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MID-TERM IMPACTS OF EXCLUDING LARGE GRAZING ANIMALS ON A BURREN GRASS/SCRUBLAND PATCH

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INTRODUCTION

In the Burren region the dynamics and effects of scrub encroachment are not fully understood. At the local scale, the authors sought to test the hypothesis that the cessation of grazing results in decreasing biodiversity and increasing scrub encroachment. This hypothesis was tested using a map-based approach, over a period of fifteen years. The study area of 960m^2, which was established in the Burren National Park in 1991, was divided in two, with one half enclosed by fencing to exclude larger grazing animals. We found a directional change towards a scrub-dominated landscape in enclosed and unenclosed sections of the study area after analysing habitat maps from 1991, 1997, 2003 and 2006. Decreasing grass sward-type habitat (referred to as sward-type from this point onwards) was also recorded. Scrub expansion did not differ significantly between the two sections. The results of this experiment support the hypothesis, with encroachment and decreasing biodiversity being recorded. Increasing scrub and decreasing sward-type habitat areas have serious implications for biodiversity and landscape, which in turn influence farm management prescriptions in the Burren.

The Burren region in western Ireland has a glaciated karstic landscape (Moles and Moles 2002) from which the topographical expressions, the archaeological remains and exceptionally high biodiversity are derived (O'Connell 1994). Karstic landscapes support calcareous grasslands, which are being threatened throughout the world by agricultural improvement and inappropriate maintenance (Rodwell 1992). This inappropriate management has led to the problem of scrub encroachment on to grassland. The problem of scrub encroachment is currently being experienced in the Burren region (Dunford and Feehan 2001; Dunford 2002; Era-Maptec *et al.* 2006; Parr *et al.* 2007), and in Australia (Fensham 2007), Slovenia (Kotar *et al.* 1995) and Sweden (Rosen and Bakker 2005).

Grazing is a necessary part of successful grassland management. Overgrazing reduces Burren grassland biodiversity (Moles and Breen 1991; Dunford 2002; Moles *et al.* 2003; Moles *et al.* 2005). Undergrazing can result in a reduction in species diversity where there are equilibrium conditions, whereas in non-equilibrium grassland, species diversity is driven by environmental factors such as weather (Tainton *et al.* 1996). However, Moles *et al.* (2005) reported evidence for equilibrium and non-equilibrium dynamics in the Burren National Park, which highlights the challenges in selecting optimal grazing prescriptions. Scrub encroachment was traditionally managed through a mixture of grazing and other methods, such as coppicing, but today coppicing is rarely undertaken (Dunford 2002). At regional scale, Burren scrub encroachment has been quantified. Studies conducted by ERA-Maptec *et al.* (2006) and Parr *et al.* (2007) delimited areas affected by scrub encroachment and described the impacts on archaeological heritage. The dynamics and effects of scrub encroachment in the Burren, particularly at local scale, are not well understood. This paper seeks to test the hypothesis that the cessation of grazing results in decreasing biodiversity and increasing scrub encroachment using a map-based approach at local scale, over a period of fifteen years. We propose to continue the experiment.

METHODS

An area of 960m^2 was established on a ridge of shattered limestone between Lough Gealain and Mullaghmore, at an altitude of 45–51m in the Burren National Park in 1991. The study area was divided in two, with one half enclosed by fencing to exclude larger grazing animals. Within the patch, five habitats are recognised and their distribution was geo-referenced and mapped in

the late autumn of the years 1991, 1997, 2003 and 2006 by researchers based in the University of Limerick. These habitats are

- a mix of limestone pavement and sward (with similar cover of each),
- 80% pavement (≥ 80% cover),
- 80% sward (≥ 80% cover),
- scrub (90% + cover of hazel (*Corylus avellana*) and/white hawthorn (*Craetagus monogyna*) and/holly cover (*Ilex aquifolium*),
- heather (90% + cover of *Calluna vulgaris*).

Habitat types were selected to reflect the major plant communities in the study area, namely limestone pavement, grass sward and scrub. A simple classification was adopted to allow straightforward identification of habitat units in replicated surveys following a standardised method undertaken by different surveyors.

