

Grazing assessor's report on status of cattle grazing and associated habitat monitoring across Epping Forest



Red poll cattle, fitted with *Boviguard*/ GPS collar, grazing amongst willow and marsh thistle at Fairmead, Epping Forest (© P. Dennis)

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28 October 2014

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1. Introduction

This is the third report by the Independent Grazing Assessor for the Conservators of Epping Forest. This follows a further visit to Epping Forest, 18-21 August 2014, evaluation of the final draft of the data review of the Epping Forest vegetation monitoring (Bealey, 2013) and new information, namely mapped survey data of *Dactylorhiza maculata* (Heath spotted orchid) at Sunshine Plain, the Epping Forest grazing expansion plan and the Trueloves restoration work plan 2014 onwards. Much of the report reflects upon a verbal progress report on the implementation of the Grazing Strategy by the Head of Conservation and key questions of concern related to the continued reintroduction of cattle grazing across the fenced jigsaw areas (management compartments).

The purpose of this report is to comment upon the current status of the reintroduction of cattle to recently ungrazed parts of Epping Forest and to evaluate the suitability of the monitoring programme, established to detect ecological change, in particular plant and animal responses to grazing management; ultimately to inform decisions on suitable timing

and stocking densities of cattle throughout the Forest. This year Jeremy Dagley, the Head of Conservation highlighted several topics which required specific attention:

- To consider the consequence of late grazing which has also been confined to areas of the Forest where cattle could be effectively enclosed since the invisible fencing has not yet been installed around the proposed jigsaw grazing areas defined in the Grazing Strategy (2008) due to further technical challenges.
- Estimate appropriate stocking densities for the forthcoming invisible fenced areas and take into account differences in the size of the Red poll and English longhorn breeds. The grazing expansion plan detailed the anticipated cattle numbers per year which can be distributed across the grazing compartments, once the invisible fencing loops are installed.
- To consider possible methods to facilitate targeted grazing/browsing across Epping Forest, e.g., use of tree fodder or further crown reduction and pollarding in 'halos' within the wood pasture to investigate if cattle could be enticed into shadier wood-pasture areas.
- Cattle were herded onto the *Pedicularis sylvatica* L., Lousewort area of Almhouse Plain to graze for several days in June 2014 (targeted grazing) and an apparent impact has been the observed consumption of lousewort seed-heads and occasional plants. The extent of this foraging behaviour and likely consequences will be discussed.
- To evaluate the survey data and site condition for the scarce species, *Silau silaus* (L.), Pepper saxifrage (census September 2013) and *D. maculata*, Heath spotted orchid (census June 2014). The former species at Yate's Meadow has yet to experience cattle grazing whilst the latter species has persisted throughout 20 years of grazing. Further consideration will be given to the likely effects of the imminent implementation of the grazing strategy.
- Suggestions for priority areas suitable for targeted grazing, either within the jigsaw areas defined by the invisible fence, once installed, or through the use of discrete circuits of temporary electric fencing and the perceived benefits to be gained for vegetation management and maintenance of target species and communities.
- Review of an update of the vegetation survey data recorded by Clive Bealey, the ecological consultant commissioned to repeat surveys along the strategically placed vegetation transects.

2. Progress towards the expansion of grazing

The consequences of the delay in completion of the invisible fencing combined with the current, relatively small number of cattle in the English longhorn and Red poll herds has been the restricted extent of cattle grazing across Epping Forest during 2014. In addition, the onset of grazing was also delayed and the consequences of these factors are considered in this section of the report.

a. Enclosure with invisible fencing

At the time of the visit, installation of the invisible fencing had been further delayed due to technical difficulties related to limits on the transmission distances of the Boviguard system and interference experienced when the fencing was buried in close proximity to existing fence lines. A new jigsaw configuration of invisible fencing had been designed with smaller compartment sizes positioned away from existing fence lines. The longest of the new loops is about 3.5 km, designed to fall below the recognised 4 km limit for the signal generators from the Lacmé company. Maps of the new jigsaw arrangement for the invisible fencing were received, 9 October and appear entirely reasonable. Actually, the smaller areas but larger number of compartments adds greater flexibility over the timing and duration of grazing management that can be exerted on the various habitats across Epping Forest throughout each grazing season. Progress was reported on the installation of the invisible fence lines at Chingford by 9 October with the expectation that nine new loops would be added to the existing loop that already encloses four hectares of Deershelter Plain heath (installed in 2011), by the end of November 2014. The effectiveness of these fenced compartments will be assessed during next year's site visit.

