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THE GRAZING ACTIVITY OF LUNDY PONIES ON LUNDY: THEIR POSSIBLE ROLE IN CONSERVATION AND MANAGEMENT

By

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ABSTRACT

The aim of this study was to investigate the time budgeting and grazing behaviour, proximity relations and zone usage of the herd of ponies on Lundy, in order to generate some baseline data. 18 Lundy ponies aged between 2 and 34 years of age were studied for 1075 equine hours, during September 2002. The main activities observed were Grazing (60%), Standing (24%), Lying (6.5%), Walking (4%) and Grooming (2.5%). Behaviours were interdependent and their occurrence fluctuated throughout the day. There was a significant difference in the occupation of zones ($P<0.001$). Zone occupancy also fluctuated during the day - for example there was an apparent transit zone only occupied for an hour mid morning. The relative occurrence of different behaviours varied between zones. The zones differed in vegetation present. There was a positive relationship between number of species present and the occupancy of a zone ($P<0.05$). It was clear that the herd operated as a single 'unit'. Activities were very similar in type, distances between two individuals remained around 1-2m and there were many associations. It was concluded that by simultaneously grazing with other herbivores (mainly the wild soay sheep) the Lundy ponies were contributing to the biodiversity and the conservation of species on the island habitat, rather than competing and being detrimental to the future of the habitat on the island.

Keywords: *Lundy, Lundy Pony, Time Budget, Grazing, Maintenance Behaviour Proximity Relations, Conservation.*

INTRODUCTION

Grazing animals (herbivores) have shaped nearly all of the grass-, heath- and moor land habitats in Great Britain over many hundreds of years (Putman *et al.,* 1987; Gordon, 1989a; Grazing Animal Project, 1999). Grazing livestock have influenced the ecology

of range land plant communities, ecosystem carbon and nutrient cycling and general heath land health (Agricultural Research Service of the United States Department of Agriculture, 2003) thus helping to maintain an ecological balance within these types of habitat. Grazing activity has led to greater levels of bio diversity - leading to an increase in the number of plant and animal species supported within the habitat (Gordon, 1989a). As the British Horse Society (BHS) (2001) states: "grazing animals have been used for a number of years as tools of conservation management on numerous sites throughout the UK in order to maintain the desirable ecological balance by controlling certain plant species so that other species are promoted".

Grazing activity must be carefully managed in order to achieve an appropriate balance between increasing biodiversity and habitat destruction. Grant and Armstrong (1993) found that heather loss was occurring due to over zealous grazing by sheep. However is not simply the case of removing a grazing species from a habitat, as this also potentially leads to a change in the constituent vegetation. It has been suggested that this could lead to loss of bio diversity (*e.g.* by dominant plant species becoming more abundant and inhibiting the survival of weaker plant species). The GAP Report (1999) even suggested that, eventually, woodland would regenerate and ultimately lead to a decrease in the number of species that the habitat could support.

It is essential to understand how the grazing species within an ecosystem make use of the resources within it, in terms of both conservation and agricultural management (Gordon, 1989b). The Grazing Animals Project (GAP) implemented in the late 1990s in the Rifle Ranges and Devils Spittleful Nature Reserves (SSSIs) investigated the extent to which grazing stock had been used (by means of surveys) and subsequently developed a management plan. One of the aims of GAP was to assist and advise individuals and organisations who were genuinely interested in improving a current grazing scheme or starting a new one. This was achieved by initiating a 'Grazing Forum Network'. The results indicated that 75% of SSSI (and similar) managers were uncertain about which stock to use (species, gender and age) whilst 58% were unsure about which time of the year the site should be grazed. In Worcester it was found that of the 79 sites that should have been grazed, a third of them were not. It was expected that this pattern was typical of other regions in GB.

Wild, feral and domestic species can be used in grazing conservation, in fact it is often preferable to utilise a combination of these in order to maximise potential of conservation success (GAP, 1999).

If herbivorous species are to be used as part of conservation (and agricultural) management then it is important to establish first, how much time these species typically spend grazing and second, what other activities they engage in. Although, time budgets have been published for domestic, agricultural livestock species (*e.g.* sheep, Arnold, 1984 and cattle, Randle, 1995), relatively few studies have specifically examined the time budgets of 'wild' grazing species. Kottmann *et al.* (1985) did however investigate

the impact of sheep grazing on heath land in order to evaluate their possible use in conservation.

Fraser (1992) considers grazing to be the 'chief occupation' of equines, not surprising since they are trickle feeders with enormous metabolic needs (Randle, 1994), reliant upon hind gut fermentation and in the wild spend up to 14hours per day eating (Duncan, 1980; Kiley-Worthington, 1987). Over the past two decades there have been a small number of studies of the grazing activity and associated behaviour of horses including Camargue Horses (*e.g.* Duncan, 1980) and Przewalski horses (*e.g.* Boyd, 1988a,b; 1998). 'Wild' or 'feral' equines typically spend approximately 50% of the (24h) day grazing (Kiley-Worthington, 1987 reported at least 57%; Boyd *et al.*, 1988 reported 46% for a herd of eight Przewalski horses kept at pasture during the summer; Boyd; 1998 reported 48% for a Takh, *Equus ferus przewalski*, stallion.)

The grazing activity *per se* of herbivorous species is subject to both seasonal (more time is spent grazing at the end than at the beginning of the season, Putman *et al.*, 1987) and circadian influences (the amount of time spent grazing decreases with decreasing day length) (see Linnane, *et al.*, 2001 on Kerry cows and Kiley-Worthington, 1987 on horses). Other influences include age (Kiley-Worthington, 1987), gender, reproductive status, the presence of habitat boundaries (Boyd, 1988b), climatic conditions (*e.g.* Fraser, 1992 reported that the amount of time spent grazing in the winter decreased due to cold and wet, and in the summer due to heat and the presence of flies) and individual differences (Kiley-Worthington, 1987; Marinier and Alexander, 1991). Marinier and Alexander (1991) demonstrated that horses differed in grazing ability and selection of species. Using observations based on the ability to choose (based on the first 3 bites) and sort (rejecting foodstuff if not liked or toxic/bitter) vegetation horses were categorised as 'efficient' , 'semi-efficient' or 'inefficient' grazers.