In addition to these habitats, five yew saplings (*Taxus baccata*) were identified for the first time within the enclosure in 2003. The boundaries of habitat units and the locations of yew saplings were determined through a mapping technique based on triangulation. Using this technique a point on a boundary between contiguous habitat units was located by measurements were taken from known points, namely the corners of the enclosure. Triangulation of a series of points along boundaries allowed the distribution of habitat units to be mapped. A Geographical Information System (GIS) was utilised to digitise the maps and calculate areas covered by each habitat. Statistical methods in Microsoft Excel®, SPSS Version 15® and MVSP® were used to compare results from 1991, 1997, 2003 and 2006 surveys.

Mammalian herbivores in the area during fieldwork included feral goats, cattle and the Irish hare (*Lepus timidus hibernicus*): although fencing would not exclude the latter species, it has not been observed within the exclosure. Domestic and feral animal stocking rates could not be calculated as animals forage freely over a large unenclosed area and the feral goat population has fluctuated in recent years as a result of unregulated culling and poaching (Hamilton 2008).

RESULTS

Figs. 1, 2, 3, and 4 show maps of habitat distributions in 1991, 1997, 2003 and 2006. The spread of scrub in both enclosed and unenclosed parts of the patch and the increase in heather within the enclosed section are clear. Heather was absent in the enclosed section in 1991, but by 2006 was significant in the enclosed area, with a commensurate decline in sward. Heather growth occurred

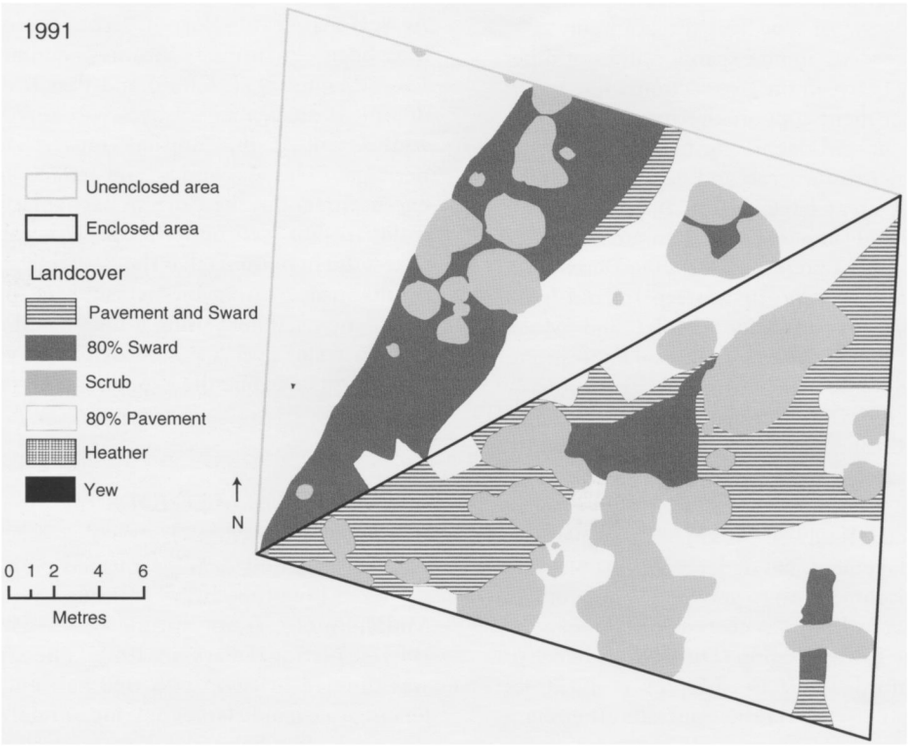


Fig. 1—Habitat map of study area 1991.

