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Body condition score as an indicator of ewe survival under extensive conditions

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Abstract

Survival and mortality of extensive hill ewes are important commercial factors and valuable indicators of welfare, but difficult to study. Body condition scoring is a tried-and-tested management and monitoring tool which has been defined as a good predictor of fitness in ewes and is easily measured under hill farm conditions. This paper presents the results of a study on ewe survival rates in hill conditions in Scotland. Ewe performance and survival rates were measured in two contrasting hill flocks over a five-year period. Statistical analysis showed that mid-pregnancy body condition score was the most reliable indicator of subsequent ewe survival, followed closely by age of the ewe and environmental and management conditions. This study confirms that there are considerable welfare issues related to hill flocks and that improved winter nutritional management is a key component to good welfare and productivity. It also reinforces the view that body condition score is a good quantitative predictor of animal welfare and that poor mid-winter score indicates high risk of mortality, both at the flock and individual ewe level.

Keywords: *animal welfare, body condition scoring, extensive conditions, mortality, sheep, survival*

Introduction

Even though farmers may increasingly adopt more extensive systems of management following revisions of the European Union's Common Agricultural Policy (Goddard *et al* 2006), levels of mortality in hill sheep (*Ovis aries*) remain a significant welfare concern (FAWC 1994; Scott 2005). Survival of animals has been long recognised as a basic measure of welfare in extensive conditions (Lawrence & Appleby 1996). However, in extensive sheep systems, many ewe deaths on the open hills, moors and fells of the British Isles are unseen, with foxes, badgers and a range of birds consuming the resulting carrion. Reductions in labour availability (Waterhouse 1996; Morgan-Davies *et al* 2006) make it less likely that the bodies of dead ewes are found, and any problems diagnosed. It is common to refer to this undiagnosed dead loss as 'black loss' and the factors linked to it are not always easy to determine.

Although hill ewe survival has been studied for its genetic component (Atkins 1986) and in conjunction with supplementary feeding in late pregnancy (O'Toole 1983), more often than not supplementary feeding and management of the ewe are seen as means to improve the survival and welfare of the lamb (Parker & Waterhouse 1986; Waterhouse *et al* 1992). However, it would be beneficial to provide an increased focus on survival of the ewe, from a commercial perspective, and considerations of the welfare factors linked to mortality or the survival from a risk of death experience. Benchmarking standards, such as SAC Farm Management Handbook (SAC 2006), give annual ewe mortalities in the North-West Highlands of Scotland as 8%, thus the probability of survival of ewes through four lambing years is barely two-out-of-three. Simple management tools to assess or predict either survival or risk of mortality are a prerequisite for action. Indeed, Webster (2003) reported that such assessment protocols for the welfare of animals kept in groups for commercial purposes "need to be based on relatively simple observations and records of husbandry and welfare".

The system of body condition scoring in sheep, which defines discrete grades from 0 (emaciated) to 5 (very fat) was first described by Jefferies (1961). Russel *et al* (1969) quantified body condition scoring in Scottish Blackface ewes and showed it was a better predictor of level of fatness than liveweight. As a result, much reference was made to condition scoring as a nutritional management tool (Pollott & Kilkenny 1976). The influence of body condition scoring on reproductive performance has proved useful in sheep flock management (Gunn *et al* 1969; Russel 1984). Body condition scoring has been incorporated into advisory literature (eg Meat and Livestock Commission 1983) and reference made to target and minimum condition scores for sheep in welfare literature (eg Defra 2002). However, there are few recent studies on body condition scoring and information from the industry reports that farmers are not widely using the technique as a management tool (K Phillips personal communication 2004). More

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recently, research has been focusing on body conformation and computer tomography scanning to estimate tissue weights and levels of fatness in lambs and ewes (Young *et al* 2002; Lambe *et al* 2003a, b), but these techniques are aimed mainly at genetic selection programmes, are relatively expensive and cannot be used on-farm.

The aim of this paper is, thus, to report upon factors having an influence on hill ewe survival (or its converse, ewe mortality) and on how body condition scoring may be a way to predict ewe survival during subsequent spring and summer as well as considering the use of this method to reduce mortality risk.