Other research based on productivity and feeding values of the vegetation grazed, foraging behaviour and diet selection, has indicated that the amount of time spent grazing per day may be a direct function of the attainment of a relatively constant nutritional requirement by the animal (*e.g.* Grant and Armstrong, 1993). It has also been suggested that the palatability of the vegetation is influential. (It is assumed that the more digestible species are concomitantly more palatable.) Studies by Armstrong, Common and Smith (1986), Hodgson, *et al.*, (1991) (both on sheep and cattle) and Archer (1973) on cross bred ponies and Thoroughbreds reported that the more palatable, highly digestible plant species were preferred. However, Kiley-Worthington (1987) reports that some animals actually choose and prefer less digestible herbage. Again it is important to take into account individual differences in horses preferences for vegetable species (Archer, 1973).

Three recent studies are very closely linked to the current study. Berkshire (1999) found that a herd of Dartmoor ponies moving through a series of identified zones within their habitat, spent 75% of their time grazing. Moreover, the preferred grazing

zones were those containing highly digestible vegetation and grasses with a high nutritional content (see Fraser, 1992). A longer term study conducted over two years between 2000 and 2001 by Freshney (2001) investigated the grazing behaviour of Dartmoor Ponies and considered their potential use as part of a conservation grazing scheme, alongside other grazing species, such as cattle and sheep. The forage selected by the ponies was monitored at four different study sites (two on open commons and two enclosed comprising *Rhos* pasture) over an entire year. The number of other grazing species present at the site was also recorded. Freshney (2001) demonstrated that the Dartmoor pony could be used in conservation grazing since it already had a positive impact on conservation partly due to the forage preference demonstrated (flowering plants which were attractive to species of butterfly were avoided). In addition non grazing behaviours exhibited by the ponies also promoted their use - such as damaging large areas of bracken by trampling through, and/or rolling in it. Heathershaw (2002) investigated the time budget and grazing behaviours, movements through identified zones and proximity relations of a small herd of 14 Exmoor ponies released onto the Quantocks for conservation purposes. Again the majority of the time budget was accounted for by grazing activity (over 75%). Closer inspection of the zones occupied most frequently revealed that these were the ones with the higher nutritional vegetation present (see also Hodgson *et al.*, 1991). Both of the studies by Berkshire (1999) and Heathershaw (2002) emphasised the importance of the proximity relations within the herd leading to the movement of the group as a single 'unit'.

Menard *et al.* (2002) consider equines to be a particularly good 'tool' for grazing management as they remove more vegetation per body unit than other grazing species and utilise the most productive plant species more effectively. They feed closer to the ground and maintain a mosaic of herbage lengths - thus promoting structural diversity and increasing the overall biodiversity of the habitat/ecosystem. It appears then, that ponies, especially indigenous native species, are suitable candidates for conservation grazing, spending approximately three quarters of their time grazing.

It is imperative that any individual animal to be used in a grazing conservation programme is selected carefully. The BHS Code of Practice for the Welfare of Horses, Ponies and Donkeys used for Conservation Grazing (2001) stresses the importance of using individuals with strong and correct conformation, especially of the jaw and teeth to permit proper grazing ability. At no time should individuals be placed under levels of nutritional stress that would necessitate them having to eat what is harmful to them. Clearly, thorough monitoring of all individuals should be undertaken in order to ensure good levels of health and welfare are being sustained.

When implementing a conservation grazing management programme it is important to take into account the unique nature of the vegetation present, the impact of the animals on the vegetation and the carrying capacity of the area to be grazed (Grant and Armstrong, 1993). There has been an argument that there is a need for some kind of conservation grazing on Lundy. Grant and Armstrong's (1993) recommendation that

the prescription of a single stocking rate is applicable to Lundy as it comprises a number of different areas both having different vegetation and supporting different species (wild, semi-feral and domesticated).

The study area described in this paper, Lundy, is an island just 1.5 miles long and half a mile wide (at its widest) situated in the Bristol Channel off the west coast of Britain. All of the waters surrounding the island form England's only statutory Marine Nature Reserve (MNR). The island itself is mostly granite with a farmed area to the South and open moor and heath land to the North. The island is protected by numerous environmental designations and the entire island is a designated SSSI (see www.lundy.org.uk). Lundy supports a number of different animal species, including domestic farmed sheep, wild soay sheep, goats, sika deer, rabbits and the herd of Lundy ponies.

Indigenous native ponies (*Equus caballus*) are present all over Great Britain. It is commonly believed that there are nine British native breeds (Auty, 2000), however it can be argued that there are in fact ten, if the Lundy pony is included. The Lundy breed originated on the island as a result of a deliberate breeding programme put in place to produce a hardy decent sized, pony. The founder individuals arrived on the island in August 1928 when the herd consisted of 34 mares and 8 foals (Symons, personal communication). The first stallion introduced at this time was a strawberry roan Welsh Mountain Pony who sired the first foals born on the island, but he did not survive his second winter (1929/1930). In order to maintain the breeding, one of the stallion colts that had been born on Lundy was kept entire and eventually became the herd stallion until around 1945. At this point he was retired to the northern end of the island with a few mares while the greater part of the herd was taken over by a new stallion. This relatively 'free breeding' over a period of 15 or so years resulted in a large number of ponies, and at the end of the 1940s there was a substantial reduction in pony numbers with over 40 being sold. In the mid 1960s the breeding policy changed and between 1967 and 1972 a Connemara stallion was used. He was then replaced by three consecutive New Forest stallions in the 1970s. Since 1980 ,seven different stallions have been used - the most recent being bred on the island. He was then removed from the island in 1999 (Symons, personal communication).

The aim of this study was to investigate the grazing behaviour, maintenance activities (time budgeting) and proximity relations of a herd of 18 Lundy ponies on Lundy. This was to first, provide some baseline data on their grazing and time budgeting activities, second, provide information on whether these ponies potentially competing with the other grazing animals of the island, namely sheep (both wild soay sheep and domesticated sheep), or if they were potentially contributing to the conservation of species and the biodiversity of the island habitat.