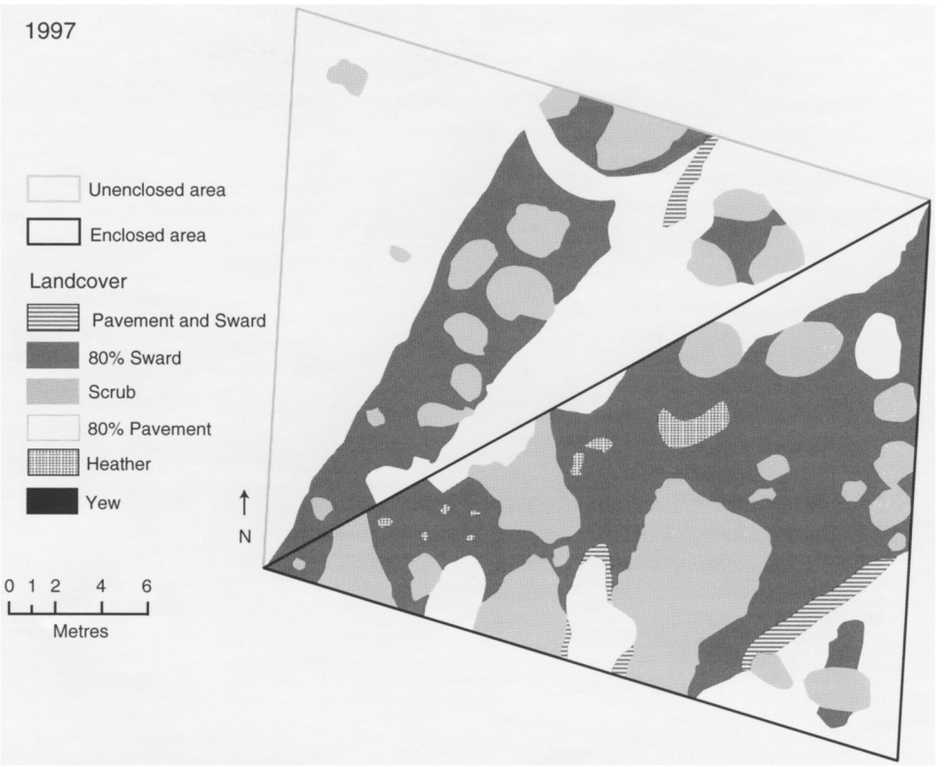


Fig. 2—Habitat map of study area 1997.

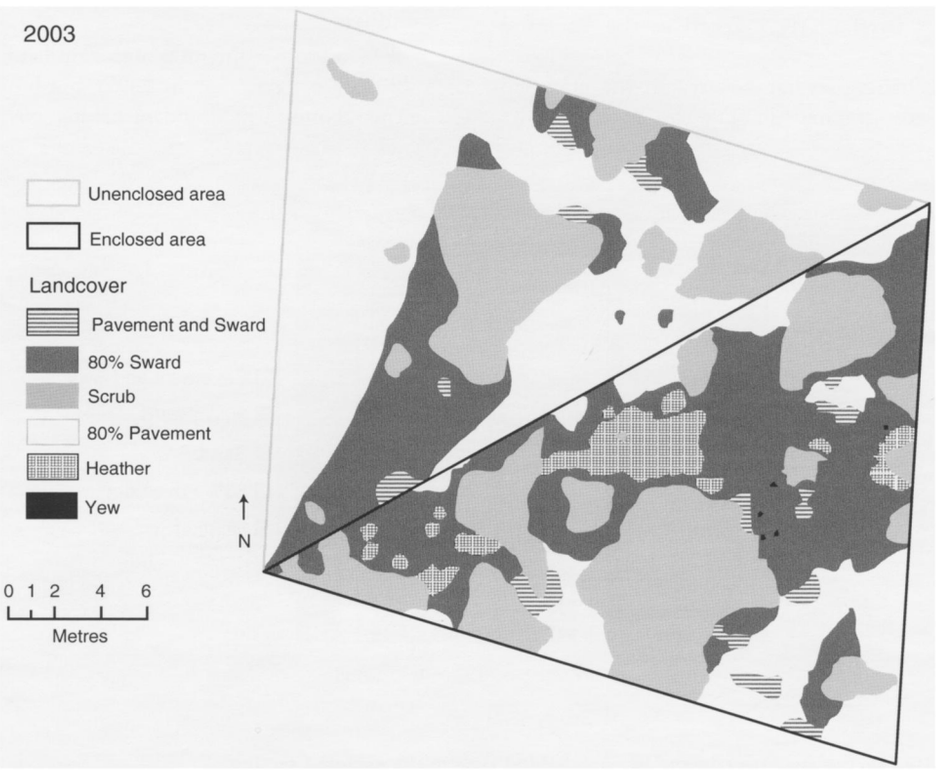


Fig. 3—Habitat map of study area 2003.