b. Build-up of the cattle herd for grazing

The Epping Forest grazing expansion plan (Epping Forest and Commons Committee, 2013) sets out a reasonable strategy for the build-up of cattle numbers for introduction to the grazing compartments as they are established by installation of the invisible fence lines. From the current 40 x breeding cows, a bull and 20 x < 2 year old Red poll and 20 x breeding cows, a bull and 20 x < 2 year old Longhorn cattle, it is anticipated that by next year and with a successful calving season, 37 calves of Red Poll and 17 of English Longhorn will be added to the herds. In addition, at least five new Longhorn heifers will be purchased. This will translate to an estimated 53.8 GLUs of Red poll and 35.2 GLUs of English longhorn at the start of the grazing season in Epping Forest (when the new calves will be 4–5 months old). By late summer 2015, before calving, this will translate to an estimated 56.5 GLUs of Red poll and 40.7 GLUs of English longhorn, assuming no sales or mortality. This will provide sufficient livestock to simultaneously graze 44.4 – 178 ha in the spring and 48.6 - 194.4 ha by late summer, dependent on the composition of the habitat mosaic within each compartment and the recommended stocking density associated with each kind. A mature Red poll (Norfolk x Suffolk cross) cow will achieve 520 kg live weight and requires 13 kg of dry matter per day (2.5% of body weight) which is achieved by 13 kg of silage or 15 kg of hay. In some compartments, grazing management must comply with the regulations of 2 GLUs ha⁻¹ associated with Natural England Higher Level Stewardship payments and management for wood pasture “HC13 Restoration of wood pasture and parkland” and Entry Level Stewardship management options which apply to compartments 24, 26 and 9/10, “EK2 Permanent grassland with low inputs” and “EK3 Permanent grassland with very low inputs”. Since the targets for grazing will be met in many cases by just a few weeks of grazing, rotation of the cattle to new compartments will permit conservation grazing of a much larger land area over the course of the grazing season, representing a significant step forward in the Grazing Strategy to achieve habitat and species conservation and landscape objectives for Epping Forest.

c. Consequences of late grazing on specific areas

Late grazing within only selected areas occurred in 2014 as a consequence of the delay in the installation of invisible fencing and movement restrictions imposed on the cattle herds the previous year, related to the detection of bovine tuberculosis adjacent to Epping Forest. The late grazing coincided with a warm year of greater than average vegetation productivity and resulted in the following effects on habitat condition. Management with light grazing should ideally remove the annual growth of abundant plant species, for a period of 10 or more weeks between April to November since this will avoid sward damage or the development of a dense, matted sward or large tussocks (Natural England, 2013). The Higher Level Stewardship scheme recommends that the sward of meadows should achieve a mixture of heights between 2–10 cm by the end of the grazing season. This should also be achieved with only light stocking (0.4–0.6 GLU ha⁻¹) during March and August to avoid disturbance to ground-nesting birds and to allow plants to flower and set seed. In conclusion, there would have been a less detrimental effect on vegetation management in areas which experienced delayed grazing because the ideal pattern of grazing is to graze at a higher stocking density later in the season. More significant effects will have taken place in areas that received no grazing or trampling by cattle, with habitats already composed of more woody, perennial plant species, since unimpeded growth will have increased their size and ground cover. Purple moor grass, wavy hair grass, marsh thistle and willow will have increased in wetter areas, whereas bramble, thorns, bracken and birch will have increased in cover in the drier habitats. Some temporary mob-stocking may be necessary to reverse the change but manual/ mechanical clearance may also be necessary in compartments where thicket has formed which would deter ingress by the cattle.

