A measurable effect of feral grazing on pasture accumulation rate

M.B. DODD, I.L. POWER, V. PORCILE and M. UPSDELL
AgResearch, Ruakura Research Centre, Private Bag 3123, Hamilton
mike.dodd@agresearch.co.nz

Abstract
Feral animals such as possums are known to utilise pasture as a substantial part of their diet, with individual animal intake rates well quantified. The objective of this study was to quantify this effect in terms of pasture accumulation rates, in areas where these animals are likely to occur in high densities; i.e. the boundaries between native forest and pastoral farms. Pasture accumulation rate was measured in small plots open to feral grazing and plots excluded from grazing with electrified flexinets, at six sites throughout the Waikato. Three further sites, within possum control schemes, were established as controls. Pasture accumulation rates were significantly greater within the exclosure plots at all six uncontrolled sites, by ~3 kg DM/ha/d in late-winter and ~7 kg DM/ha/d in late spring. In contrast there were no significant differences between open and exclosure plots at the three sites where there was active possum control. This effect is quite substantial in the context of livestock consumption, though is not entirely reconcilable with predictions based on possum intake and diet studies. It nevertheless represents a source of loss which is easily countered, with additional benefits in terms of lowered Tb risk and improvement of native vegetation condition.

Keywords: feral grazing, grazing exclosure, pasture accumulation rate, possum diet

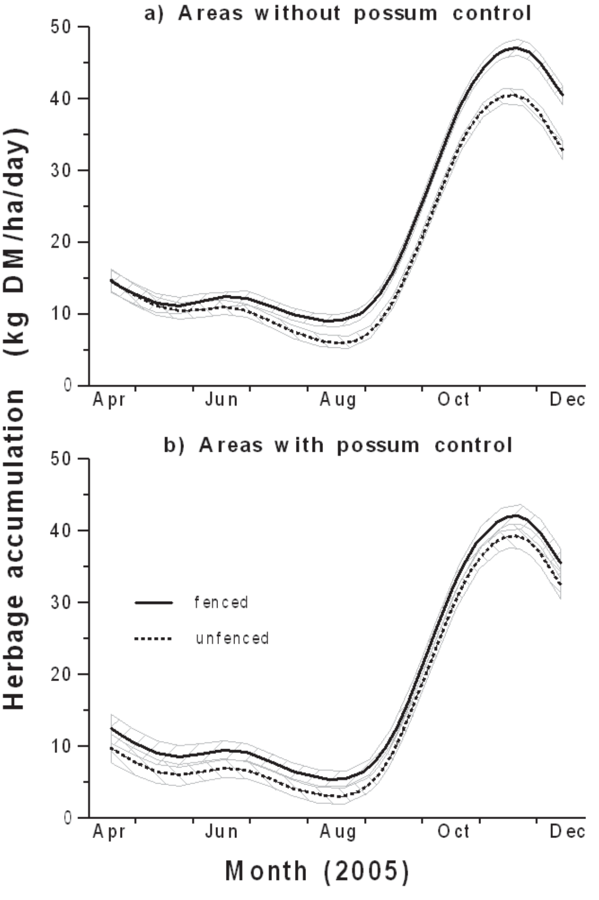
Introduction
There are a number of feral animals inhabiting pastoral landscapes, including possums (*Trichosurus vulpecula*), hares, rabbits, goats, rats, wallabies and pigs. These have various levels of impact on farm systems through browsing of vegetation and their role as disease vectors. With the exception of possums, control measures are typically informal and uncoordinated. However in the case of possums, approx. $50 million p.a. is spent nationally by the Animal Health Board (AHB) on control for the purpose of eradicating Tb in livestock (AHB 2005). This is augmented by approx $12 million spent by Department of Conservation on control principally in native forest for the protection of indigenous flora and fauna (Parkes *et al*. 1997), and an unknown amount spent by other organisations and individuals. The imminent success of the AHB programme and likely decline in associated funding will have a significant impact on spending, hence initiatives are underway to develop local community-based schemes to ensure ongoing possum control. Quantitative information on the various undesirable impacts of possums at the local scale can contribute to enhancing these efforts.