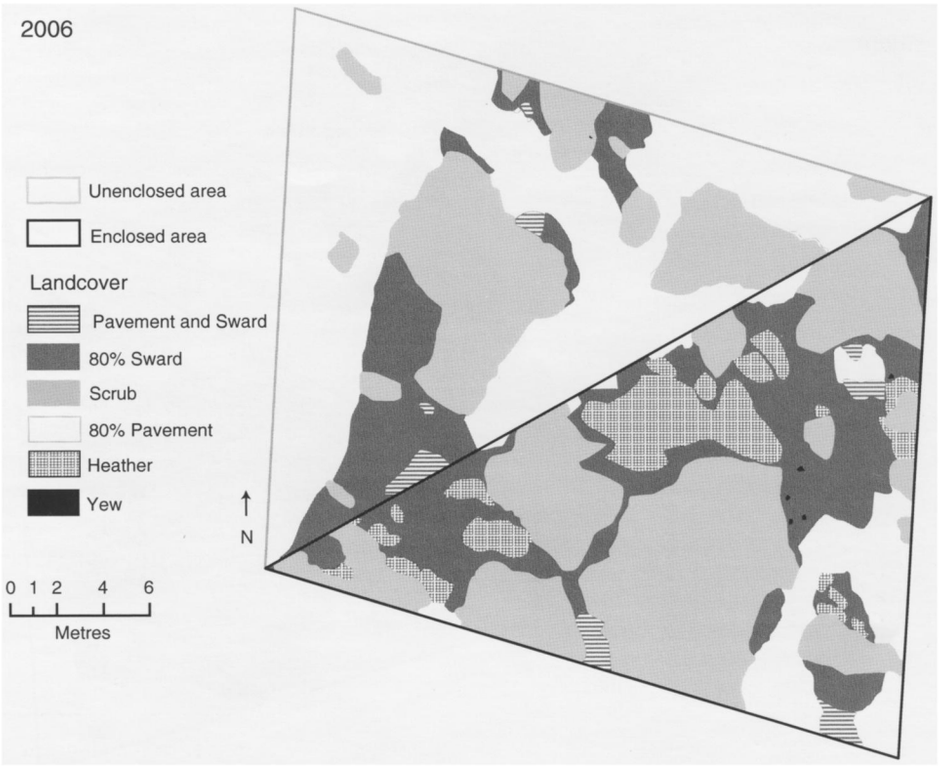


Fig. 4—Habitat map of study area 2006.

between 2003 and 2006 on areas previously occupied by 80% sward. The decrease in pavement habitat is particularly marked in the enclosed section.

The changes in habitat area in the enclosed section are graphed in Fig. 5, which shows that:

- scrub covered the largest area in 2006. It increased by 11% since 2003 and 14% since 1991,
- 80% sward was the most abundant habitat before 2003 (46% coverage in 1997), but by 2006 was the second most abundant habitat, covering just 27%,

