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Ecological implications of land abandonment in Britain: some comparison with Europe

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SUMMARY - While there has been relatively little recent abandonment of farm land in Britain, research has been focused on the ecological implications of land abandonment in upland areas and of set-aside schemes. Abandonment of upland grazing land causes dramatic changes in the botanical composition of the vegetation. These changes depend on several interacting factors, including distance from and floristic composition of border vegetation, nutrient and other site factors, weathering processes and other external factors after abandonment and the composition of the pioneer vegetation. The implications of schemes which will set aside agricultural land differ depending on the region and the type of agricultural exploitation. For example, in lowland arable areas invasion of the biota must frequently come from field margins. In contrast, in uplands, where the vegetation has not been so strongly transformed, the processes may be less dramatic, but the rate of change may be slow.

Key words: Britain, lowland, upland, set-aside, grassland, forest.

RESUME - "Implications écologiques de l'abandon des terres en Grande Bretagne: comparaisons avec l'Europe". Malgré le nombre réduit de zones cultivées récemment abandonnées en Grande-Bretagne, la recherche s'est attachée à l'étude des conséquences écologiques de l'abandon dans les régions de montagne et les zones ne devant pas être cultivées (set-aside schemes). L'abandon des pâturages de montagne débouche sur une modification spectaculaire de la composition botanique de la végétation. Ces changements dépendent de plusieurs facteurs interagissants, parmi lesquels l'éloignement des bordures et des haies et leur composition végétale, les nutriments et autres éléments du terrain, les processus de désagrégation et autres facteurs externes qui se manifestent après l'abandon, et la composition de la végétation pionnière. Les implications des systèmes qui laissent de côté des terres cultivables, diffèrent selon la région et le type d'exploitation agricole. Par exemple, dans les plaines cultivables, l'envahissement par le biote provient le plus souvent des haies et bordures. Par contre, dans les montagnes, où la végétation n'a pas été aussi fortement transformée, ces processus sont moins spectaculaires, et le rythme de changement peut être plus faible.

Mots-clés: Grande-Bretagne, plaines cultivables, régions de montagne, set-aside schemes, pâturage, forêt.

Introduction

Since the last war, the agricultural support system, combined with the desire of sucessive governments to increase self-sufficiency, has prevented any significant abandonment of land in Britain. Even with the agricultural surpluses experienced in recent years, there has been little increase - in marked contrast to other European countries. As a result there has been little stimulation to carry out work on the ecological implications of abandonment.

The studies that are applicable have often resulted from fencing experiments to exclude grazing and were not specifically concerned with abandonment. Green and Burnham (1989) have presented the results from a range of studies on land which might be surplus to agriculture, which range from 0.2 m ha to 6.3 m ha. However, these theoretical calculations have not yet led to a significant area of land being abandoned in Britain probably because alternative enterprises are still available. The recent official set-aside scheme is designed to take land out arable production but involves a relatively small area, probably only thousands of hectares; it also requires statutory management procedures, not complete abandonment. The main trend within British agriculture, particularly in the lowlands, is still one of increasing the intensity of production. This trend is largely a result of socio-economic factors. For example, a common response to lower prices is to increase production so as to compensate for loss of income. Anecdotal evidence suggests that future trends could well be different because of the accelerating rate

of change. Thus, lowland farms in the south-east of England have perhaps been moving to sheep production in order to replace the declining profitability of crops, such as wheat. Such increased lowland sheep production is in turn, putting pressure upon the traditional upland sheep areas.

These generalised statements are supported by the EC document on Land Abandonment (1980), which states that there is little or no abandoned land in Great Britain. However, the picture could well change if the current pressures on the agricultural industry continue, although other agricultural options remain, eg. new crops, such as sunflowers, are available in the lowlands. Some areas have been indirectly affected by other activities, eg. forestry, and are now virtually abandoned from agricultural production. Thus high mountain areas within the bounds of large new forests, such as the Cairnsmore of Fleet in southern Scotland may no longer be farmed. However, this land is rarely completely abandoned; rather, the level of production declines, and both sheep and deer may range on such land. The increasing concern about such abandonment is reflected in two new initiatives taken within the Institute of Terrestrial Ecology. The first is a desk study of the ecological implications of land abandonment in upland areas, and the second is a project on the ecological consequences of the set-aside scheme, sponsored by the Department of the Environment.

The limited work currently available on land abandonment is reviewed in the next section, before a summary of the general information available on the ecological effects of abandonment. Other sources of information at an ecological level which can indicate the effects of abandonment are then considered, and finally, some comparisons are made between Britain and other areas in Europe.

