Responses of ground flora and insect assemblages to tree felling and soil scraping as an initial step to heathland restoration at Norton Heath Common, Essex, England

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SUMMARY

Thinning of the woodland canopy by selective tree felling and removal of humus and nutrient-rich soil by scraping are techniques being used as a first step to regenerate heathland vegetation and associated insect assemblages at Norton Heath Common in southeast England. Two years subsequent to initial restoration activities, there has been germination and establishment of two heathland plant species, gorse *Ulex europaeus* and sheep's sorrel *Rumex acetosella*, in the tree-cleared and soil scraped areas, whilst the warmer microclimate created by tree felling has led to higher thermophilous insect species richness, particularly of butterflies. It is hoped that the continuation of felling and soil scraping will lead to the return of other characteristic heathland plants, especially heather *Calluna vulgaris*, and rarer species such as lousewort *Pedicularis sylvatica*.

BACKGROUND

The floristic decline of Norton Heath Common in southeast England is well documented in an account of a walk from Ongar Railway Station to Fyfield and Norton Heath (Smith 2002), that was a re-creation of a ramble led by Essex Field Club Members in 1913 (Willmott 1913). The author of the 1913 account described the surface of the heath as being disturbed by shallow excavations for gravel and that the resulting swampy heath and shallow pools "*should prove happy hunting grounds for botanists*". The author goes on to list the array of heathland plants that were found, these included common milkwort *Polygala vulgaris*, heath bedstraw *Galium saxatile*, heather *Calluna vulgaris* and lousewort *Pedicularis sylvatica*. Sadly as Smith (2002) highlights, these plants have all been lost, and the heath now comprises largely dark and shady woodland, which has become established due to the absence of gravel digging, a great decline in rabbit *Oryctoloagus cuniculus* grazing due to myxomatosis, and a lack of traditional livestock grazing. No *Calluna* currently occurs, and only two non-woody herbs remain on the southwest section of the heath (targeted for restoration), wood sage *Teucrium scorodonia* and yellow pimpernel *Lysimachia nemorum*.

Heathland is included in the Essex Biodiversity Action Plan (BAP) due to its local rarity, with only 5.5 ha of *Calluna* heath remaining in the county (Thompson & Maclean 1999). A recent consultation on Part 2 of the Commons Act (2006), has suggested the creation of statutory 'Commons Councils' to ensure commoners and landowners work together at a local level to enable effective scrub control (DEFRA 2008). This may facilitate the restoration of heathland vegetation on commons where succession to woodland has occurred in the last 100 years (Rackham 1986). This present paper documents the early stages of a project aimed at restoration of heathland vegetation and heathland insect assemblages at Norton Heath Common in Essex, England. The results of this ongoing management will determine whether it is possible to restore the vegetation and invertebrate communities of the former open heathland through a programme of tree felling and creation of soil scrapes.

ACTION

Restoration area: Norton Heath Common is divided in two by a road running diagonally from the northwest to the southeast corner. The northeast section (grid reference TL 601043) has a dense bramble *Rubus fruticosus* agg. understorey and a few old gravel workings; this section is to remain as an unmanaged non-intervention area as it gets less sunlight than the southwest section (grid reference TL 601042) where the main restoration work is planned by Epping Forest Countrycare. Restoration will include extensive tree felling (up to 30% of the trees on the heath are potentially to be felled), with a combination of scraping of soil to remove the humus and nutrient-rich topsoil aiming to stimulate germination of heathland plant species persisting in the seed bank.

Tree thinning: On 16 February 2007, Epping Forest Countrycare felled 15-20 silver birch *Betula pendula* and pedunculate oak *Quercus robur* trees on the southwest wooded section of the heath to allow more sunlight to reach the then very sparse understorey comprising *R. fruticosus* agg., wild honeysuckle *Lonicera periclymenum* and *T. scorodonia*. Most of the trees that were felled were 50-60 years old and have become established since the outbreak of myxomatosis in the 1950s. Approximately another 50 trees were felled and removed in the winter of 2007/08. The restoration area was approximately 1 ha in size.