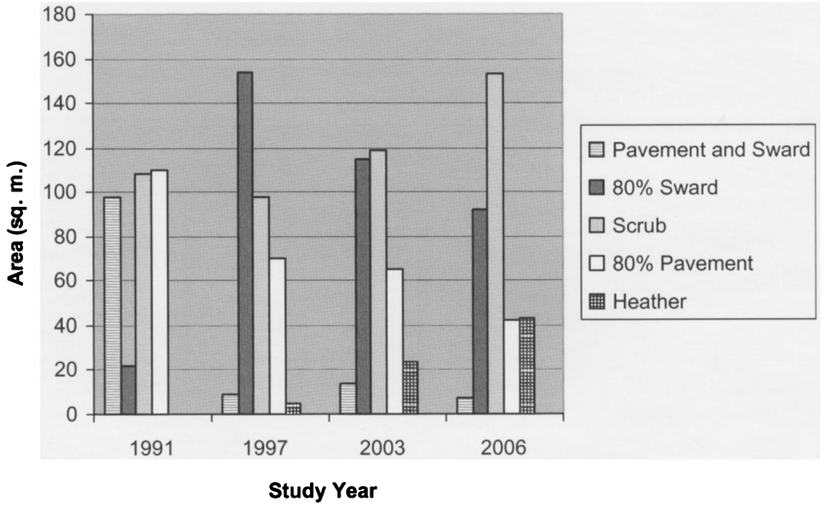


Fig. 5—Bar chart of the area covered by each habitat type in the enclosed section.

- the area covered by pavement and sward decreased by 2% from 4% since 2003, and by 27% since 1991,
- heather was absent in 1991, but by 2006 it covered 13% of the enclosed section,
- yew was first recorded in 2003 and has spread very little since then.

There appears to be clear directional change in habitat cover in the enclosed section. Since 1997 there has been a decrease in 80% sward and 80% pavement habitat, while there has been an increase in heather and scrub habitats. These patterns can clearly be seen in the period between 2003 and 2006.

Fig. 6 shows the variations throughout the study years in the unenclosed habitat.

- In 2006, 80% pavement was still dominant, followed by scrub, 80% sward and pavement and sward habitat.
- Scrub showed the largest increase in area (5%) between 2003 and 2006, and sward the largest decrease (4%).
- Heather and yew were not recorded.

From Fig. 6, the decrease in area of 80% sward habitat since 1991 and the increase in scrub habitat area since 1997 are both clearly visible. In 2003 and 2006 there was a change in habitat dominance as scrub replaced 80% sward as the second-largest habitat.

Correspondence analysis was performed to identify patterns in the association of habitats with study years. These scores or associations represent the similarity (and distances) between the relative frequencies for the habitat areas and study years (Benzécri 1992). We found that scrub was the most associated habitat in both enclosed and unenclosed sections in 2006. The correspondence analysis joint scatter plots for the enclosed section and unenclosed sections are displayed in Fig. 7 and Fig. 8. These results indicate that under ungrazed treatment there appears to be directional change towards a scrub and low heather-dominated vegetation. In the unenclosed section a directional change in habitat change is also indicated, with 2003 and 2006 study years showing the development of an increasingly scrub-dominated vegetation.

Correspondence analyses results when viewed in conjunction with total habitat area results clearly show that both sections of the study area are experiencing a directional change towards greater scrub dominance. Scrub expansion in enclosed and unenclosed sections did not differ significantly (*t*-test).

DISCUSSION

The methods used allowed habitat areas to be mapped, quantified, and subsequently analysed for particular attributes and processes. The analysis was restricted by the limited amount and type of data, variables and area. The limited study area affects the general applicability of the results, with a danger of pseudoreplication (Moles *et al.* 2005). The methodology does not take into account grazing that could have occurred in the enclosed section due to hares, which were not excluded by fencing, and juvenile goats. As the enclosed and unenclosed

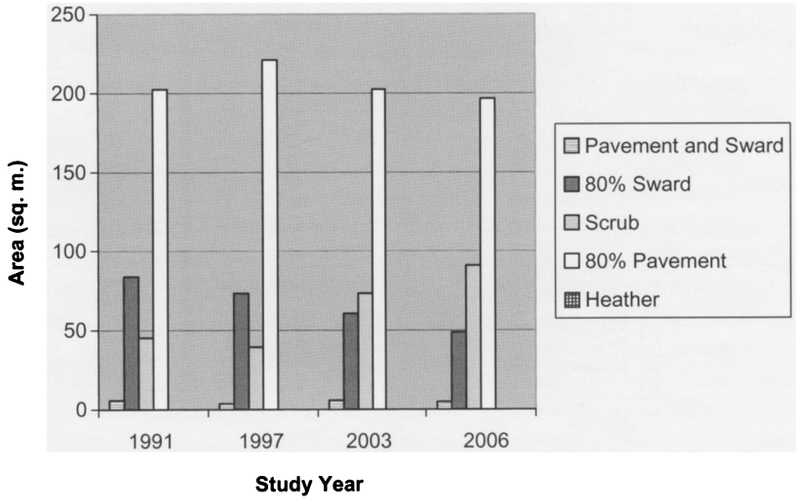


Fig. 6—Bar chart of the area covered by each habitat type in the unenclosed section.