Ecological effects of abandonment

The effects of land abandonment are related to the basic ecological characteristics of the area concerned. In Britain, a major distinction can be made between the lowlands with crop plants, where soils have been agriculturally improved by the addition of nitrogen and phosphate, and the uplands, largely found in the north and west, where soil nutrient levels are low and the vegetation is dominated by native species. Not only is there a basic difference between the ecology of these zones, but also a major difference in the availability of propagules for colonisation. Superimposed on these major geographical zones are other factors, such as altitude and soil, which modify the patterns of colonisation markedly and which are necessary to define the ecological conditions present but this major division is fundamental.

Studies in the lowlands are limited because of the scarcity of abandoned land. Thomas (1963) made use of information available from transects in studies carried out before and after the advent of myxomatosis in the rabbit population. He showed a decline in species number following a cessation of grazing, and provided evidence that, in due course, the chalk grasslands, if abandoned, will revert first to scrub of *Crataegus* and *Sambucus* and eventually to some form of woodland, depending upon the soil conditions. Ward and Jennings (1989) also studied the dynamics of vegetation in the chalklands and reported a rapid colonisation in the first few years, followed by a period of stabilisation. These studies suggest that, in such situations, some sort of woodland will result from abandonment. Webb (1986) considers the ecological status of heathlands in Britain, and concludes that one of the main causes of loss of heathland is colonisation by trees, mainly of *Betula*. The reason is the decline in management of the heathlands within the 20th Century, in comparison to their former extensive use for cutting of fuel and also grazing. The increased level of nitrogen currently present in rainfall also encourages the expansion of woodland, rather than the former heathland vegetation dominated by *Calluna* and *Erica*. These conclusions are supported by Marrs (1988) who points out that there are cycles within the vegetation, but that these inevitably terminate in woodland in lowlands.

The classic sites for abandonment in the lowlands are the Broadbalk and Geescroft wilderness at Rothamsted Experimental Station in Hertfordshire. These sites were associated with experiments to examine the effects of fertilisers, and were a result of the failure of crops in treatments with no added nutrient. The sites were fenced and left without cultivation in 1881 and 1886 (Jenkinson 1970). Both sites are on slight slopes on brown earth soils, with relatively low rainfall. Initially, the vegetation consisted of weed species which changed rapidly over the years -23 of the species recorded in 1913 had been present in 1886, but 42 had come in since, and 17 were eliminated by competition.

Progressively, the areas were colonised by shrubs, and eventually by trees. By 1915, the Broadbalk was a dense thicket of oak, hazel and blackberry and other tree species. By 1960, the sycamore had increased but some of the initial hawthorns were dying. Geescroft developed in a similar way but had a higher proportion of ash. Jenkinson (1970) presents figures for the trees, which by this time were some 15 m in height, with total basal areas of 31.9 m^2 ha^{-1} in Geescroft and 54.8 m^2 ha^{-1} in Broadbalk. The sites have been used to illustrate the accumulation of organic matter, and demonstrate the long-term implications of abandonment in the lowlands of Britain.

Miles (1987) summarises the information available on the colonisation by *Betula* of open heather moorlands at intermediate and low altitudes in Scotland.

A variety of other woody species are colonising these moorlands and current evidence (Watson, 1989) suggests that significant colonisation is taking place, largely as a result of a decline in the traditional methods of moorland management by burning. There is also a suggestion (DAFS, 1986) that grazing pressure is declining in remote western areas, perhaps also leading to tree colonisation.

In the uplands, the majority of studies which have taken place are largely dependent upon fenced experiments to exclude grazing, which is the principal agricultural activity in these areas. Rawes (1981) studied blanket bogs, and showed the increase in *Calluna* and the decline in the small species, such as leafy liverworts. The botanical composition responded rapidly to the removal of grazing initially, but the rate of response subsequently slowed. In a later paper, Rawes (1983) showed a continuing decline in numbers, even after 24 years. On the more acidic land, *Deschampsia flexuosa,* and eventually *Vaccinium,* colonised the acid grasslands, and on the wetter soils distinctive patterns developed of aggressive species such as *Deschampsia caespitosa. Juncus squarrosus* moorland moved more into *Eriophorum* or *Calluna* bog. In these studies, high in the Pennines in northern England, no shrubs or trees were recorded due to the small size and limited seed source. In the same area, Marrs (1988) showed that vegetation structure changed dramatically with the decline in grazing, with significant increases in *Calluna* and decline of bryophytes.

