during 2009.

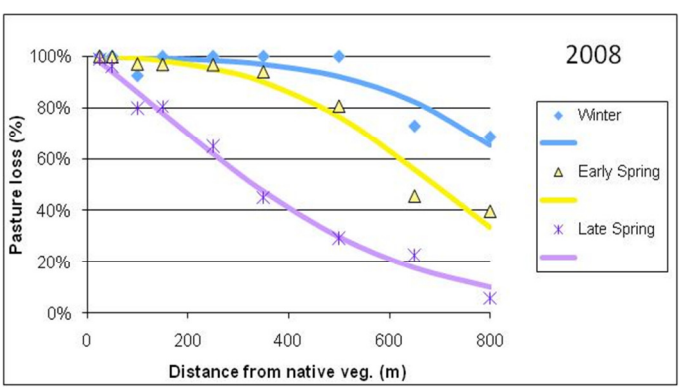

Figure 2. Percentage of pasture lost to wildlife browsing in early winter, early spring, and late spring, at varying distances from the native vegetation edge during 2008.

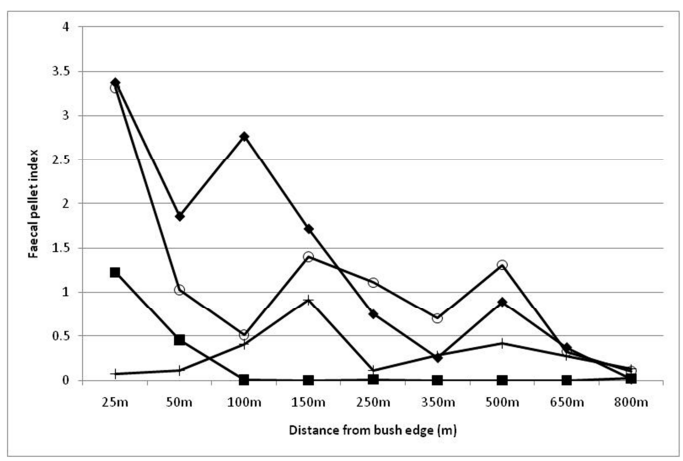

Figure 4. Relative feeding time measured by faecal pellet weight for early autumn (+), late autumn (○), late winter (♦), and late spring (■), at varying distances from the native vegetation edge during 2009.

per ha per annum in the first 800 m from the native vegetation edge (Table 1).

Consistent with biomass findings, wildlife feeding activity assessments showed decreases with distance from the native vegetation edge and decreases during spring (Figure 4). Feeding index rates decreased with distance from the native vegetation edge in all seasons. The feeding index rates were below 0.2 g/day for all dates at 800 m. Rates were lowest for the spring 2009 collection, with minimal activity past 50 m from the native vegetation edge.

Browsing resulted in an increase in the amount of bare ground/residual matter in all seasons except winter and spring 2009 (Table 2). Percentage ground cover of improved grasses was greater under exclosures than exposed plots, except in winter 2009.

Pasture growth rates in the exclosure plots were higher than the exposed plots, however both were below the growth rates predicted by the pasture growth model (Figure 5). Growth rates peaked in spring and the highest growth rates were recorded in the spring of 2009. Growth rates under the exclosures reached the simulated growth rates in March 2009.

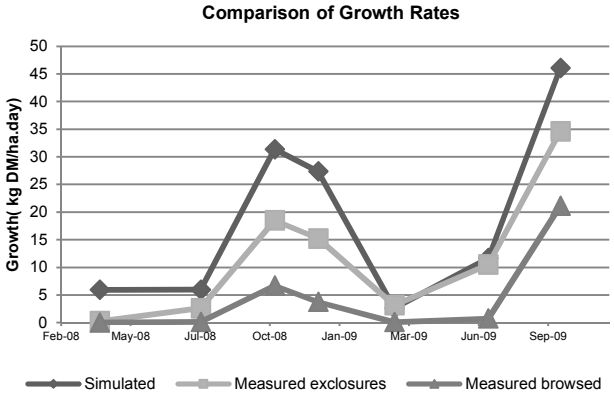

Figure 5. Measured pasture growth rates from exclosure and exposed plots with simulated growth rates produced from the SGS Pasture Model for the period February 2008 to October 2009.