The objectives of the study were to examine the use of identified zones on the island by the ponies, to identify the main physical features and vegetation present in each

zone; to use information on their maintenance behaviours to construct a time budget - paying particular attention to grazing activity and to examine the proximity relations of the ponies within the herd to ascertain the extent to which the herd operates as a single grazing unit.

It should be noted that this study was of an investigative rather than experimental nature therefore there was no single hypothosis under investigation. Rather it was intended to obtain baseline data of use for further studies.

METHOD

a SUBJECTS

The herd comprised 18 Lundy ponies, ranging from 2 to 34 years of age. At the time of this study there was no stallion present on the island. There were 17 mares and 1 gelding (Lundy Albion). Each pony was given a code (derived from its full name) for recording purposes. Details of subjects can be found in Table 1. (Lundy Eliza can be seen in the coloured plates at the back of this Annual Report.)

PONY NAME	CODE	AGE (years)	COLOUR	DISTINGUISHING CHARACTERISTICS
Belinda	BE	34	Dun	Star, 3 white socks
Calloo	CA	28	Dark Dun	Star, no white feet
Stonechat	SX	21	Bay	Little white on left hind foot
Phonenix	PH	11	Cream Dun	3 white socks, left fore dark
Cirl Bunting	CB	9	Cream Dun	Stripe, 4 white socks
Red Kite	RK	8	Bay	Star and stripe, dark legs
Reed Warbler	RW	7	Cream Dun	Greyling, obese at time of study
Lerina	LE	7	Dark Brown	Mealy nose
Jilly	JI	5	Bay	Star, small white hind socks
Jenny	JE	5	Dun	Blaze, wall eye
Iona	IO	4	Bay	Large blaze, white hind socks
Annie	AN	4	Cream Dun	3 white socks, dark right fore
Eliza	EL	2	Dun	Star, no white on legs
Charlotte-Louise	CL	3	Bay	4 white socks
Hannah	HA	3	Dun	Star, 3 white socks
Eclipse	EC	3	Cremello	Distinct body colour, pink skin
Francis Anne	FA	2	Bay	Blaze, white hind socks
Albion (gelding).	AL	3	Cream Dun	Very pink nose

Table 1: Individual subject details

b STUDY AREA

For the purposes of this study the island was divided into 6 zones as illustrated in Figure 1. These were defined by physical boundaries such as walls.

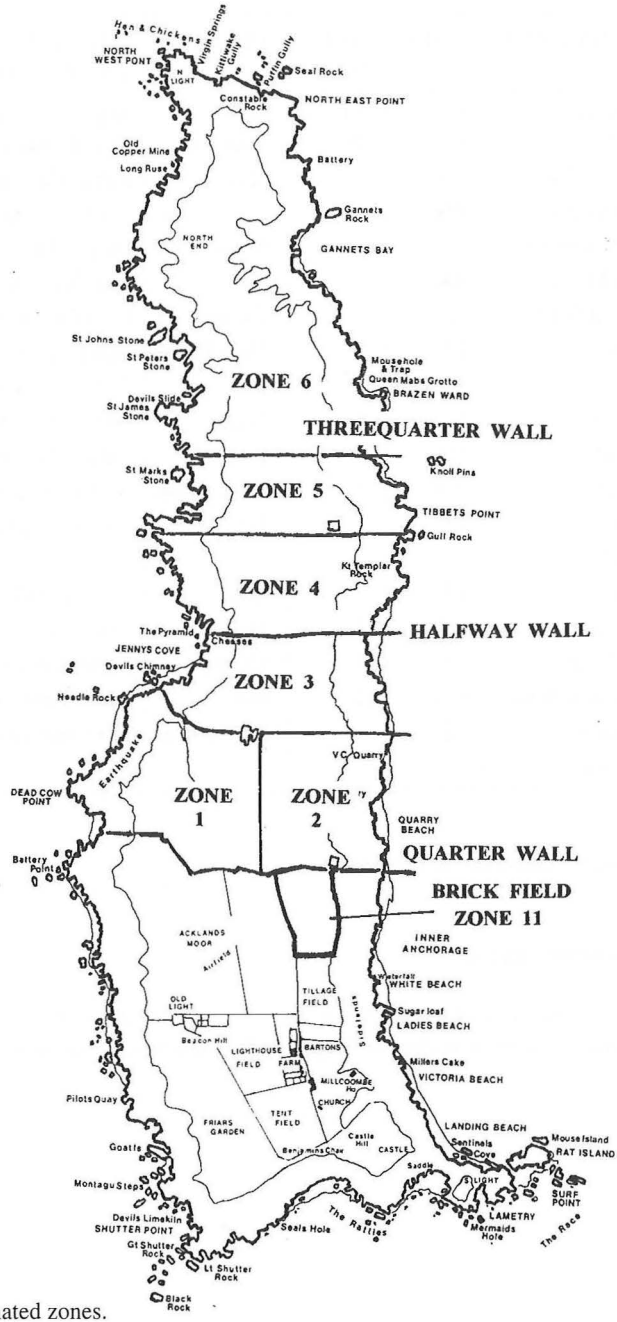


Figure 1: Designated zones.

Initially there were six designated zones. However as the study progressed the herd were given access to one of the fenced fields (Brick Field) usually reserved for the farmed sheep - this area was labelled zone 11 for recording purposes (see Figure 1). The physical and geographical characteristics of each zone are described in Table 2.

ZONE	CHARACTERISTICS
1	On east side of island. Contains scrub, heather areas and bracken areas with clear grass areas. Large pond which ponies often drink from.
2	Very similar to zone 1 but does not have water available. Larger areas of bracken and heather than in zone 1. On the west coast of the island and during the study was slightly more sheltered than zone 1.
3	North of zones 1 and 2 and extends up to Halfway Wall as northerly boundary. Has more bracken than zones 1 and 2, which is partially managed (cutting and rolling) to limit its occurrence. Extends from west to east Coast.
4	Area above Halfway wall to a line level with Tibbets, extending from West to east Coast). Contains a larger area of grassland than zones 1, 2 and 3, although the bracken and heather is more abundant on the west coast. Halfway Wall is southerly boundary. A three sided ruin projects from Halfway Wall affording shelter from the weather in all directions. Drinking water available.
5	Area about Tibbets to Threequarter wall, extending from west to east Coast. (Threequarter Wall is northerly boundary). Very similar vegetation to zone 4, however more bracken - most of which has been rolled.
6	Area above Threequarter Wall. Largely rocky, with less grass present. Bracken abundant on East Coast. (Ponies were not allowed access to zone 6 during this study)
11	Brick Field - fenced field usually used for the domestic sheep. Immediately south of Quarterwall on east side of the track running from south-north up the island.