Chapman and Rose (1986) took advantage of an area of bog which had been enclosed inside an extensive forest. They showed how the bog changed dramatically, from a pattern dominated by burning and grazing to one that was environmentally dominated by changes in drainage and subsequent drying out because of the management practices associated with afforestation. A decrease in grazing pressure could, therefore, have dramatic effects on the balance of vegetation in upland areas. Smith and Channon (1988) studied a similar area, and showed that the cessation of grazing and agriculture had led to drying out. However, this situation could be indirectly caused by the trees or by the increased efficiency of the drains in newly afforested land.

Hughes *et al.,* (1975) described how, in fencing experiments in Snowdonia, north Wales, the response varied markedly according to the soil type; *Nardus* declined in one area with *Molinia* replacing it, whereas *Deschampsia caespitosa* expanded in *Agrostis/Festuca* grassland. Hill (1983) summarised the data after a further 10 years and showed that, although the *Agrostis/Festuca* swards had retained their original character on the brown earth soils, the balance in species had changed, with more aggressive species dominating locally. The peaty podzols showed a more diverse stage of development with *Molinia* becoming the major species locally, whereas dwarf shrubs dominated elsewhere. The major changes took place between 4 and 8 years after enclosure, after which very little invasion by new species occurred, although one or two trees of *Sorbus aucuparia* had arrived. Other work in Snowdonia by Good (1989) showed that scattered shrubs of *Crataegus monogyna* had colonised in the 1930s in upland grazing, but had not developed into woodland because of grazing pressure in recent years. Miles (1987) further summarised the principles of dispersion by woody species, and the way in which they could colonise mountain areas, describing the dispersal mechanisms of the plants concerned.

Changes in upland areas are less dramatic compared with the overall structure of the vegetation in the lowlands, because of the paucity of woodland species in the uplands. However, the structure within the dwarf shrub vegetation does change dramatically, as does the balance of species within the vegetation. The above studies have been usually carried out in small fenced plots and therefore involve influences, eg of small mammals, which would not be comparable if areas of landscape were involved. The EC document (1980) summarises the process of succession on reverted areas, and suggests that it is governed by the following factors:

(a) Distance from bordering vegetation.

(b) The floristic composition of the bordering vegetation.

(c) The condition e.g. the nutrient level, land cover type or pollution level of the land after it has reverted.

(d) Weathering processes after the land has been left to revert.

(e) Floristic composition of the pioneer revertionary vegetation.

(f) Natural site factors.

(g) External intervention after the land has reverted.

Such a list of factors would enable the extraction of relevant ecological information for a given site, and produce a diagnostic procedure for identifying the end point of reversion. Miles (1987) has presented the available information on changes in upland vegetation, mainly due to grazing pressure, and Hill (in prep) is currently collating information on set-aside.

Work which is currently suitable for examining the implications of abandonment

An extensive data base is available as described by Bunce and Heal (1984) within ITE, derived from a survey of vegetation carried out in 1978 throughout

Britain with a partial resurvey in 1988 and with complete coverage in progress in 1990. The species data were recorded from 5 random quadrats within 256 1 km x 1 km squares, with an additional series of quadrats placed on linear features, ie hedgerows, streamsides and roadside verges. General details of the approach are also given by Bunce and Heal (1984). The following main analyses of species data have been carried out:

(a) Using only the presence data from the initial analysis, a clustering method has been used to group species with similar environmental affinities. These species groups have been used as a basis for determining the main change in environment between sample periods. A separate classification of species has been made for agricultural grasslands (Bunce and Jenkins, 1989).

The latter groups have been derived from the species cover information and therefore reflect more closely management practices than the presence or absence of individual species. The groups are being used to demonstrate the changes which have taken place over time with management practices and show the change in balance within species that could take place with abandonment.

(b) Vegetation types have also been produced, which contain complexes of species groups, and provide a broader scale of interpretation. The overall classification has been made of complete lists of species obtained from quadrats in 1978 in order to produce a simple and robust vegetation classification. The classes are broad, and enable the overall pattern of vegetation in Great Britain to be determined, thus providing a framework for examining the implications of abandonment and change.