Possums are numerous in pastoral environments (up to 25/ha, Batcheler & Cowan 1988), particularly where farms are adjacent to native forest blocks or have retained remnants of the original forest cover (Byrom 2000). In this context a number of studies have shown that possums incorporate a significant amount of high quality pasture in their diet (Gilmore 1965; Gilmore 1967; Harvie 1973; Coleman *et al*. 1985). One study used this information to (erroneously) estimate the stock unit equivalent of possum grazing at 17 possums to one ewe (Harvie 1973; see Fitzgerald 1977 for a revision). The impact of this feral grazing, in terms of the loss of pasture otherwise available for livestock production, has been the subject of much debate. Possum diet studies, with their attendant limitations (Spurr & Jolly 1981) have only been able to estimate the potential effect, which is highly dependant on possum densities and alternative sources of forage for possums at any given location. A field trial was conducted in the Waikato to determine whether this potential consumption of pasture was measurable in paddocks. The objective was to quantify any differences in pasture accumulation rates that could be attributable to feral grazing.

Methods
Nine sites in three clusters were selected across the Waikato region – Naike, Whatawhata and Te Miro – where paddocks were adjacent to native forest blocks of at least 30 ha having some data on possum populations from trapping operations. Six of the sites (two in each cluster) were in areas with no possum control, and three of the sites (one in each cluster) were in areas where possum control had been occurring for at least 3 years.

At each site six 3×3 m plots were established within 100 m of the bush edge for measurement of pasture accumulation rate by mowing. For each harvest (4-6 week intervals), two of the plots were excluded from feral grazing with electric flexinet fences. The fences were rotated around the exclosure plots with each pasture harvest, ensuring that all plots had the opportunity to be grazed by feral animals throughout the course of the trial (April-December 2005). Livestock were also completely excluded from the sites with a single electric wire to prevent uneven dung and urine deposition over the plots.

Figure 1 Mean pasture accumulation rate in plots excluded (solid line) and not excluded (dashed line) from feral grazing. (a) areas without possum control (b) areas with possum control. Hatched areas represent 95% confidence intervals.



At each harvest, two 3 m strips on each plot were mown to a height of ~2cm and the pasture weighed and sub-sampled for dry matter determination. The results were analysed with the Flexi® Bayesian smoother (Upsdell 1994).

Results

At the six sites without possum control, the exclosure plots had a significantly higher mean pasture accumulation rate than the open plots from August through to December (Fig.1a). The magnitude of this difference ranged from ~3 kg DM/ha/d in late winter to ~7 kg DM/ha/d in late spring. Mean pasture accumulation rates for the open pasture plots at these times were ~7 kg DM/ha/d in late winter and ~50 kg DM/ha/d in late spring. Thus the relative increase in pasture accumulation rate resulting from feral grazing exclusion was lowest in late spring at ~14% and highest in mid winter at ~ 43% of open pasture. Monitoring data indicated that possum populations at these sites were between 17% and 33% residual trap catch (RTC, the number of possums caught as a percentage of the number of traps used multiplied by the number of nights of trapping, which is the standard method of population assessment).

There was no significant difference in mean pasture accumulation rate between open and exclosure plots during the whole period of the trial across the three sites where possum control operations were occurring (Fig. 1b). Monitoring data indicated that possum populations at these sites were below the 5% RTC level normally defined as the target for possum control operations.

Discussion

There is evidence from previous studies in forest/pasture landscapes that possum diet consists of a substantial amount of pasture (Table 1). An average across these studies quantifies this as 26% in winter and 24% in spring. Other studies of overall possum consumption indicate an intake rate of 80 g DM/hd/d (Fitzgerald *et al.* 1981). Harvie (1973) used data on possum diet to perform a rough calculation which erroneously arrived at the conclusion that 17 possums consume the equivalent pasture of one sheep. The correct conclusion from the calculation was that the local possum population ate the equivalent of 1/17 of the sheep flock. The calculation also assumed very high possum intake rates (350 g DM/hd/d, based on stomach content mass, cf. Fitzgerald *et al.* 1981) and high possum densities (43/ha), but even if these are accepted, the correct ratio reported should have been 33 possums to one sheep.

A recalculation using more realistic assumptions from a wider range of studies indicates that 45 possums consume the equivalent pasture of one sheep and that a moderately high possum population (25/ha) consumes the equivalent of 1/22 of an average sheep flock (Table 2). At an overall pasture consumption rate of only 0.5 kg DM/ha/d by possums, this indicates little scope for recouping the cost of possum control in terms of improved animal production, given a cost of ~$70/ha for possum control on farms (P. Thomson, pers. comm.)

Table 1 Summary of possum diet studies measuring the percentage of pasture in possum stomach contents.