Table 2: Physical and geographical characteristics of zones.

c LUNDY PONY MANAGEMENT

The ponies are usually given full access to most of the island from Quarter Wall through to the North End of the island throughout the summer and winter seasons. They receive no supplementation during the summer season. During the winter their grazing is supplemented with hay. Because of her age (34) the oldest mare, Belinda is brought into a sheltered area with another individual for company. After being halter trained and handled to small extent as foals (for management purposes), the ponies are subject to minimal handling. Their feet are trimmed twice a year and they are also wormed twice a year. They are observed for injury and checked daily for health and welfare purposes (BHS, 2001). They are however accustomed to humans being in close vicinity owing to the large number of visitors to the island.

d OBSERVATIONAL METHODS

A scan sampling method was used in which all of the individuals in the herd were observed in the set order (listed in Table 1) every 15 minutes (Altmann, 1974; Martin and Bateson, 1986). Observations were made between 5th and 19th September 2002. Recording took place in the morning (AM) between 8.00 and 11.45 and then again in the afternoon (PM) between 15.00 to 18.45. The weather (general conditions, wind and temperature) was noted for each observation session. At each recording point, *i.e.* for each individual pony, the following information was recorded onto a pre constructed check sheet: maintenance behaviour engaging in, zone occupied (1-6 or 11) and proximity relations.

The ethogram for Lundy Pony maintenance activities is in Table 3, along with codes used for recording.

MAINTENANCE BEHAVIOUR	CODE	DEFINITION
Standing	ST	Stationary, not eating, may be resting a hind leg
Grazing	GR	Eating selected vegetation, including browsing (eating non grass items)
Drinking	DR	Consuming water
Grooming (self)	GRO	Grooming self (either with teeth or feet) or rubbing on an object
Grooming other	GROS	Two individuals mutually groom
Social interaction	SI	Two or more individuals engage in a social interaction
Elimination	EL	Defecation or urination
Walking	WA	Moving at a walking pace - for at least 4 strides

Trotting	TR	Moving at a trotting pace - 2 time beat
Cantering	CA	Moving at a canter pace - faster pace with 3 time beat
Object Directed	OB	Behaviour directed towards inanimate object
Human directed	HU	Behaviour directed towards human
Standing dozing	STDZ	Standing whilst resting or sleeping
Suckling	SU	Infant suckling from dam
Lying	LY	Lying down while propped on sternum
Lying out flat	FYFO	Laying prostrate, flat on one side, including neck and head
Rolling	RO	Lying down and rolling on back momnetarily, often from side to side.

Table 3: Maintenance activity ethogram.

For each focal animal the following Proximity data were recorded: the identity (pony name code) of the nearest neighbour and the distance of the nearest neighbour. For this distances were judged by eye (having practiced) and categorised according to Table 4.

CODE	DISTANCE
1	touching
2	0 - 1 m
3	1 - 2 m
4	1 - 2 m
5	5 - 10 m
6	10 - 20 m
7	20 - 30 m
8	30 - 50 m
9	50 - 100 m
10	> 100 m

Table 4: Nearest Neighbour (NN) distances and codes.

e ZONE VEGETATION IDENTIFICATION

Vegetation samples were taken from each zone using 5 independent random samples from transects measuring 1m x 1m. The vegetation species were subsequently confirmed by the plant ecologist Dr E. Williams.

f STATISTICAL ANALYSIS

The data were analysed using the Minitab (v13) statistics package. Exploratory Descriptive Data Analysis was conducted. A one way Analysis of Variance (ANOVA) was used to assess occupancy of zones and a Factorial ANOVA was carried out to investigate the occurrence of different types of behaviour within the different zones. Chi-squared tests were used to investigate associations between zone occupation and time of day.

RESULTS

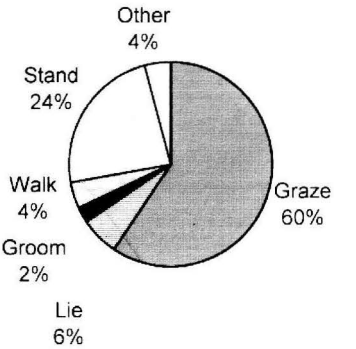
The entire herd of Lundy ponies was observed for a total of 60 human hours which represented 1075 equine hours. There were 4302 observations in all, 239 each of maintenance, proximity relations and zone usage per pony.

During the study the weather conditions were consistently warm (temperatures typical of September) with only occasional low to moderate winds and very little rainfall.

a TIMEBUDGETS AND GRAZING ACTIVITY

1 Timebudgets

The frequencies and percentages of time spent engaging in each of the behaviours listed in the ethogram were calculated. Of all of the behaviours listed in the ethogram (Table 2) only 5 accounted for more than 2% of the total behaviours observed (Grazing 59.4%; Grooming self 2.5%; Lying 6.5%; Standing 23.7% and Walking 4.0%). Figure 2 illustrates the most predominant behaviours. Behaviours representing 2% or less were combined into the 'other' category, which accounted for 4.2% of the overall activity.



Based on 239 observations per pony over 60 human hours.

Figure 2: Timebudget of maintenance activity

2 Daily patterns

The occurrence of the five most frequent maintenance behaviours during the observation periods were plotted (Figure 3) in order to uncover any patterns throughout the day.