d. Tracking cattle in grazed compartments

There was significant evidence based on the location of dung pats, hoof prints and grazing and browsing damage to vegetation, to demonstrate the extent of cattle foraging within compartments. The 11 Red poll cattle (reduced from 15 in-calf heifers earlier in the year) at Fairmead were accessing open meadows, broad and narrow rides and were also foraging in glades with dappled shade. There was no apparent evidence that cattle had foraged in the shaded, closed canopy parts of the woodland. These same cattle had also been grazing the wetter grasslands on the route towards Peartree Plain where a lattice of cattle pathways was seen amongst the *Deschampsia* and *Molinia* tussocks, tall, marsh thistle stems had been snapped and trampled and the rosettes at ground level grazed by the cattle. Branches of willow saplings had also been browsed and Red poll cattle at the site were actively consuming willow growth during the visit. There were dung pats in a newly cleared wood-pasture at Pear tree Plain which demonstrated increased access where there was greater light penetration to the woodland floor. Browsing and grazing was apparent in these dry forest areas characterised by birch and hornbeam regrowth. The herdsman, Roger and work experience student, Neil, demonstrated the GPS live tracking system used to locate the cattle in the Forest. After the visit, I was given access to 'heat maps' based on the recorded cattle tracks, provided by the GPS provider, Cosignal Ltd. (Fig. 1). The map is illustrative rather than representative since it presents data from just one Red poll cow. The green, orange and red markings illustrate where the cow foraged and the warmer

colours, places where they spent more time. The general pattern corroborates the field observations that foraging is restricted to edges and illuminated glades of the Forest. This restricted extent of foraging suggests that the stocking densities of cattle will initially need to reflect the foraged not the total area within a particular compartment otherwise the effective stocking density on a particular type of vegetation could exceed the ideal density for conservation grazing. The next section considers methods to increase the extent of grazing and foraging in each compartment.



Fig. 1. Heat map based on GPS tracking data of one Redpoll cow, 17-26 August, a total of 10 days of movements (Source: Rob Blackwell, Cosignal Ltd.)

e. Methods to attract cattle to graze throughout each compartment

A challenge remains to encourage cattle to move between all parts of the grazing compartments that would benefit from grazing. The main question is how to deter preferential grazing of nutritious lawn grasses in the open meadows rather than along rides and under the partial canopy of woodlands? The forage of the shaded field layer of the woodland will be lower in carbohydrate and less palatable, even if meadow grass species are part of the plant community. Two methods were considered as a means to encourage cattle to forage deeper into the woodland from rides and glades. I witnessed tree surgery work during a visit to Bury Wood (Compartment 24) on 20 August where a work party was undertaking crown reduction of trees in 'halos' around the pollards within the wood pasture. Based on observations at Peartree Plain, this should encourage cattle ingress into such illuminated glades from the adjacent rides. Additional crown reduction/ pollarding in halos and possibly to open up links to rides may further encourage cattle to forage a greater extent of each compartment, certainly a rather better strategy than mob stocking with periods of respite (short periods with high stocking densities of cattle).

During the visit to Bury wood, various freshly cut branches of hornbeam, birch and beech were collected and loaded for a feeding trial at Peartree Plain to assess the interest of the cattle. Birch and hornbeam were selected but it was also clear that cattle preferred to pull at leaves and twigs of living/ standing tree branches on the fringe of the ride than from cut branches stacked on the ground. A further feeding trial of cut tree branches (tree fodder) with fresh leaf material is proposed for next summer and material harvested in summer 2015, dried and fed in winter 2015-16. The aim of this activity is to entice cattle into the shadier wood-pasture and to encourage targeted grazing/ browsing.

Advice had been sought by the Head of Conservation from Ted Green (Ancient Tree Forum) on experiences elsewhere in the use of tree fodder to entice cattle into wood-pasture. In addition, there is valuable information from records of traditional use of tree fodder by livestock farmers in Sogne og Fjordane county, western Norway (Austad & Hauge, 2006). The study provides a valuable source of information about the timing and methods used for pollarding, storage and feeding methods and the tree species preferred and selected by livestock.

3. Evaluation of targeted grazing areas and sites inhabited by scarce plant species

Discussions about scarce plant species management with targeted grazing took place during field visits to various compartments on Tuesday 19 and Wednesday 20 August.