Study	Autumn	Winter	Spring	Summer
Gilmore (1967)[1]	40	50	45	40
Gilmore (1967)[2]	25	35	30	40
Harvie (1973)	32	29	24	49
Warburton (1978)	30	6	7	11
Coleman et al. (1985)	12	12	12	12
Average	28	26	24	30

[1,2] two sites monitored in the same study

Table 2 Hypothetical winter stock unit comparison between sheep and possum.

	Sheep	Possum	Ratio
Body weight (kg)	55	2.4	23:1
Daily intake (g)	900	80	11:1
Daily intake (% LW)	1.6	3.3	1:2
Pasture in diet (%)	100	25	4:1
Pasture intake (g DM/hd/d)	900	20	45:1
Density (No./ha)	12	25	1:2
Population intake (kg DM/ha/d)	11	0.5	22:1

However, the data from this pasture measurement study show a potential winter consumption rate of 3 kg DM/ha/d, six times that estimated in Table 2. Regaining this level of pasture availability for livestock would enable an increase in winter stocking rate of ~3 SU, which at a current gross margin of ~$21/SU (MAF 2005) would virtually cover the cost of possum control. However, there appears to be some incongruity between the predicted effect (Table 2) and the measured effect. The immediate conclusion, that possum densities are closer to 150/ha seems improbable. Possum densities vary greatly in pasture/forest landscapes, with estimates of between 0.1 and 25/ha across several studies (Batcheler & Cowan 1988). Quinn (1968) provides the highest documented estimate of 15-20 per acre (37-49/ha). Thus it seems appropriate to consider alternative explanations.

Firstly, it should be noted that the method used here also excluded other feral grazers such as hares and rabbits, which may also contribute to reductions in pasture accumulation rate, though the farmers reported that possums were by far the most abundant ferals. In addition, the close proximity of the measurements to native bush blocks is likely to have maximised the probability of measuring a large effect of possum grazing on the basis that this is where most foraging activity will occur (Byrom 2000). Further work to relate pasture accumulation rate differentials to the distance from the bush edge, as well as monitoring possum foraging out from the bush edge, would give a better overall assessment. Anecdotal observations from the farmers involved in this study suggested that possums move out from the bush edge to targeted foraging sites such as maize crops and willow trees. Spurr & Jolly (1981) conducted a similar cage exclusion trial (without a low possum density control) and found a significant result in only one of six sites, on a chou moellier/swede crop.

Another possible explanation is the small shelter effect of fencing on pasture growth (~10% in Bird *et al*. 2002). However, given that the plots were adjacent to forested areas and therefore not on exposed sites, all plots probably benefited similarly from shelter and so this is unlikely to have been a differentiating factor. An initial design for this trial used small (0.25 m^2) exclusion cages, but the data did suggest a microclimate effect and hence the trial was redesigned to use flexinets on larger plots.

In addition to the amount of pasture potentially consumed by possums, of further interest is the pasture species being eaten. This study did not assess pasture composition differences in the exclosure and open plots, and the possum diet studies are equivocal. The data in Warburton (1978) and Coleman *et al*. (1985) indicate a greater proportion of grasses than clovers in the diet. Gilmore's (1967) data show that the consumption of white clover vs. grasses varied with site and season. The small bite size of possums, and their likely ability to be highly selective, has implications for pasture quality and warrants further study.

The implication of this study is that possum control has the potential to significantly increase pasture feed supply in addition to other benefits such as Tb control and native forest restoration. This study shows that this possible source of loss in pasture accumulation rate from feral grazing is measurable in the field at a time of year (late winter-early spring) when livestock feed demand typically exceeds supply. This is when pasture is most valuable and marginal losses least tolerable. Quinn (1968) cites a Wanganui farmer being able to increase winter stocking rate by 15% once possum control had commenced. One of the farmers on whose property the study was conducted has estimated that he has been able to consistently gain an additional 30-40 kg liveweight per head on his bulls since becoming part of a regional possum control scheme.

There is an interesting postscript to this study. Comparative assessments of pasture accumulation rate using different techniques show variation in estimates (Devantier *et al*. 1998). Cage-cutting techniques effectively exclude all but the smallest herbivores (e.g. mice, invertebrates) while non-exclosure techniques (rising plate, visual, modelling) measure a pasture sward open to feral consumption. In most cases, these non-exclosure techniques have given lower estimates of pasture accumulation (Field *et al*. 1981; Piggott 1997; Devantier *et al*. 1998). One possible contribution to this difference highlighted by this study is the extent to which feral animals (e.g. possums, hares) may be consuming pasture.

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