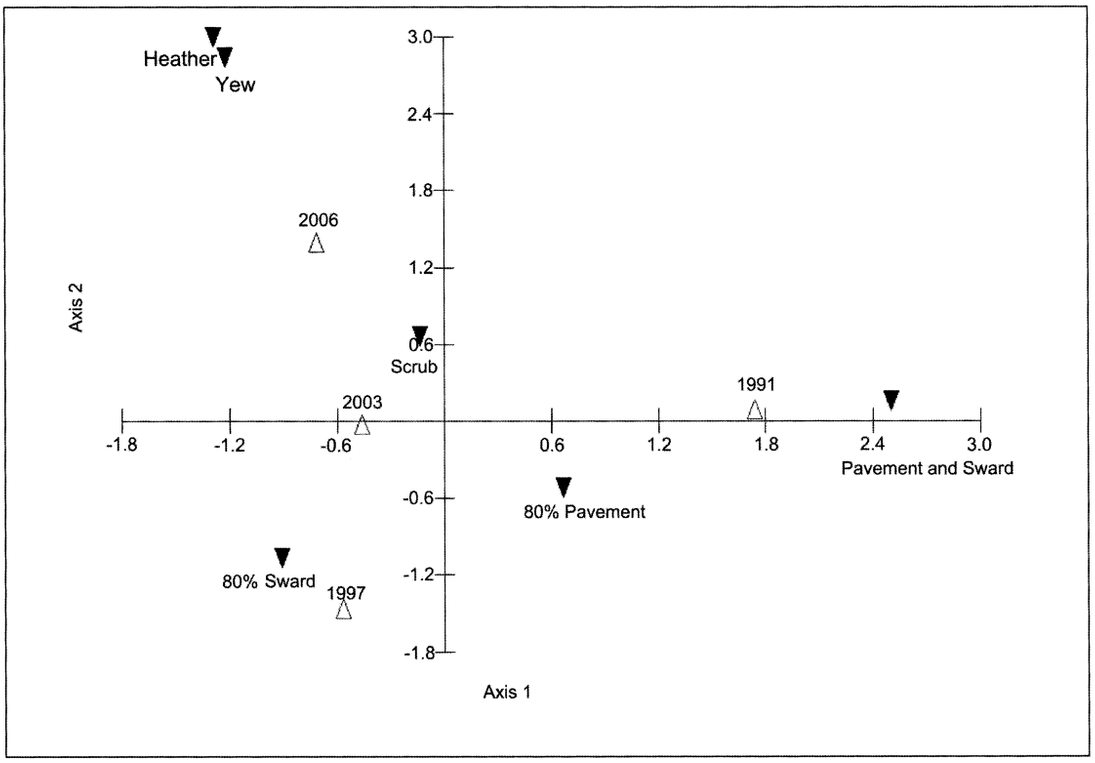


Fig. 7—Correspondence analysis joint scatter plot for enclosed section.

sections are not replicates, the inferences that can be drawn from the results are limited.