a. Long Running Heath: Heath spotted orchid

The site had been grazed over 20 years since the construction of a wooden perimeter fence in 1994. Since 2004, electric fences have been used to graze 4 ha with 4 English longhorn cattle for six out of the ten years. The priority is heather restoration and management but the grazing regime on the site, which has been grazed over 20 years, is undergoing review to consider more extensive wood-pasture grazing and how to balance this with the needs

of the scarce plants including both orchids and heather. Shallow scrapes have been effective at encouraging *Calluna vulgaris* but the plants remain small and vulnerable. Heather plants on the woodland margin showed signs of defoliation by heather beetle and excavation of the leaf litter revealed numerous adult beetles resting in this moist refuge. A map of heath spotted orchid plants surveyed in 2009, 2013 and 2014 revealed reasonable populations in the southern sector where there is interest about the effects of cattle and deer grazing on flowering and seed maturation. The site is also important for adders and tree pipits, which could both be detrimentally affected by cattle grazing. Late season stocking has been applied in accordance with recommendations for heathland management (Gimingham, 1972) and to avoid disturbance to reptiles and ground-nesting birds. Also, there have been 'rest years' agreed with Natural England, including 2014. Grazing is required to reduce the extent and competition from purple moor-grass and bracken and succession to silver birch. The ambition is to encourage expansion of the dry heath by grazing a larger area enclosed by electric fence. The following approaches were agreed:

- It will be desirable to push the electric fence back beyond the woodland margin since the scalloped effect will vary the vegetation structure and edge transitions to encourage greater biodiversity.
- A strategy of annual cattle grazing is more desirable than breaks (rest years) during the restoration phase because of the competitive nature and rapid growth of purple moor-grass, bracken and silver birch. This strategy should be reviewed at the time when the heathland restoration switches to a maintenance phase of management.
- The timing of grazing presents a dilemma because earlier grazing will take more of the early, more nutritious growth of purple moor grass and trampling will have a greater impact on emergent bracken fronds. This conflicts with concerns about detrimental effects on heath spotted orchid, adders and tree pipits (although there are currently no breeding pairs on the site). The compromise will be use of low stocking densities during the sensitive flowering and breeding periods.

b. Trueloves meadow: Southern marsh orchid

Visited this ungrazed site on Tuesday 19 August, historically acquired from M. Davies as a setaside field after a period of mixed farming. I was also provided with a printed management plan. The site has no formal conservation designation but supports populations of southern marsh orchid, fleabane and grasshopper warbler. Management must comply with HLS agreements and the site is currently undergrazed with abundant cover by Michaelmas daisy, bramble, hawthorn and dog rose but the concern here is that the stocking densities of cattle may be too high to retain the conservation status of the site (ca. 2 GLU ha⁻¹). The proposal to attempt experimental rotational grazing between invisible fenced jigsaws would allow assessment of changes to the vegetation that might alter the habitat suitability for the scarce plant species, e.g., fleabane. Boundaries include various tree species of interest but there is much willow and birch regrowth and the management plan to clear back birch, thin and pollard willow and clear back all but some selected shrub patches seems very reasonable. This would seem to be a reasonable approach to achieve the local conservation objectives but also to open up the site as a spillover area for grazing cattle and to facilitate cattle movements between adjacent compartments where grazing is

proposed. After mechanical scrub and tree clearance, grazing should suppress later bramble, dog rose growth and the rate of regeneration of shrub and tree species.

c. Fernhill wood: Ancient Woodland Site with occasional pollards

Visited on Tuesday 19 August after viewing Trueloves meadow, Fernhill wood is an Ancient Woodland Site purchased by Epping Forest in 1997. There was major felling of trees in the 1930s but some pollards remain with distinct open, damp, crescent areas which support ragged robin, adders tongue fern and creeping jenny. The 12 ha area is post-and-wire fenced because there is less sensitivity to fixed fencing due to minimal public access. It has been grazed with 10 cattle and has received occasional, manual scrub clearance by conservation volunteer parties but is clearly undergrazed. A sizeable increase in stocking density is required, perhaps to an HLS level of 1.5-2 GLUs ha⁻¹ but the bramble and dog rose growth may need additional manual clearance since closed shrub patches are rapidly developing.