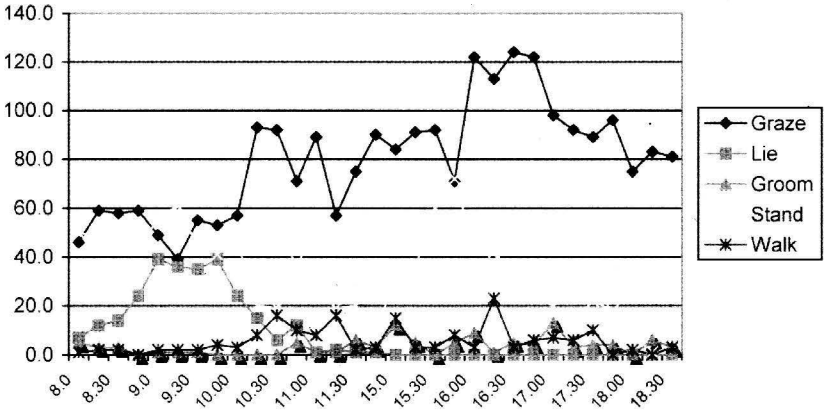


Figure 3: Maintenance activity patterns.

b ZONES

(Note. Zone 6 was not occupied at all owing to restricted access, therefore not included in analysis.)

1 Zone occupation

A One way ANOVA conducted to compare the relative occupancies of the six different zones indicated that there was a significant difference ($F_{5,107}$=14370; P<0.0001) as illustrated by Figure 4.

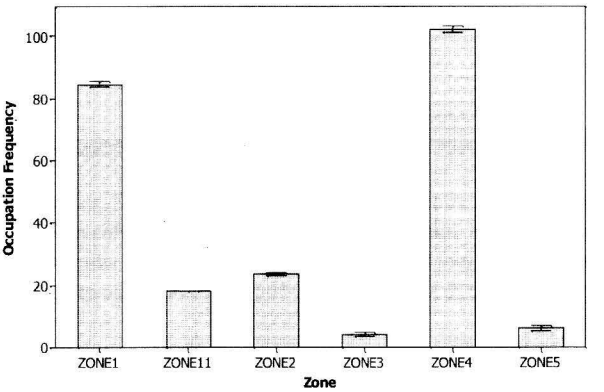


Figure 4: Interval plot of zone occupancy.

It is worth noting that there was very little variability between members of the herd (*i.e.* within the herd) regarding zone occupancy. A series of Tukeys tests demonstrated that there were significant differences in the frequency of occupancy between almost all pairs of zones ($P<0.001$) with the exception of zones 3 and 5 which were still significant however, at $P<0.01$.

2 The relationship between zones and behaviour

The occurrence of the five most abundant maintenance behaviours was investigated. Figure 5 illustrates the total amount of maintenance activity recorded in each zone, whilst Figure 6 shows the relative amounts (%) of each of the five main activities (grazing, grooming, walking, standing and lying) and the remaining activities (collectively referred to as 'other').

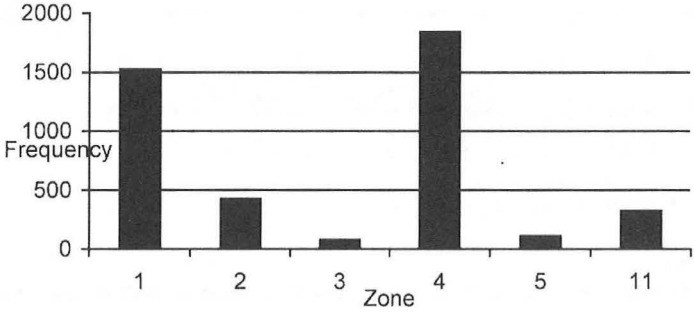


Figure 5: Total maintenance activity occurring in each zone.

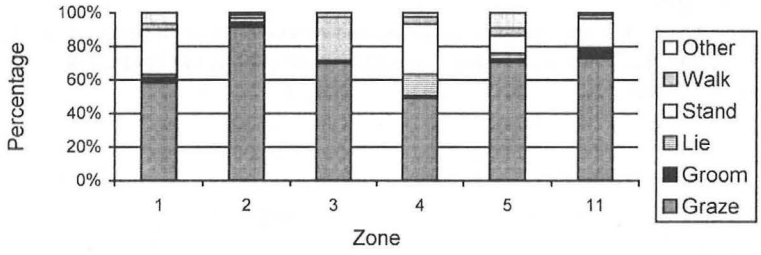
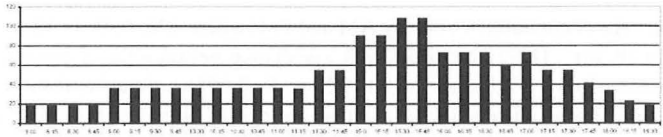


Figure 6: Occurrence of maintenance activities occurring within each zone.

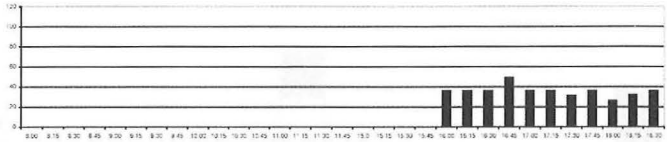
There was a significant association between activity and zone ($Chi\text{-}Squared_{25} = 657.167$; $P<0.0001$). Inspection of the Standardised Residuals indicate that this may be attributed to/caused by two 'factors': most of the lying activity occurring when in zone 4 and very little in both zones 2 and 3, and, a lot of grazing and a concomitantly small amount of standing in zone 2.

3 Occupation of zone by time of day

The occupation of zones during the observation periods was also examined (Figure 7).



Zone 1



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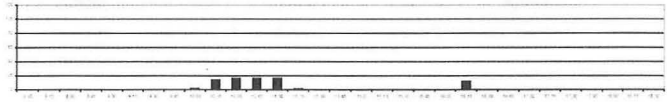

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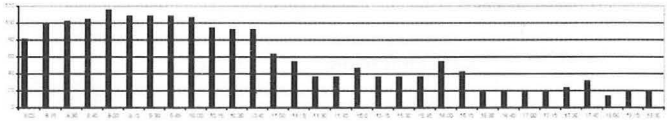
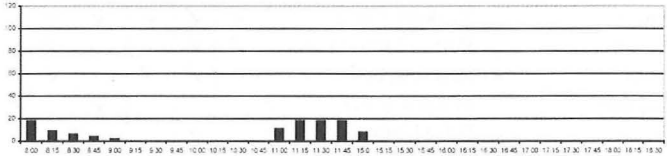
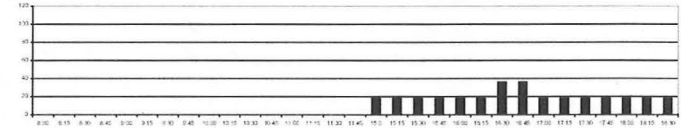


Zone 4



Zone 5



Zone 11

Note. The y axis is frequency (0-120) and x axis is time of day (0800 to 1845)
Figure 7: Occurrence (frequency) of ponies in each zone by time of day.