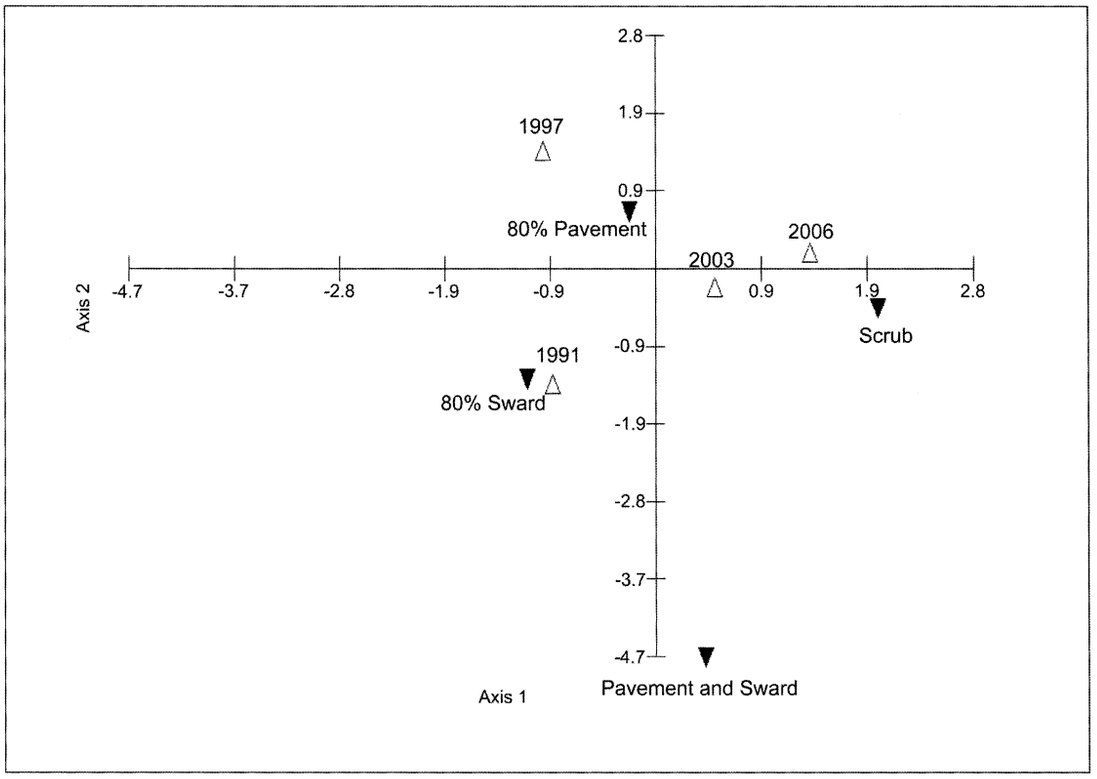
The results of this experiment, however, support the hypothesis, with encroachment and decreasing biodiversity being recorded. Decreasing biodiversity is inferred from the decrease in sward-type habitat. The limestone grasslands in the Burren are known to be species-rich, often having > 40 plant species per square metre (Dunford and Feehan 2001). These grasslands have niches with particular environmental and biological characteristics (Rodwell 1991) that support species-rich diversity. Inappropriate management of the unenclosed section is also resulting in scrub encroachment and a decrease in sward-type habitat. Scrub is appearing as the dominant habitat in both sections of the study area: recently it has been expanding at its greatest rate since 1997.

The presence of heather in the enclosed section supports the hypothesis, as with increased cover, *Calluna* spp can out-compete other species (ERA-Maptec Ltd *et al.* 2006), thus reducing biodiversity. This result also indicates a relationship between the emergence and growth of heather and grazing. Bohnsack and Carrucan (1999) drew attention to this relationship by describing the main threat to the heathlands in the Burren as overgrazing.

CONCLUSION

The current management prescriptions of the study area seem to be resulting in a move towards a scrub-dominated landscape. In both sections, there is decreasing 80% sward habitat area and increasing scrub habitat area. Increasing scrub and decreasing 80% sward habitat areas have serious implications for biodiversity and landscape, which in turn influence farm management prescriptions in the Burren. This study demonstrates the current encroachment of scrub in the Burren, in agreement with previous studies (Dunford and Feehan 2001; Dunford 2002; ERA-Maptec Ltd *et al.* 2006 and Parr *et al.* 2007).

The Burren has a heterogeneous landscape and ecology, and for this reason further studies are required, particularly those at the small–medium scale pertinent to developing farm management prescriptions in the Burren, with regards to varying



△ Correspondence analysis case score for year of study.

▼ Correspondence analysis variable score for habitat type.

Fig. 8—Correspondence analysis joint scatter plot for unenclosed section.

grazing pressures and the control of scrub. In the longer term, the scrub could represent a resource in the production of biofuels or for biorefining.

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