d. Almhouse Plain: Lousewort

The lousewort area at Almhouse Plain was visited on return from the ponds at Peartree Plain on Wednesday 20 August. Targeted grazing with Red poll cattle had been applied to this vegetation for several days in June. Despite the short period of grazing, there had been an obvious impact on the lousewort, with seed-heads and a few plants being consumed. The effects on the lousewort population were investigated and discussed. This foraging behaviour was fairly widespread across the site and probably had a greater effect because the area had been grazed too early in the year and perhaps for too long in duration since the more palatable plant species may have been depleted. Lousewort is known to disappear from unmown or nitrogen fertilized oligotrophic wet meadows and is especially vulnerable due to the biennial pattern of flowering and seed production (Demey *et al.*, 2013). The apparent seed loss may be compensated by the process of endozoochory, the dispersal of plant seeds via passage through the gut of grazing animals. Instead of a localised seed rain, the seeds are potentially dispersed over a wider area, deposited in cattle dung and for some plant species, the seed germination rates are also greater after passage through the gut (Pakeman *et al.*, 2002). Published studies of endozoochory have not included accounts of lousewort, so germination trials would need to be completed to verify that this is the case. Incidentally, a European study has demonstrated myrmecochores, or seed dispersal by *Myrmica* sp. ants, over intermediate distances (Leps, 2005), thus there is potential for the founding of new clusters of plants by both cattle and ants. Whilst at Almhouse Plain, also observed that sneezewort flowering had been suppressed by the cattle grazing but the plants appeared to be healthy with vigorous compensatory growth.

e. Yate's meadow: Pepper saxifrage

Yate's meadow remains ungrazed although it has been managed with annual hay cuts, and awaits installation of invisible fencing prior to the introduction of cattle grazing. At the time of my visit, it had not yet been mown for hay and there was already colonisation by bramble, dog rose and thorn which indicated that the initiation of cattle grazing or remedial topping of the vegetation is highly desirable. A search for pepper saxifrage based

on the GPS map of plants surveyed in September 2013 was unsuccessful and of concern. Conservation staff were to return to double check the denser patches of Pepper Saxifrage during a visit to carry out ragwort control. Hopefully, the apparent absence of plants was due the fine summer which may have advanced the growth and flowering in 2014. This reinforces the need to map individual, notable plant species across Epping Forest, as an effective means of assessing large inter-annual differences, in particular if there are adverse responses to a change in management, for instance for pepper saxifrage during the transition from cutting to grazing management in Yate's Meadow.

f. Priority areas for further targeted grazing

A more general consideration was made of priority areas for further targeted grazing, either within the jigsaw areas defined by the invisible fence, once installed, or through the use of discrete circuits of temporary electric fencing. There are benefits to be gained for vegetation management and maintenance of target species and communities, especially if such fences permitted mob stocking of undesirable vegetation such as bracken and birch regrowth or willow, marsh thistle, *Deschampsia* and *Molinia* tussocks. The timing, period and stocking density of cattle would need to be carefully considered in relation to the nature conservation objective/s, ground and weather conditions of each area.

4. Review of the vegetation survey methods and data

A survey has been repeated of the eight belt transects of 50 m length located on transition boundaries between woodland and open vegetation of selected compartments shortly to be grazed (Palmer's Bridge, Peartree Plain, Barn Hoppit, Bury Wood, Big View, Sunshine Plain (x 2) and Rushey Plain). The report from the consultant ecologist was not produced in time for this review but a consideration of the results will be included in the next grazing evaluation. Earlier analysis of annually collected botanical survey data from the grassland at Whitehall Plain, 2007-2012, provided evidence that vegetation change was relatively slow under consistent, annual management (Bealey, 2013).

The additional W-shaped walks in glades have been added to the vegetation survey this year in which a Grazing Impact Assessment of vegetation was applied. The assessment focuses on species according to the DAFOR scale (dominant, abundant, frequent, occasional or rare) or to selected plant species with different levels of adaptation to grazing. It will be possible to assess how well this was implemented when the report of the consultant ecologist is produced.

It is worth repeating that the combination of vegetation grids; transects along which fixed quadrats are used for plant survey; field GPS recording with GIS mapping of the distribution of specific plant species of conservation interest (e.g., lousewort on Almhouse Plain, heath spotted orchid on Long Running Heath and pepper saxifrage at Yate's Meadow); and fixed point photography, all contribute to a suitable and effective monitoring programme, essential for successful application of the Grazing Strategy. This will enable assessment that the annual grazing effect is to consume the annual productivity of abundant, competitive plant species and to allow an increase in the population sizes of the desired, scarce plant species.