Monitoring: Twenty permanent quadrats (50 x 50 cm) were marked out with wooden stakes to monitor the response of the ground flora to management. Monitoring of the ground flora took place on 18 May and 20 July 2007 and 18 May and 21 July 2008. On all survey dates a 50 x 50 cm (0.25 m²) frame quadrat was placed (top left corner of the quadrat touching the stake) at each of the 20 permanent quadrat locations. Each quadrat had 100 divisions to assist percentage cover/occurrence estimates of the vegetation. In each quadrat, the number of squares that each plant species (herbs, grasses, ferns and rushes) was recorded in was noted (e.g. if a species appeared in 100 squares it was recorded as having 100% occurrence in the quadrat). The method allowed an objective determination of the abundance/species richness of plants that could be repeated on each survey date.

The dense leaf litter and fertile topsoil were scraped off within and around 10 quadrats (approximate size of each scraped area was 2 x 2 m, depth approximately 10 cm; Fig. 1) to ascertain if this technique led to enhanced germination of heathland species in comparison to leaving soil unscraped (10 quadrats). In addition to the plant surveys, several highly visible and readily identifiable insect taxa (butterflies, Odonata, Orthoptera, bumblebees *Bombus* spp.) were recorded as indicators of responses to opening of the tree canopy; approximately 2 hours were spent recording insect species present within the restoration area on each survey occasion.

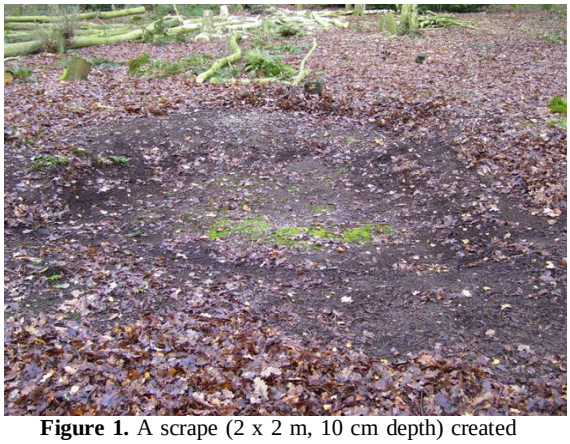

Figure 1. A scrape (2 x 2 m, 10 cm depth) created to initiate the germination of heathland vegetation; the vegetation in the middle of the scrape is a moss (note: mosses were not recorded in quadrat surveys), 12 December 2008.

CONSEQUENCES

Plant responses to restoration: In the restoration area, there was an increase in average vascular ground flora species richness in the 2 x 2 m scrapes over time, which contrasted with the unscraped quadrats in which species richness remained low (Fig. 2). The removal of the top 10 cm of soil in the scraped areas in some places exposed the underlying gravel, and presumably the underlying seed bank, which reduced soil nutrients, and enhanced germination and plant establishment.

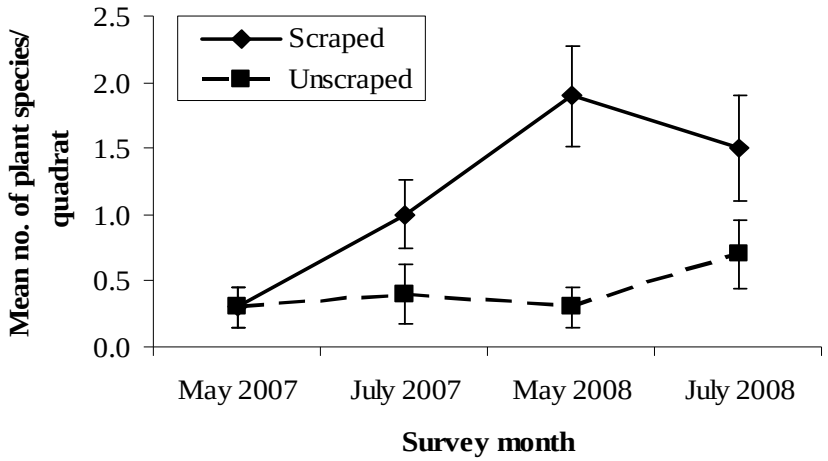

Figure 2. Plant species richness within the 2 x 2 m scraped areas and comparative unscraped areas (standard error bars shown) at Norton Heath, May 2007 to July 2008.