Materials and methods

Study site

Data were collected from SAC Kirkton and Auchtertyre farms, located in West Perthshire in Scotland. The farms are representative of the wet, western hill and mountain regions of Scotland, UK. The mean annual rainfall for the study site is 2,800 mm, with the first three months of the year tending to be the wettest. Average temperatures peak in June and August at 15°C, and are lowest in January at 1°C. The hills range from 200 m up to 1,017 m above sea level, with semi-natural pasture. The in-bye fields and sheep housing are 188 m above sea level.

Off-wintering farms were located in other parts of Scotland, near Dunblane (Stirlingshire), Kilmarnock (Ayrshire) and East Kilbride (Lanarkshire) on productive lowland farms with sown pastures.

Animals and management

Two ewe flocks, managed very differently whilst grazing adjacent valleys, were considered in this study. One flock was composed of Scottish Blackface ewes, grazing all year round on the hill and being mated to their own breed (traditional flock). The other flock was off-wintered from November to February on lowland pastures on three other farms, with half of the Scottish Blackface ewes being mated to Texel rams and half to Scottish Blackface rams (away-wintered flock). Thus, in combination, these flocks covered much of the extremes of hill sheep production systems, and a contrasting range of winter nutrition, whilst having the same underlying management and health treatment protocols and the same animal monitoring and measurement protocols. Summer pasturing was also similar.

All ewes were tagged with unique numbers and recorded on a number of occasions linked to management tasks in each year, namely at pre-mating (November), mid-pregnancy ultrasound scanning (February), marking (June) and weaning (August).

Although there was a policy of managing the ewes by condition score (sheep with poorer conditions were separated from the rest and fed accordingly) in both flocks, animals in the traditional flock tended to lose weight and body condition score during winter, whilst those in the away-wintered flock gained condition and weight. At mid-pregnancy scanning, twin-bearing ewes from both flocks were separated and kept off the hill on in-bye fields or in a shed until lambing, and fed hay and concentrate compound feed at higher levels than single-bearing ewes, reflecting their additional energy requirements. Ewes on the hill grazings were regularly supplemented with concentrate feed, in a similar manner for both systems. All ewes were born on the farms and kept until they had their fourth lambing season, after which they were sold on for further breeding or fattening on lowland farms, typical of standard Scottish hill systems. Replacement females were drawn from each year's lamb crop in a consistent manner to maintain flock size. Each year, there were similar numbers of animals in each age group.

The flocks had generally good levels of health management and surveillance, being managed within a flock health plan, including measures to prevent infectious diseases from the off-wintering procedure. No infectious diseases were contracted, no known problems occurred in mineral deficiencies and there were no extreme cases of parasitism.

SAC has an ethical review process and the work and procedures described were approved through this process by its Animal Experiments Committee.

Data analysis

Ewe performance data (bodyweights and body condition scores at each of the four recording events outlined above, and mid-pregnancy scanning results) were obtained from records kept routinely from the flocks. Body condition scoring was conducted along with bodyweight measurements by one experienced technician using the scoring system as described by the Meat and Livestock Commission (1983), with sub-divisions at 0.25 points on the scale, in the range from 2–3.5. Beyond the score of 3.5, it became difficult to differentiate by quarter, thus condition scores were recorded as '3.5–4' and '> 4'. The records covered a period of 4 years (1999–2004, the year 2001 was not included in the dataset, as access to some of the sheep was restricted due to the effect of the outbreak of foot and mouth disease). A core number of ewes were recorded repeatedly during their breeding lifetime (entering the flocks in 1999 and leaving it in 2004), with subsequent cohorts added annually until 2003.

In total, an average of 1,487 ewes per year were recorded over 4 years. In the traditional flock 843 ewes were recorded over 4 years (ranging from 905 ewes in 1999/2000 to 760 ewes in 2003/2004), giving a total of 3,377 records, and in the away-wintered flock, 643 ewes were recorded over 4 years (ranging from 743 ewes in 1999/2000 to 610 ewes in 2003/2004), resulting in 2,571 records.

Survival was calculated from individual ewe records between pre-mating (November) and weaning (August), with repeatedly missing sheep characterised as dead. The number of ewes that were known to have lost their tags was subtracted from the sheep characterised as dead.