Figure 8 shows the occupation of zone by AM and PM (where AM; 0800 to 11.45 and PM; 15.00 to 18.30). There is a significant association between the occupation of zones and time of day (Chi-squared$_5$=1492.46; P<0.001). Examination of the Standardised Residuals indicated the association was caused largely by the occupation of zone 4 during the AM period and zone 2 during the PM period.

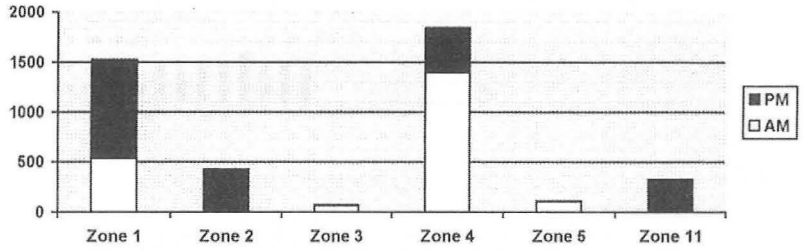


Figure 8: Occupation of zone by AM and PM

4 Vegetation within each zone

The grass species present in each zone are listed in Table 5.

Species	Common name	Zone					
		1	2	3	4	5	11
Potentilla erecta	Tormentil	✓		✓	✓	✓	
Anthoxanthum odoratum	Sweet Vernal	✓					
Deschampsia flexuosa	Wavy Hair Grass	✓	✓	✓	✓	✓	
Holcus lanatus	Yorkshire Fog	✓	✓	✓	✓	✓	
Molinia caerulea	Purple Moor Grass	✓	✓			✓	
Festuca rubra	Red Fescue		✓	✓		✓	
Trifulium repens	White Clover				✓		
Erica cinerea	Bill Heather		✓				
Caluna vulgaris	Heather				✓		
	Bedstraw				✓		
	Moss	✓	✓	✓	✓		
	Sedge	✓	✓				
Pteridum aquilinum	Bracken	✓	✓	✓	✓	✓	
	Rye						✓
Total no of species present		8	7	5	8	5	1

✓ indicates species present

Table 5: Vegetation present in each zone.

There was a significant relationship between the number of vegetation species present in each zone and occupancy as shown by Pearson's Product Moment Correlation Coefficient (r_3=0.911; P<0.05) and a regression analysis: Zone Occupancy = -2487 + 497(no. of species) (P<0.05). This is illustrated in Figure 9. Note that the data from Zone 11 were excluded from the analysis as this was not available to them throughout the entire study.

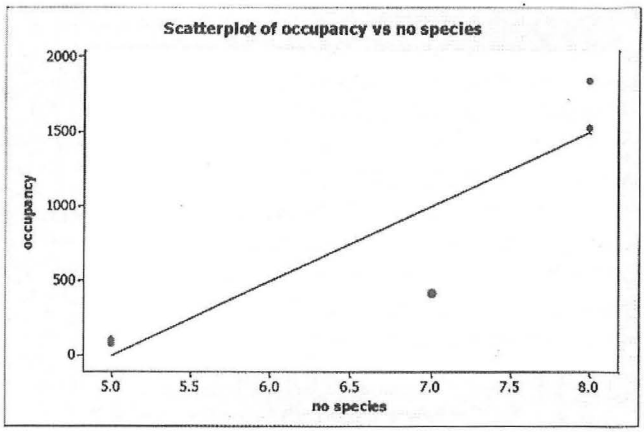


Figure 9. Relationship between zone occupancy and number of vegetation species present.

c PROXIMITY

The Proximity distance was recorded in code form (see Table 3). Distances were normally distributed (Anderson-Darling Normality Test, P<0.005). The median distance code representing the average distance maintained between any two individuals was 3 (*ie*. between 1 and 2m). Distances between nearest neighbours ranged from a minimum of 1 (touching) to a maximum of 7 (*ie* between 20 and 30m).

The popularity of each individual was derived from the number of times that it occurred as another pony's nearest neighbour (Figure 10).

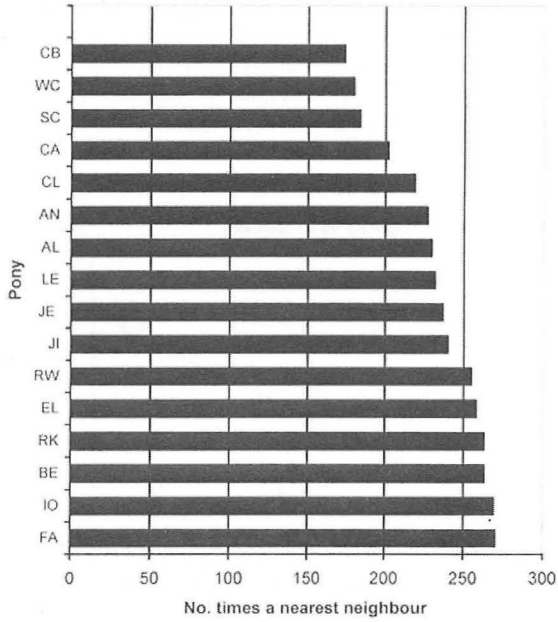


Figure 10: Pony popularity

The proximity data were explored further in order to identify any associations between 2 or more individuals (Table 6).