In general terms, the changes resulting from abandonment or dereliction which falls short of complete loss of management can be related to the main vegetation types. An alternative approach is to use the species groups for indicating the management status of particular areas. Examples of such groups derived from multivariate analyses for cultivated grasslands are given by Bunce and Jenkins (1989) and the relationships are discussed in this paper. The species groups present in a particular area can indicate the potential for manipulating the land, and show what would happen in the case of abandonment. Studies are currently in progress using this approach to detect changes between 1978 and 1990. Preliminary interpretation suggests that, in lowland cereals and grasslands, there is little evidence of colonisation by native species, and any subsequent vegetation is likely to be very different. It is only in high mountain areas where the current vegetation is likely to continue relatively unchanged following abandonment because it has been relatively little affected by management. In the lowlands, the majority of species are restricted to linear features and small fragmentary parcels left in the corners of fields. Linear features contain more species per unit area, as well as many species not widely present in the surrounding landscape. In upland areas, the picture is more complex in that residual semi-natural vegetation contains many of the species present in the linear features. This emphasises the difference between the agricultural landscapes of the lowlands as opposed to the open grazings of the uplands where species are widely available in changing situations. In the lowlands, the species will have to spread from the linear features back into the open countryside, which Marshall (1986) has shown many species are unable to do. This inability is confirmed by the results of Hodgson (1989). The problem is further emphasised when the seedbank data are considered. Pearson (1989) has shown that, in the upland areas, the availability of seed from the soil is more limited than in the lowlands. So that in lowlands the seedbank would provide propagules whereas in the uplands the surrounding vegetation is more likely to be important.

Interpretation of the major divisions could be used to indicate the likely trends which could take place following abandonment together with general ecological knowledge that can be used to indicate the implications for species. The above discussion relates largely to the vegetation, and relatively little information is available from zoological studies. However, certain changes, eg the expansion of voles in fenced plots eg Rawes (1981), are well documented. The work by Sykes, *et al.*, (1989) provides quantitative information about the changes following afforestation, changes that are likely to be similar to those following abandonment. A succession of species took place, leading, after only 15 years, to bird populations typical of woodlands rather than moorland. General observations also on the spread of predators, eg. kestrels alongside motorway verges, and long-eared owls in forestry plantations that have recently been fenced.

Regional implications of potential abandonment

The approach described by Bunce and Heal (1984) can also be used to provide an objective framework for the country into broad zones (Bunce and Heal, 1984), within which the implications of abandonment can be examined. For the present purposes, the examination will be done at the level of four major regional divisions, which have geographical distributions, and vary locally according to altitude.

1. Lowland cereal lands

These areas are mainly in East Anglia, southern England, the Midlands and the Scottish lowlands. Aban-

donment in these areas is unlikely because of high profitability and high quality of the soil. One option considered above is set-aside, but there is no guarantee that this programme will continue after the five years of the current cycle. Not only are native species restricted largely to linear features, but there are also very high nitrogen and phosphate levels in most soils. Abandonment would, therefore, involve dispersal into soils that have been highly modified. Woodlands in this zone are generally small and fragmentary, and are therefore not a particularly useful source of propagules. The exceptions to the above rules are the areas of lowland heath (see above), where abandonment may lead to colonisation by trees. Wind dispersed trees are also of particular interest in the longer term.

2. Lowlands dominated by intensive grasslands

These areas are mainly in south-west England, the lowlands of Wales and northern England, extending into Scotland. The land is dominated by dense grasslands with high nitrogen levels and high productivity. The fields have largely lost their original variability through the intensive use of fertiliser and slurry application. Therefore, the problems are comparable to those in the cereal lands, in that most fields have a limited resource of species. However, they differ in that hedgerows and small woodlands are more common, and therefore provide a source of propagules. In many areas dense grass cover may inhibit colonisation by species for a significant period of time.

3. Marginal uplands

These are the most variable areas in Britain, both in terms of landscape and in vegetation as they contain elements of the limited cropland lowland grasslands, as well as upland vegetation at higher altitudes. Most abandonment in Britain has taken place in small fragmented units within this zone, largely as a result of the difficult terrain. There is a major difference between the propagules available from different types of linear features and as walls tend to predominate in this zone, the structure of the landscape will therefore affect colonisation. The colonisation of upland vegetation in this type of land could well be different from the true upland zone because more seed is generally available from woody species. Watson (1989) has recently described patterns of reversion in marginal uplands of northern Scotland.

4. Uplands

In the uplands, the principal factors are altitude and latitude and as they increase so the rate of growth slows, and the associated rate of change. In sample plots on Snowdon in North Wales at c. 1000 m, very little difference can be seen over periods of time up to 20-30 years. However, there is a major local difference in different soil types and local drainage conditions which can lead to different patterns. Furthermore, there is considerable variability between the varied vegetation of north-west Scotland, which is northerly in its affinities, and the more uniform upland vegetation of Snowdonia and the south-west of England. The variations therefore, need to be taken into consideration, and it is difficult to generalise because of the range of conditions present.