5. Student projects

The value of engagement with academic staff at Higher Education Institutions in order to co-design undergraduate or postgraduate research projects was stated in the previous report (Dennis, 2013). Discussion with grazier, Roger Beecroft, about the cattle grazing scheme generated some additional research project ideas and questions:

- What is the nutritional value of leaves of different tree species at different times of the year? It is necessary to appreciate the dietary value of tree forage once cattle are restricted to smaller, invisible fenced compartments composed mainly of woodland with limited forage as ground cover.
- Assessment of the nutrient value of the major grass and herb species within each grazed compartment at different times of the year. This would allow a better estimate of suitable stocking densities for each compartment.
- A study of cattle tracks from GPS collars compared with mapped vegetation patterns can be conducted using a Geographic Information System. A prior decision is needed whether some cattle should have more frequent GPS recordings of location to provide finer resolution information. The data are normally collected hourly but the proposal is to have collars of selected cattle set to 15' or more frequent intervals since this would allow the investigation of precise foraging pathways.
- The data from the satellite telemetry based on the cattle GPS collars offers the opportunity for research projects on both animal movements around each compartment and habitat selection and vegetation preferences. This would inform management and allow further refinement of stocking densities and the periods of grazing consistent with conservation objectives for Epping Forest.

6. Summing up

Delays to the expansion of cattle grazing across Epping Forest have occurred due to restrictions on cattle movements associated with a Bovine TB outbreak two years ago and the need for further, technical development of the *Boviguard* invisible fencing system. Visits to various sites around Epping Forest where rank vegetation or rapid encroachment of bramble, dog rose and thorn were evident, demonstrated the urgent need to initiate the cattle grazing. There appears to be ongoing progress with the installation of the invisible fencing whilst a modest build up in cattle numbers has taken place during 2014. There are sufficient baseline data on plant species, especially scarce species, to allow early review of responses to the reintroduction of cattle grazing and I look forward to reading the report from the ecological consultant in due course and engaging in discussion about the best form of data analysis to apply to those data. Next year should be an exciting year when years of planning and preparation will come to fruition to achieve and maintain the stated objectives of the Grazing Strategy over the next 5-20 years:

- Restore and maintain the favourable condition of key forest habitats using good forest management (including conservation of scarce and notable plant and invertebrate species).
- Conserve the Forest as a special mosaic landscape distinct from surroundings.
- Maintain cultural tradition and protect common rights of pasturage.

7. References

- Austad, I. & Hauge, L. (2006). Pollarding in western Norway. Proceedings of the 1st European colloquium on pollarding, Vendôme, France, 26-28 October 2006.
- Bealey, C. (2013). Epping Forest Vegetation Monitoring Data Review. Unpublished report to the Head of Conservation, Epping Forest. Consulting at Damerham Ltd., 2 St George's Cottages, South End, Damerham, Fordingbridge, Hampshire, SP6 3HP.
- Dagley, J. (2008). Epping Forest Grazing Rationale and Strategy. City of London, June 2006 (updated 2008), 90 pp.
- Davies, O. (2009). Management Guidelines for Grassland in Environmental Schemes, ADAS Pwllpeiran, Ceredigion, 30 May 2009.
- Demey, A., Ameloot, E., Staelens, J., De Schrijver, A., Verstraeten, G., Boeckx, P., Hermy, M. & Verheyen, K. (2013). Effects of two contrasting hemiparasitic plant species on biomass production and nitrogen availability. *Oecologia* doi:10.1007/s00442-013-2602-2.
- Dennis, P. (2013). Grazing assessor's report on the status of cattle grazing and associated monitoring across Epping Forest. Report to the Conservators of Epping Forest, City of London, Aber-Bangor Consultancy Ltd., Aberystwyth University, 26 September 2013, pp. 8.
- Epping Forest and Commons Committee (2013). Epping Forest Grazing Expansion Plan 2013–2018. Wildlife and Countryside Services, City of London, 13 February 2013.
- Gimingham, C.H. (1972). Ecology of heathlands. Chapman & Hall, London.
- Leps, J. (2005). Biodiversity and plant mixtures in agriculture and ecology. In: M. Wachendorf, A. Helgado'ttir & G. Parente (eds) Sward dynamics, N-flows and forage utilization in legume-based systems. Proceedings of the 2nd COST 852 Workshop, Grado, Italy, 10–12 November 2005. ERSA, Gorizia, pp 13–20.
- Natural England (2013). Higher Level Stewardship, Environmental Stewardship Handbook, Fourth Edition, Peterborough. Available at: <http://publications.naturalengland.org.uk/publication/2827091?category=45001>.
- Pakeman, R.J., Digneffe, G. & Small, J.L. (2002). Ecological correlates of endozoochory by herbivores. *Functional Ecology* 16: 296-304.