In the scraped quadrats, gorse *Ulex europaeus* and sheep's sorrel *Rumex acetosella*, were first recorded in 2008 (Table 1). These species represent the first signs of heathland plants re-establishing, and show that the management is starting to have a positive effect on re-instatement of some heathland plants.

Rosebay willow-herb *Chamerion* (*Epilobium*) *angustifolium* also appeared in the scrapes, it will be interesting to monitor the spread of this species in the restoration area as it can dominate large areas of heath to the detriment of the more desirable heathland plants. Heather *C.vulgaris* has yet to reappear on the heath; in essence, the scrapes provide a good starting point for germination of any heather seed present in the soil seed bank as they are devoid of much vegetation cover (generally less than 10% cover in 2008 in restoration area; Table 1), however at this early stage of the tree clearance the canopy is considered too dense to enable successful regeneration. Indeed, the plant that has benefited most to date is male fern *Dryopteris filix-mas*, a typical woodland species.

Table 1. Mean percentage cover of vascular plant species in the scraped and unscraped quadrats in 2007 and 2008 (maximum cover indicated in brackets).

	Scraped		**Unscraped**	
Plant species/taxa	2007	2008	2007	2008
Silver birch *Betula pendula*	0.0 (0)	0.0 (0)	0.1 (2)	0.0 (0)
Rosebay willow-herb *Chamerion angustifolium*	0.0 (0)	0.1 (1)	0.0 (0)	0.0 (0)
Male fern *Dryopteris filix-mas*	0.0 (0)	0.0 (0)	4.9 (98)	5.3 (40)
Grasses Fam: Poaceae	5.0 (99)	1.2 (17)	0.0 (0)	0.0 (0)
Rushes *Juncus* spp.	0.0 (0)	2.0 (20)	0.0 (0)	0.0 (0)
Wild honeysuckle *Lonicera periclymenum*	0.6 (5)	0.2 (2)	0.0 (0)	0.0 (0)
Bramble *Rubus fruticosus* agg.	1.3 (10)	2.9 (21)	13.6 (98)	1.4 (23)
Sheep's sorrel *Rumex acetosella*	0.0 (0)	1.2 (13)	0.0 (0)	0.0 (0)
Gorse *Ulex europaeus*	0.0 (0)	1.5 (7)	0.0 (0)	0.0 (0)
Stinging nettle *Urtica dioica*	0.1 (1)	0.0 (0)	0.0 (0)	0.1 (2)

Insect response to restoration: Over time since restoration was initiated**,** insect species richness of the selected study taxa increased (Table 2). Opening up of the canopy has benefited butterflies in particular. Butterfly species recorded for the first time (in 2008) included small copper *Lycaena phlaeas* (a localised species in Essex), meadow brown *Maniola jurtina* and gatekeeper *Pyronia tithonus*. *L. phlaeas* is considered a good indicator species of acid grassland and heathland habitat in the county. There was also a noticeable increase in the number of Odonata species recorded in the general heathland restoration area (although none are heathland indicator species); species using the restoration area included common darter *Sympetrum striolatum* and southern hawker *Aeshna cyanea*. The large red damselfly *Pyrrhosoma nymphula* was also recorded around a previously shaded pond; this species is considered localised in Essex (Benton & Dobson 2007).

Orthopteran species richness increased by only one (meadow grasshopper *Chorthippus parallelus*; a common and widespread species, was new), whereas an additional three bumblebee species were noted in 2008 (Table 2); although all are relatively common in a UK context, *Bombus* bees are in general decline throughout much of south-east England.

Table 2. Selected taxa of insect species recorded on the restoration area of the heath in 2007 (first season after felling started) and 2008 (second season after felling) (X indicates observation; no attempt was made to quantify numbers of individuals observed).