General information relating to habitat change within the four zones

1. Lowland arable

In the lowland arable zones evidence of abandonment can be seen on such sites as motorway verges and in vacant areas near towns. After abandonment, the high nitrogen/phosphate levels lead to rapid and dense growth, into which it is difficult for many species to establish. Strong colonisers such as *Urtica, Cirsium* and *Rumex* can often take over completely, and form dense mats of vegetation, with few gaps for other species to invade. Such a situation often occurs in motorway verges, where woodland species can only become established in the shade around the edge of tree groups. The timescale of such reversion is likely to vary widely from place to place, according to soil conditions and, particularly, the availability of seed.

2. Grassland

Abandonment in these areas would be very similar to that of the lowland arable zone, except that aggressive grass species are likely to take over, rather than the more generally available weeds. *Arrenatherum, Dactylis* and *Agropyron repens* are the main species involved, and can be seen dominating grasslands left vacant following building development plans or along roadsides that have been left unmanaged. *Anthriscus sylvestris* and *Heraculum spondylium* are also sufficiently aggressive species to colonise such grasslands. Eventually, *Rubus* and *Crataegus* would probably take over, leading eventually to woodland, although the timescale is not certain. Again, the final stages of the succession are likely to be variable in time, and dependent upon local soil conditions and the availability of seed.

An exceptional example on some motorway verges is the colonisation of *Primula veris* on more lime-rich substrata, with clear zones of expansion around the initial colonising plant. Again, the motorway verges show the

difference between abandonment where the soil conditions are relatively low in nutrients as compared with those sites where soil has been moved from agricultural situations, where coarse species tend to take over.

3. Marginal upland

If anything, this area has the most potential for change. Small fields and field corners are present in many upland marginal areas where dereliction has taken place, and eventually some form of forest is likely to return in most situations. The type of forest will depend upon the available seed source and the type of soil conditions present. In the lower levels, the woodland is likely to be of *Quercus*, whereas at high levels, *Betula* and *Juniperus* are likely to be important, dependent upon the ecology of the local conditions.

4. Upland

Abandonment of upland vegetation depends on the altitude and soil conditions, and needs to be related to the variable mosaics which occur in some areas in northwest Scotland. Although variation is wide in true upland situations, dwarf shrub heath would eventually return. Also, scattered shrubs of *Juniperus* are likely to colonise at the lower levels, and open woodlands may eventually develop. Such abandonment is likely to stabilise after some time. The original balance of grazing in upland areas has been highly modified because of the elimination of large predators. Also, soil conditions in the more extreme areas have changed considerably, because of the removal of forest and long, intensive periods of grazing. The succession will, therefore, be limited, according to local conditions and, in many cases, may not proceed to any significant degree.

Britain's place in Europe

The same framework will be followed in using the four broad zones to relate to conditions in Europe.

1. Lowland agricultural

The conditions here are comparable to other regions in northern Europe where intensive agriculture predominates, except that, in Britain, more hedgerows are still generally present in the landscape because of the more Atlantic conditions. However, as the EC map shows, abandonment in these areas is unlikely under current conditions, although set-aside is a possible option for the reduction of cereal surpluses.

2. Grassland

The agricultural grasslands in Britain are generally more intensively managed than in many areas of Europe and, because they are effectively monocultures, they are likely to develop similar patterns as in the lowland arable areas. Comparable areas can be seen in the grassland areas of Denmark and France, but, as with the previous category, hedgerows and linear features are probably more important in Britain than in these other areas except in Normandy and Brittany. Detailed comparisons would need to be made of the regenerative capacity of different landscapes in these zones, in order to determine the potential effects of abandonment.

3. Marginal uplands

The EC document shows that abandonment is currently mainly taking place in this zone throughout Europe, from the Auvergnes to the Vosges, Jura, Pyrenees and the mountains of Spain. More limited areas have been abandoned in Britain but an important factor is the greater extent of forest in Europe which means that there are more propagules available from woodland species. The expansion of woodland therefore takes place more rapidly than in Britain enhanced because the soils are also generally more suitable for forest growth. This abandonment in Europe tends to be followed by quite rapid development of forest whereas in Britain the process is slower.

4. Upland

The scale of the British uplands, with their Atlantic vegetation and extensive bogs and mires, is not encountered on the European Continent. Limited areas in western Norway are similar, but further south the soils are not as degraded as in Britain. The effect of abandonment is, therefore, likely to be less pronounced because of the slow rate of change in the vegetation and soil. The hay meadows, grazings and alpine vegetation present in mountain areas on the Continent are not present in British mountains, except as fragments on high cliffs where they are buffered against change. The former categories are dependent upon intensive management in Europe and are changing, whereas in Britain, with range grazing, the change is likely to be much slower, as described above. To conclude, abandonment is likely to have less effect in the higher mountains of Britain, compared with similar topographic areas in Europe.

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