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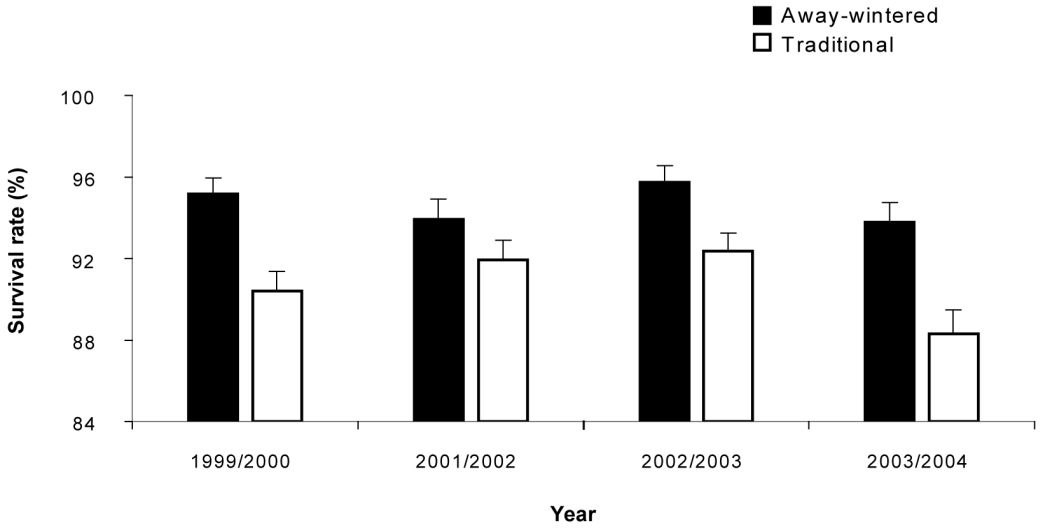
Figure 1



Raw annual ewe survival rate for traditional flock and away-wintered flock, unadjusted for effects.

Table 1 Total number of records in each flock and in each condition score (CS) category at pre-mating and mid-pregnancy scanning between 1999 and 2004.

	Traditional flock		Away-wintered flock	
	Pre-mating	**Mid-pregnancy**	**Pre-mating**	**Mid-pregnancy**
Total number of records in each CS category				
≤ 2	38	34	6	3
2.25	43	91	13	11
2.5	155	393	42	80
2.75	1,402	1,630	822	525
3	1,211	888	986	615
3.25	191	86	146	219
3.5	49	29	110	236
3.5–4	99	25	319	572
> 4	9	2	39	227
Total number of records	3,373		2,571	

Analysis was carried out using a statistical model to predict survival (Genstats® 8th edition, General Linear Models, with binomial distribution and logit link function; McCullagh & Nelder 1989). Weights and body condition scores at pre-mating (November) and mid-pregnancy scanning (February), flock (traditional or away-wintered), year, ewe age, scanning results (number of lambs carried in February) and mating group (mated to either Blackface or Texel) were tested for significance. Given the nature of our records, the same ewe could occur in the dataset in more than one year. However, since death can only occur once, each ewe × year combination was treated as independent in the analysis.

Forward step-wise regression was used to eliminate non-significant terms and generate a minimal model. The minimal model was subsequently used to predict survival rate. To make predictions, the parameter estimates were back-transformed using the following equation:

$$P = \frac{e^{(c + m_1x_1 + m_2x_2 + m_nx_n)}}{1 + e^{(c + m_1x_1 + m_2x_2 + m_nx_n)}}$$

where P is the probability of surviving, c is the intercept, m_1 is the slope of the first parameter, x_1 is the value of the first parameter, and so on.

Results

Figure 1 shows the annual ewe survival rates measured for the traditional flock and the away-wintered flock, with the traditional flock having significantly (P = 0.094) lower survival rates than the away-wintered one.

A comparison of the distribution of individual records between condition score categories in each flock from 1999 to 2004 is presented in Table 1. From this it can be seen that condition scores are generally higher in away-wintered individuals than the traditional flock ewes, both prior to and during pregnancy.