		NEAREST NEIGHBOUR (NN)																		Average distance (code) no NN
		AL	AN	BE	CA	CB	CL	EC	EL	FA	HA	IO	JE	JI	LE	PH	RK	RW	DC	
FOCAL PONY	AL	0	16	17	7	6	12	17	6	13	23	16	14	12	8	46	6	10	9	3
	AN	15	0	8	11	7	12	4	21	5	29	23	10	23	23	9	11	14	11	3
	BE	17	9	0	**40**	2	9	18	9	7	7	12	3	6	21	51	9	5	12	3
	CA	12	15	**51**	0	16	3	13	6	5	2	15	16	6	9	18	12	12	25	4
	CB	16	8	13	16	0	7	3	13	14	10	23	8	16	16	22	24	27	2	4
	CL	7	17	10	6	9	0	11	12	27	18	45	12	12	9	5	11	24	1	3
	EC	22	4	29	16	15	13	0	13	25	12	12	19	9	14	9	9	8	6	4
	EL	9	17	7	5	8	9	14	0	4	**69**	12	6	5	7	6	3	3	53	3
	FA	8	3	7	2	6	16	19	2	0	8	16	6	14	1	9	**105**	6	4	3
	HA	13	24	5	2	10	16	17	**74**	9	0	10	8	11	4	5	2	4	22	3
	IO	18	13	20	11	15	37	11	15	16	10	0	8	10	8	14	19	9	4	3
	JE	19	12	2	13	8	19	12	4	5	14	10	0	43	15	10	9	**46**	3	3
	JI	9	16	8	4	14	11	11	6	12	13	11	43	0	20	17	10	22	9	3
	LE	18	21	13	9	9	13	5	4	3	10	10	19	26	0	24	8	40	5	3
	PH	27	15	41	17	11	6	7	4	6	10	15	10	18	20	0	9	9	9	3
	RK	5	5	10	11	18	13	9	3	**109**	9	14	5	3	4	9	0	6	6	4
	RW	8	20	7	10	13	23	4	1	5	6	15	**44**	16	42	11	9	0	3	3
	SC	7	11	15	22	6	8	5	65	5	27	10	5	9	11	15	7	10	0	4
	All	**230**	**227**	**263**	**201**	**174**	**218**	**180**	**258**	**270**	**277**	**269**	**237**	**240**	**232**	**283**	**263**	**255**	**184**	**Overall median=3**

Grey shaded figures indicate association

Table 6. Associations between individual ponies

DISCUSSION

a TIMEBUDGETS AND GRAZING ACTIVITY

A large proportion (60%) of the ponies time was spent grazing, with a further 24% grazing. The remainder of activity comprised mainly walking, lying (resting) and grooming (Figure 2). A further 4% of their time was spent engaging in 'other' behaviour/s. Although apparently 'less common' this category includes social behaviour and object directed activities and other relatively infrequent activities such as urinating and defecating which were probably under estimated due to the recording method used. However it should be remembered that these are as important as the other more abundant behaviours. The proportions of behaviours (notably grazing, resting - standing and lying, and walking) were similar to those reported on similar herds of 'wild' ponies in other studies conducted at a similar time of the year - i.e. towards the end of the normal grazing season. For example, Duncan (1980) reported that Camargue ponies spent 57% of their time grazing whilst Menard *et al.* (2002) reported 65%. Similar figures were reported for Przewalski horses by Poplow (1984) - 55% and Griffiths (1985) - 65%. It should be noted that lower figures are presented in studies where the equine herd is subject to manipulative husbandry (such as where their grazing area is smaller and perhaps access restricted to certain times of the day; Kiley-Worthington, 1987). For example Crowell-Davis (1994) reported that a herd of Welsh Mountain Pony mares were only observed to graze for 32.5% of their time.

The behaviours exhibited by the ponies in this study clearly followed a distinct 'daily pattern' (Figure 3). The occurrence of the five most common behaviours observed (grazing, standing, lying, walking and grooming) were interdependent. Grazing and walking showed very similar peaks (around mid morning and late afternoon). This observation is not surprising as grazing ponies typically only eat 2 mouthfuls of vegetation before moving forwards (Marinier and Alexander, 1991). The relatively high level of grazing (and consequently walking) observed during the observation period is not surprising given that observations were confined to daylight hours (Crowell-Davis, 1994) and also the fact that equines are known to need to eat for up to 14 hours per day (Kiley-Worthington, 1987). Standing activity peaked at 9.30am and again around 4pm, and not surprisingly coincided with troughs in grazing activity. Unlike many ungulates, equines have a structural adaptation allowing their legs to lock and not require physical effort to remain upright: as a result they can 'sleep' whilst standing. Very little lying activity was observed - and when it was, it was as a group (with just one or may be 2 individuals remaining standing positioned at the perimeter of the group). The less common grooming activity peaked in periods of low grazing activity.

b ZONE OCCUPATION

The most frequently occupied zones on the island were 1 (with a large pond) and 4 (with a ruin affording shelter and natural drinking water available.) (For a full description

see Table 2). Zone 11 (Brick Field) was occupied for some of the time - however since this area was not normally available to the ponies was attributed largely to 'novelty value'. Zone 2 was marginally more frequently occupied than either of zones 3 and 5 which were the only two zones to be occupied to a similarly small extent (P>0.05).

The error bars displayed in Figure 4 indicate that there is very little variation between ponies in their occupation of the different zones - suggesting that the ponies are tending to move around the island as a group, in other words as a single 'unit'. This phenomenon is not surprising given the highly sociable nature of equines and the influences that individuals have on each other, especially where the herd comprises mother-young dyads (Boyd, 1988a; Crowell-Davis, 1994; Weeks *et al.*, 2000). Further evidence of the herd behaving as a single unit is provided by average distance between any two individuals at a time being only 1 to 2m. All individuals were frequently the nearest neighbours of others, with some individuals being more popular (*e.g.* FA, Francis Anne) than others (*e.g.* CB, Cirl Bunting). More detailed examination of the proximity relations between individuals revealed a number of significant associations, in particular between similarly aged individuals (*e.g.* between CA, Calloo and BE, Belinda and between HA, Hannah and EL, Eliza) (Table 6).