DISCUSSION

Browsing of pastures by wildlife resulted in significant reductions in pasture growth. These reductions are extremely variable and can range anywhere from between 0-100%. The amount of pasture lost to browsing was influenced by the proximity to the native vegetation edge. It was also affected by the amount of herbage on offer which is directly influenced by seasonal conditions. Results from faecal pellet weights are consistent with the hypothesis that wildlife prefer to graze close to native vegetation edges. Both the weight of faecal pellets and the percentage reduction in pasture production decreased with distance from the native vegetation edge. Both measurements, taken over time, indicated that the distribution of animals' feeding varied seasonally. There is a significant financial cost of the reductions in pasture DM and may exceed A$300 per ha per annum within the first 800 m of the native vegetation edge. Sustained browsing by wildlife over multiple seasons has led to changes in the composition of pastures towards annual weedy grass species and limited perennial grass production. It has also led to an increase in the amount of bare ground as a percentage of canopy cover.

Use of the faecal pellet weight data to examine habitat use by wildlife and compare to pasture measurements seems appropriate (Southwell 1989). This appears to be the first study in Tasmania that has attempted to correlate pasture losses with faecal collections. In this case, pellet weights were used as a measure of relative feeding time; the greater the weight, the more time wildlife spent in that area. Animals defecating in the survey areas were presumed to be feeding, given that the fixed survey areas were in pastures that provided no shelter.

Variation in the amount of pasture lost to browsing wildlife has been demonstrated by other trials within Tasmania. A short-term study by Donaghy and Tegg (2001) on a dairy farm in north-west Tasmania showed lower rates of pasture loss. Average DM percent loss was 34% on irrigated pasture and 21% on dryland pasture. Lower amounts of pasture loss were likely due to larger distances from native vegetation edges (not defined) and greater availability of pasture than experienced at Fosterville in the current study. The Fosterville study identified that the percent reduction in DM increased with the advancement of the summer season. This was consistent with the study by Donaghy and Tegg (2001) and was most likely due to a decrease in availability of pasture. Statham and Rayner (1995) also showed great variation in the amount of DM loss, recording a loss ranging between 17 - 100% over 6 sites, with 5 of the 6 sites recording losses greater than 40% DM. Distance from the native vegetation edge was not considered as a treatment in either study.

With more pasture being available in spring, it is plausible that the percentage pasture loss to browsing would decrease, given that individual animal intakes are unlikely to increase to the extent of keeping up with pasture production. This relationship was found to be the case in the current study. However, in a wider animal production context, sheep were lactating during spring and a greater amount of pasture was required to sustain growth of lambs. However, utilisation of available feed by grazing animals is generally at its lowest during spring. In situations where stocking rates are increased to utilise more of the surplus pasture grown during the spring period, the impacts of wildlife browsing are likely to become more significant. In addition, farm productivity is likely to be impacted most during the autumn-winter period. At this time, livestock and wildlife are likely to be competing for the same feed resource, since the availability of pasture is relatively low.

If wildlife are favouring perennial grass species over annual plants, then annuals are more likely than perennials to reach a reproductive state and set seed, which increases the seed bank for germination of seed in future years. Therefore over time, annual grasses are more likely than perennial grasses to colonise gaps in the pasture and become the dominant pasture species. This is not desirable, as annual grasses are generally less productive and have a shorter growing period than

perennial grasses, and they produce seeds that can contaminate wool.

Further investigation is required into the browsing patterns of wildlife. Landscape changes have meant that there are more improved pastures bordering forested areas. It is likely that larger populations of wildlife have become reliant on improved pastures. It is therefore likely that their diets may have changed. Analysis of gut or faecal samples would help evaluate this hypothesis.

Control of wildlife during autumn and winter, as opposed to spring, is likely to have a greater role in protecting the amount of pasture available for livestock and other production purposes. Control of wildlife through exclusion fencing is likely to increase pasture productivity in close proximity to native vegetation edges. Limiting browsing damage of wildlife is likely to extend the persistence and quality of introduced or improved pastures.