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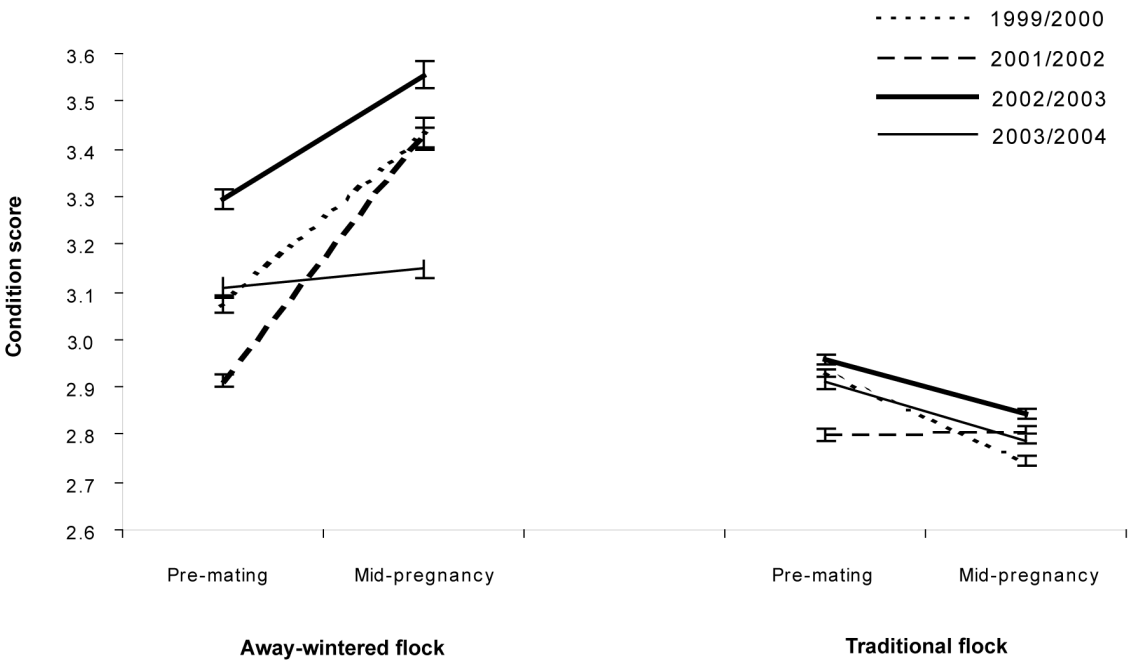
Figure 2



Mean body condition scores at pre-mating and mid-pregnancy scanning for each flock, between 1999 and 2004.

Table 2 Parameter estimates, standard errors and probabilities of significant variables in the minimal model of survival rate of ewes.

Parameter	Estimate	SE	*P*-value
Intercept	1.587	0.288	< 0.001
Age ≥ 5	–2.153	0.310	< 0.001
Flock–away wintered	0.377	0.146	< 0.01
Mid-pregnancy condition score category			
≤ 2	–0.396	0.462	ns
2.5	0.707	0.300	< 0.05
2.75	1.18	0.273	< 0.001
3	1.358	0.288	< 0.001
3.25	1.374	0.394	< 0.001
3.5	1.039	0.395	< 0.01
3.5–4	1.473	0.369	< 0.001
> 4	1.424	0.463	< 0.01

F statistic: $F_{15,5651}$ = 18.87; Significance: $P < 0.001$; Variance accounted for: 4.48%.

Figure 2 presents the raw means for body condition score at pre-mating and at mid-pregnancy for both flocks, in each year. In the away-wintered flock, with the period between pre-mating and mid-pregnancy being spent on lowland good quality pasture, the ewes experienced bodyweight improvement (not shown) and large increases in body condition score ($P = 0.045$), whilst in the traditional flock, the condition score tended to decline through pregnancy ($P = 0.042$).

The step-wise regression showed that the factors which significantly affected the likelihood of survival were: mid-pregnancy body condition scores (in general, higher scores were associated with increased survival rate; $P < 0.05$), flock (away-wintered flock having increased survival rate; $P < 0.01$) and age ($P < 0.001$), where ewes of 5 years and over were less likely to survive (Table 2). No other significant differences were identified between age groups and none of the other factors included in the model were significant. The regression model generated (Table 2) was used to predict survival probabilities of ewes at each mid-pregnancy body condition score category. These are shown in Figure 3.