1 Zone and behaviour

It would be logical to argue that occupation of zones may be related to the existence of physical features of the area - for example, walls and ruins for shelter and water for drinking, and of course vegetation available for eating. Indeed, in this study, different total amounts of activity (logically reflecting total amount of time in occupation) occurred in the different zones (Figure 5). Furthermore, within each zone different types of behaviour were exhibited (Figure 6). In all zones the predominant activity was grazing, almost to the exclusion of all else, accounting for at least 75% of the activity within zones 2 and slightly less, in zones 5 and 11. Zones 2 and 5 both contained areas of bracken which had been rolled and 'managed'. Zone 2 included the quarries whereas zone 5 included a part of the west coast of the island, which during the study afforded more shelter. Zone 11 was essentially a farmed, agricultural field - and a 'novelty' to the ponies therefore it is not surprising that they spent most of their time in there eating grass. Significantly more standing activity was recorded in zones 1 and 4 than in any of the other zones. Zone 4 contained a 3 sided ruin projecting from halfway wall which afforded the ponies shelter from all directions. Lying behaviour appeared to be confined largely to Zone 4, which again may be related to the presence of shelter. Like zone 1 it is also an area where the ponies spent the majority of their time (Figure 5). In addition the two natural drinking water sources were located in these two zones. The ponies spent very little of their time in Zone 3, which was immediately to the south of HalfwayWall. Moreover, Zone 3 appears to be a 'transit' zone as most of the walking activity exhibited by the ponies occurred through zone 3. Observations of standing, resting or grazing were very rare in Zone 3.

2 Zone and vegetation

Most areas of heath and moorland contain a mosaic of vegetation types, which differ in their dry matter production, feeding value and attractiveness to grazing herbivores. (Grant and Armstrong, 1993). Lundy is by no means different. Many grazing species are present and the Lundy ponies like other equids display seasonality in their grazing. This study was conducted in the Autumn, a time noted for a greater variety in choice made (Gordon, 1989b) due largely to declining food quality (Putman *et al.*, 1987; Hodgson *et al.*, 1991).

Fourteen different types of vegetation were distributed over the area occupied by the ponies during this study (Table 4). The zones differed in composition, *e.g.* zones 1 and 4 comprised a greater variety of species than zones 3 and 5. Some species, namely Bracken (*Pteridum aquilinum*), Wavy Hair Grass (*Deschampsia flexuosa*) and Yorkshire Fog (*Holcus lanatus*) were present in all zones. Red Fescue (*Festuca rubra)* occurred in all apart from zone 1. Purple Moor Grass (*Molinia caerulea*) was present in zones 1, 2 and 5 but not 3 or 4. Tormentil (*Potentilla erecta*) was present in all zones apart from Zone 2. White clover (*Trifolium repens*) was only found in zone 4, whilst Sweet Vernal (*Anthoxanthum odoratum*) was only present in zone 1. Zone 11 was very different in composition as it was improved pasture comprising mainly of rye grass.

Zone occupancy appeared to be related to the number of species present - the diversity ($P<0.05$) and furthermore, could possibly be predicted from it ($P<0.05$). The most frequently occupied zones (1 and 4 - see Figure 5) were the most diverse. Zone 2 was slightly less diverse and occupied significantly less often than 1 or 4. Zones 3 and 5 contained only just over half the vegetation species present in zones 1 and 4 and were significantly less occupied than all of the other zones.

In relating zone occupancy to its component vegetation it is interesting to note that Red Fescue demonstrated to be non palatable to equines by Archer (1973) was absent from the two most commonly occupied zones (1 and 4). Moreover zone 4 was the only zone in which the highly palatable (Archer, 1973) and preferred (Fraser, 1992). White Clover (*Trifolium repens*) was present.

Heather was only present in zones 2 and 4. It did not appear to be a preferred feedstuff for the ponies. This is in line with the findings reported by Putman *et al.* (1987) that New Forest ponies used in conservation grazing consumed heather towards the end of the grazing season, and Freshney (2001) who discovered that Dartmoor ponies avoid heather even when little other forage was available.

Purple Moor Grass (*Molinia caerulea*) was found to be a preferred forage for New Forest ponies (Putman *et al.*, 1987) and Dartmoor ponies (Freshney, 2001) and indeed Lundy ponies. This was present in zones 1 and 5 and selected and consumed by the Lundy ponies. It is interesting to note that Sweet Vernal (*Anthoxanthum odoratum*)

was relatively rate only occurring in zone 1 as it is usually invasive and known to be resistant to wind, weather and grazing (Williams, personal communication), but not trampling.

c CONSERVATION OR COMPETITION?

Large grazing herbivores have an impact on the structure and functioning of upland ecosystems supporting particular flora and fauna. Different herbivores display different grazing ecologies when sharing a grazing area (Gordon, 1989 a,b,c). Equines are known to be good generalist herbivores which happily coexist with others (Menard *et al.*, 2002). It is beneficial to operate a mixed species grazing 'strategy' (Menard *et al.*, 2002), with one of the best combinations being the equine (*Equus sp.*) and the sheep (*Ovus sp.*). The different species exhibit different preferences: equines prefer 'grassy' substrates, whereas sheep will consume more 'woody'/' shrubby' substrates (Gordon, 1989b; Hodgson *et al.*, 1991). In addition equines and sheep reduce the sward to different heights. The short sward heights may help to promote invertebrate conservation (Freshney, 2001).

One of the potential problems of grazing an area solely with horses is that they refuse to eat from the pasture where their dung is present. This rapidly results in the production of lawns (overgrazed areas) and patches (areas which remain untouched),and consequently a much reduced grazing capacity. Sheep however will eat from these patches, returning the pasture to full capacity and also help to reduce the worm burden of the habitat as they will 'mop' up the equine worms. This worming consideration is important on Lundy especially as the herd is only wormed twice a year. Sheep are also useful for 'repairing' areas poached by horses hooves. The horses also increase the biodiversity of the islands habitats through their non grazing activities such as walking through the bracken and rolling in it.

CONCLUSIONS

This study provides baseline data on time budgeting and grazing activities of the herd of Lundy ponies. The ponies tend to behave as a single unit, moving together through the different zones identified for the purposes of this study. It can be argued that the Lundy ponies play an very important role on the island. The ponies are not competing with the other herbivores present on the island, the grazing habits of the ponies and sheep complement each other and together are probably contributing to the conservation of species through increasing the biodiversity of the island habitat. Ideally it would be possible to assess the grazing habits of the soays but given their shy nature this would be very difficult to achieve. In summary, the ponies play an important role in island ecology.

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