Insect taxa	2007	2008
Butterflies (Lepidoptera)		
Orange tip *Anthocharis cardamines*	X	X
Peacock *Inachis io*		X
Small copper *Lycaena phlaeas*		X
Meadow brown *Maniola jurtina*		X
Speckled wood *Pararge aegeria*	X	X
Large white *Pieris brassicae*	X	X
Green-veined white *Pieris napi*		X
Small white *Pieris rapae*		X
Comma *Polygonia c-album*		X
Hedge brown *Pyronia tithonus*		X
Red admiral *Vanessa atalanta*		X
Dragonflies (Odonata)		
Southern hawker *Aeshna cyanea*		X
Common blue damselfly *Enallagma cyathigerum*	X	X
Blue-tailed damselfly *Ischnura elegans*	X	X
Large red damselfly *Pyrrhosoma nymphula*	X	X
Ruddy darter *Sympetrum sanguineum*		X
Common darter *Sympetrum striolatum*		X
Grasshoppers (Orthoptera)		
Field grasshopper *Chorthippus brunneus*	X	X
Meadow grasshopper *Chorthippus parallelus*		X
Dark bush-cricket *Pholidoptera griseoaptera*	X	X
Bumblebees (Hymenoptera)		
Red-tailed bumblebee *Bombus lapidarius*	X	X
White-tailed bumblebee *Bombus lucorum*		X
Early-nesting bumblebee *Bombus pascuorum*		X
Buff-tailed bumblebee *Bombus terrestris*		X
Total number of species	**9**	**24**

Conclusion and recommendations

The creation of scrapes has been at least partially successful so far in terms of leading to the germination and re-establishment of two heathland plants, *R. acetosella* and *U. europaeus*, which appeared in the second season after tree felling was initiated. As yet, there has been no *C. vulgaris* recorded, but this may be due to the limited tree felling (and hence still relatively closed tree canopy) and soil disturbance undertaken so far. It is hoped that the creation of less shaded areas and of scrapes over a larger area of the heath will also lead to the germination and re-establishment of rarer plants such as *P. sylvatica*, which were recorded at the site nearly 100 years ago (Willmott 1913). Soil scraping has seen the successful return of this plant to two sites in nearby Epping Forest (Dagley *et al*. 2008) which gives hope for its return at Norton Heath Common. If *P. sylvatica* does not return through germination in the scrapes, then it may reintroduced via seed from the Epping Forest sites.

The tree felling, albeit small-scale to date, has led to increases in insect species richness of the taxa monitored, particularly of thermophilous butterflies requiring open habitat conditions. This is due to the warmer conditions created by the opening up of previously dense birch-oak canopy (Fig. 3). *L. phlaeas* was recorded for the first time in 2008, which coincided with the return of its larval foodplant, *R. acetosella*. The enhanced microclimate has also led to increases in the species richness of bumblebees, dragonflies and grasshoppers. The dark and cool microclimatic conditions of the mature birch/oak woodland were particularly unfavourable for thermophilous insects. The open glade created on the heath is likely to have additional benefits for insects due to the shelter from the wind provided by the surrounding woodland (Unwin & Corbet 1991), these kinds of 'sun trap' sites have been found to be favourable for Orthoptera (Gardiner & Dover 2008). Around the main pond, continued felling may be important to maintain and enhance habitat conditions necessary for the localised damselfly, *P. nymphula*. However, several of the small flooded gravel pits will be left shaded by the woodland canopy as some aquatic invertebrates prefer shaded ponds (Andrews 1995).

It is hoped that the felling of trees will be continued in future years by Epping Forest Countrycare, and that the soil scraping will be increased to cover a much larger area of the former open heath. To enable more extensive soil disturbance, a shallower depth of scraping may be necessary (e.g. < 5 cm depth); research has shown that at some sites, removal of the top 2 cm of organic soil can be sufficient to create suitable conditions for regeneration of *Calluna*, and that deep scraping (as in this project) may in fact remove the seed bank (Helsper *et al*. 1983). This survey provides some evidence that heathland vegetation on small commons (in this case *R. acetosella* and *U. europaeus*) can be regenerated through relatively minor tree felling in conjunction with soil disturbance.

Figure 3. Fixed point photographs of the restoration area in May 2007 (top) the first season after minor winter tree felling, and May 2008 (bottom) showing how the felling has altered the woodland (more light penetration and ground flora) in the second season after winter felling (waymark post removed); male fern *Dryopteris filix-mas* can be seen developing on the forest floor.

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