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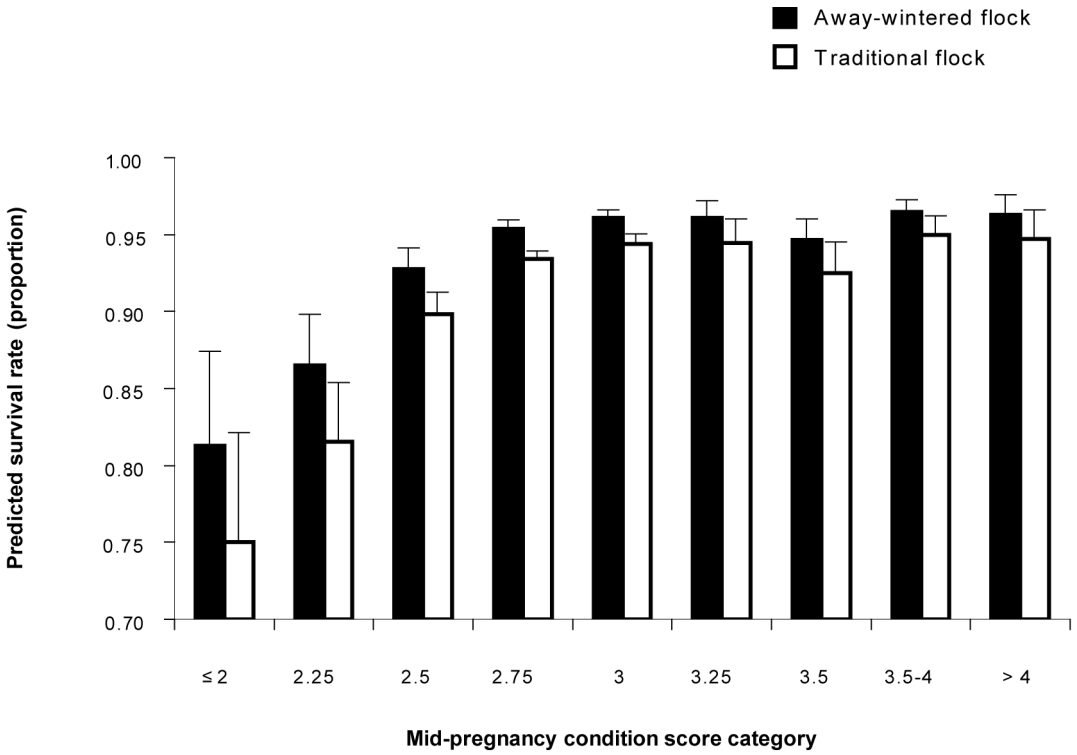
Figure 3



Predictions (estimated mean proportions) of ewe survival at different body condition scores at mid-pregnancy scanning, for each flock.

Discussion

Despite considerable variation in the management for the two flocks (through different winter nutrition), leading to great variation in the trajectories of bodyweight gain or loss and differences in body condition score changes throughout the annual cycle, the relationships between ewe survival and body condition at mid-pregnancy, as seen in Figure 3, are similar. Both flocks showed a broadly comparable risk of death from condition score 2.5 and above, and a greatly increasing risk of mortality at mid-pregnancy, as condition score decreased from 2.25.

However, the considerable variation in the flocks' management also led to differences in mortality and survival. Although differences were not always statistically significant, the away-wintered system had higher survival rates than the traditional hill system across the full range of condition scores. The resulting survival or death studied was after the period of away-wintering. So, the differences in survival rates between the two systems could be explained by residual impacts of the better away-wintering nutrition or by somewhat different management after the mid-pregnancy condition scoring, such as grazing conditions or other spatial factors linked to the environment. However, both systems involved multiple-bearing ewes being housed and fed in the same sheep-shed, whilst singles were supplemented and managed separately in each system.