ACKNOWLEDGEMENTS

I greatly appreciate the contribution of others to this study. In particular, supervisors Prof. Tony Norton, Dr. Richard Rawnsley, Dr. Mick Statham, Helen Statham, Dr. Alistair Gracie, and Dr. Danny Donaghy for guidance, expertise and support. I thank Amelia Fowles, Rebecca Fish, and Bruce Dolbey for field and technical assistance. I also extend thanks to John Dawson, project leader of the 'Alternatives to the Use of 1080 Program', from which this study was funded. Finally, I thank Simon Foster for providing land suitable for the study and his interest and passion in it.

LITERATURE CITED

COLEMAN, J. D., T. L. MONTAGUE, C. T. EASON, and H. L. STATHAM. 1997. The management of problem browsing and grazing mammals in Tasmania. Landcare Research Report (New Zealand) LC9596/106, prepared for The Browsing Animal Research Council, Tasmania, Australia.

COLEMAN, J. D., R. P. PECH, B. WARBURTON, and D. M. FORSYTH. 2006. Review of research into alternatives to the use of 1080 for management of browsing damage by mammals in Tasmania. Landcare Research Report (New Zealand) LC/0506/144, prepared for the Department of Primary Industries and Water, Tasmania.

COMMUNITY LEADERS GROUP. 2001. Tasmania Together Government activity report. Tasmania Together, Hobart, Tasmania, Australia.

DONAGHY, D. J., and R. TEGG. 2001. Report of effects of wildlife on pasture growth at Elliott Research & Demonstration Station. Tasmanian Institute of Agricultural Research. Contract Report for Dairy Research & Development Corporation.

DRIESSEN, M. M., and G. J. HOCKING. 1992. Review and analysis of spotlight surveys in Tasmania: 1975-1990. Report 92/1, Department of Parks, Wildlife and Heritage, Hobart, Tasmania, Australia. 64 pp.

JOHNSON, I. R., G. M. LODGE, and R. E. WHITE. 2003. The Sustainable Grazing Systems Pasture Model: Description, philosophy and application to the SGS National Experiment. Austral. J. Exper. Agric. 43:711-728.

JOHNSON, K., S. FOSTER, and H. FOSTER. 2006. 'Fosterville', 'Merton Vale' and 'Bloomfield' Property Management Plan.

MANNETJE, L. 'T. 1978. Measuring quantity of grassland vegetation. Pp. 63-90 *in*: L. 't Mannetje (Ed.), Measurement of Grassland Vegetation and Animal Production. Bulletin No. 52, Commonwealth Bureau of Pastures and Field Crops, Farnham Royal, England, UK. 260 pp.

MANNETJE, L. 'T. 2000. Measuring biomass of grassland vegetation. Pp. 151-177 *in*: L. 't Mannetje and R. M. Jones (Eds.), Field and Laboratory Methods of Grassland and Animal Production Research. CABI Publishing, Wallingford, Oxon, UK.

SAS. 2004. SAS User's Guide. SAS Institute Inc., Cary, NC.

SOUTHWELL, C. 1989. Techniques for monitoring the abundance of kangaroo and wallaby populations. Pp. 659-693 *in*: G. C. Grigg, P. Jarman, and I. Hume (Eds.), Kangaroos, Wallabies and Rat-Kangaroos. Surrey Beatty and Sons, Sydney, Australia.

STATHAM, M. 2000. Demonstration of the economic benefits to grazing from effective wallaby control. Report to the National Feral Animal Control Program, Bureau of Rural Sciences, Hobart, Tasmania, Australia.

STATHAM, M., and P. J. RAYNER. 1995. Loss of pasture and crop to native animals in Tasmania. Pp. 171-176 *in*: Proceedings, 10th Australian Vertebrate Pest Control Conference, Hobart, Tasmania, Australia.

WARDLAW, T., and D. BURTON. 2008. Targeted culling of browser species that most threaten eucalypt plantations. Forestry Tasmania, Hobart Tasmania (Unpublished report to the 'Alternative to the use of 1080 program').