Survival is notoriously difficult to model, due to the large number of unexpected environmental factors which can influence this trait. Despite testing a large number of factors in the model, the best model still only accounted for less than 5% of the variation in survival. However, mid-pregnancy score was the strongest predictor of survival, despite occuring before the periods of late pregnancy, lambing and early lactation, which are widely accepted to be periods of high risk (SEERAD 2002). The threshold condition score of 2.25 was in close agreement with the figure of condition score 2, for which the Defra guidelines recommends that "ewes which have a score of 2 at mid-pregnancy must have sufficient grazing or supplementary feeding to maintain condition for the remainder of the pregnancy" (Defra 2000).

Amongst the other individual parameters influencing survival, litter size (number of lambs carried at mid-pregnancy scanning) was found to be non-significant when the step-wise regression has included the stronger impacts of conditions scores, flock and age. While other studies have suggested higher risks in multiple carrying ewes (Kelly *et al* 1992; Azzarini *et al* 1998; Langford 2003), the results of this study suggest that differential management of sheep scanned as multiple, single and barren prevented any impact of lambing litter size on survival. Moreover, since the multiple-bearing ewes had higher mean condition scores at mid-pregnancy

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3.47 ± 0.02 than the single bearing ewes 2.96 ± 0.01, it might be expected that their survival would be higher. Age was a significant factor, with ewes greater than 5 years old at pre-mating showing the highest levels of mortality. This result confirms the effects seen in studies in Australia and Norway (Fogarty *et al* 1976; Warren & Mysterud 1995) and supports the current standard practice of drafting old hill ewes for breeding on lower land through transfer or sale.

These results raise the question of whether condition score was the cause of differences in survival or an effect of other factors which affected survival. Did low body condition lead directly to increased death or were the ewes affected by other health problems, with poor condition being one of the symptoms? This analysis cannot answer this question, especially given the high loss of extensive-grazing hill ewes, for which often no post mortem can be carried out because no carcasses are available. What it does demonstrate, though, is that high risk is associated with low body condition, especially from mid-pregnancy onwards. There were significant differences between the two flocks in their mid-pregnancy body condition scores (P = 0.028) and their ewe survival rates (95.1 and 91.8% for away-wintered and traditional, respectively; P = 0.034), with the former related to improved nutrition. This supports the view that improving nutrition and winter management will have a positive impact on body condition and thus reduce the risk of ewe mortality.

Overall survival and mortality rates in this study are within the range seen for benchmarking standards, with the SAC Farm Management Handbook (2006) quoting 8% mortality for Blackface in the North and North-West of Scotland. In this study, 8.2% mortality was found in the traditional flock, whereas this figure fell to 5% for the away-wintered flock, indicating significant welfare improvement. To see this percentage of ewes die, for whichever reasons, suggests a significant welfare problem for these sheep. Furthermore, given that the likely contributors of death are a range of chronic, infectious diseases and parasites (Kearney 1985; Mitchell 2005), it can be argued that many sheep will survive these challenges, but not without a cost to welfare. Thus, condition scoring and modified management at a flock or individual sheep level offers a significant role in improving ewe survival and, therefore, the welfare of sheep that both die and survive in extensive conditions.

Given that survival declines rapidly below condition score 2.75, the current advice (eg Defra 2000) of avoiding sheep in condition score 2, may be too low a standard for hill flock management. To have a higher proportion of flocks maintaining condition of individual sheep above a score of 2.5 would be more likely to improve welfare. Indeed, sheep between condition scores of 2 and 2.5 at mid-pregnancy may be at an increased risk of coming close to death (even if they eventually survive) and are, in effect, in a 'danger zone', which should not be considered as good welfare practice.

Animal welfare implications

This study confirms that there are considerable welfare issues related to hill flocks and that better winter nutritional management is a key component to good welfare and productivity. It also reinforces the message that body condition score is a good quantitative predictor of animal welfare and that poor mid-winter score indicates high risk of mortality, both at the flock and individual ewe level.

Conclusions

These results and predictions showed that mid-pregnancy body condition score is a very important animal welfare indicator, which can be used to predict subsequent ewe survival across a wide range of winter management, nutrition and body condition changes. Preventing ewes falling to lower scores, by culling or transferring out those with very low body condition in the autumn and by good nutrition in early and mid-pregnancy, is confirmed as sound advice.

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