Chapter (non-refereed)

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Impacts of agriculture on southern grasslands

M G MORRIS
Institute of Terrestrial Ecology, Furzebrook Research Station

1 Introduction

This paper aims to outline the changes which intensification of agriculture has produced in lowland grasslands, and particularly on their invertebrate faunas. It also, and more importantly, identifies 4 main areas of research which are judged to be vital for an understanding, and possible reconciliation, of modern agriculture and wildlife conservation.

2 Agricultural impacts

The primary aim of agriculture is, and always has been, to channel photosynthetic solar energy directly or indirectly into a form which can be assimilated by man as food. The primary aim may be associated with a number of different subsidiary aims, which at different times have had a varying effect on the primary aim because of economic, social and other factors.

Until, say, the decade 1940-50, agriculture was sufficiently inefficient overall to allow some photosynthetic energy to be channelled into pathways which did not produce food. This inefficiency was not intentional, but occurred because agriculture lacked the technology and means to be efficient (in terms of energy transfer). The conservationist, inasfar as he existed before 1940, and wildlife were the beneficiaries of inefficient agriculture. There is no means of knowing how far inefficient agriculture in historic terms reduced or altered the wildlife interest, except in the very broadest terms, for instance in the change in the proportion of woodland compared with grassland on agricultural holdings, or in the past records of species which are now locally or nationally extinct.

This analysis, although, of course, simplistic, helps explain and emphasize why modern intensive agriculture and wildlife conservation are fundamentally incompatible. When lowland grasslands, specifically, are considered, it is evident that the picture is one of straightforward destruction of all the kinds of grasslands which are richest for wildlife. This destruction has been of 2 distinct kinds, though ultimately the results have usually been the same.

First, much grassland has been converted into arable land, because of the profitable advantages of specializing in cereals rather than sheep or cattle. Areas which have 'traditionally' been regarded as grasslands, such as the South Downs, have been ploughed up and sown to barley and other cereals over what is perceived to be a very short period. Changes of this sort, though perhaps not on the same scale, have occurred in the past, largely in response to economic factors such as the rise (or fall) in the price of wool, or the ability (or inability) to import grain more cheaply than it could be grown.

The second type of change has occurred in the areas of grassland themselves. Traditional technology, often complex and highly evolved, eg the management of water meadows, has given way to systems which concentrate on the production of single-species crops of particularly high yielding strains of grasses, such as rye-grass, deliberately 'improved' by breeding. Emphasis is on leys, or very short-term 'permanent' grasslands. Species-rich swards have been changed by the application of 'artificial' fertilizers, particularly nitrogen, which greatly affect the competitive advantage enjoyed by a few vigorous grasses over herbaceous species. Sod-seeding, and 'single pass' machines which combine herbicide application to existing swards, sowing of more 'productive' grass species, and fertilizer treatment in one operation, though in less general use, have contributed to changes in the type and species composition of agricultural grasslands. More generally, draining of the lower lying and wetter grasslands and 'improvement' of poor, acid grasslands on sandy soils have also taken place, with the original swards being either destroyed or greatly changed.

Generally speaking, farmers find it profitable to convert only relatively large areas of comparatively flat or gently sloping land to arable or ley. With very few exceptions, however, lowland grasslands are examples of plagioclimax vegetation, in which ecological succession (to woodland or forest) is in dynamic equilibrium with management in the form of grazing or mowing for silage or hay, or a mixture of grazing and cutting. The loss of management from these areas which have escaped destruction, usually small and steep, itself leads to very considerable changes in the sward, though to some extent these are reduced or retarded because soils on such steep areas tend to be thin and physically unstable. Although such changes are profound, they are less catastrophic than those produced by ploughing or re-seeding, and in some cases may even be beneficial, at least temporarily, to some species of wildlife (Morris 1971; Thomas 1983).

3 Effects on wildlife

The effects of changes in lowland grasslands on their plant species composition are obvious enough. Large numbers of herb species do not grow in rye-grass leys, and orchids do not flower in barley fields on the chalk.

The effects on phytophagous insects which are restricted to particular species of plants are almost equally apparent. Familiar examples are the Adonis and chalkhill blue butterflies, which feed only on horseshoe vetch. The foodplant grows only in unimproved, traditionally grazed, calcareous grasslands, and where it is absent the butterflies will not be found.

However, little information exists on how other, more general, feeders have been affected by these changes. The Game Conservancy has studied intensively 'whole faunas' on farmland, including the biomass of invertebrates available as food for gamebirds such as partridges. The faunas of the grasses themselves, and the extent to which rye-grass or other agricultural species supports diverse associations have been investigated in much less detail. Preliminary work by Morris and Rispin (unpublished) shows that rye-grass leys support fewer generalist Hemiptera, particularly grass feeding leafhoppers, and Coleoptera than unimproved grassland on the same farm. Grass feeding butterflies, such as species of Satyridae and Hesperidae, do not apparently utilize species of rye-grass as foodplants.

Though agricultural land is, or was, an important habitat for vertebrates, these animals, because of their size and mobility, tend to be less restricted to 'grasslands', 'woodlands' or other physiognomically defined biotopes. Although they are in a sense less restricted and more flexible in their ecological requirements, their conservation in fragmented and isolated habitats poses special problems which are less pressing for plants and invertebrates.

4 Current research

Research on the conservation of the invertebrate animals of lowland grasslands has tended to concentrate on the management of existing nature reserves and other protected sites. There has been a *de facto* recognition, or at least assumption, that their conservation on agricultural grasslands is inappropriate. Survey and, to a lesser degree, site selection play a far greater part in the conservation of invertebrates than they do for plants (where past survey has been more thorough) or vertebrates, particularly birds (where, despite the many RSPB reserves, the animals tend to be less site-dependent). Research on grassland management has included investigation of traditional practices (grazing, mowing), as well as of more radical ones (burning, re-seeding with 'conservation' mixtures) and the timing and duration of management. It has proved difficult to persuade reserve managers to depart from relatively simple management systems, such as 'annual light grazing', for a number of reasons.

4.1 Structure of grasslands

Management research has readily identified structure and its dynamics as important factors in the conservation of grassland invertebrates. Different species require very different conditions in the sward, with some, such as the Adonis blue butterfly or the leafhopper *Macrosteles laevis*, present only on very short, recently managed swards. Other species require much taller, less recently disturbed grasslands and, in general, there are more of these species. Management of small grassland nature reserves, therefore, has to be well organized, with an emphasis on maintaining both 'short' and 'tall' grasslands continuously in time (though not in space) by the practice of rotational management. Though grassland structure is clearly important in determining the presence and abundance of invertebrate animals, recent research has identified other factors. In particular, the availability of nitrogen has been identified as crucial for many insect populations, perhaps most. Pressing needs for further research in this field are identified in the next section.

4.2 Effects of area and isolation

Of more recent relevance has been research on the general topic of the effects of area and isolation on invertebrate populations, with emphasis on practical ways of dealing with local extinctions on nature reserves through 'artificial' re-establishment of populations, once their detailed requirements have been thoroughly understood. The actual effects of fragmentation and isolation of grassland habitats have been little studied, although valuable insights into the probable nature and magnitude of the problems have been acquired from studies on other biotopes, particularly lowland heaths.

5 The needs for future research

5.1 Modern agricultural land as a habitat for wildlife

Despite clear perceptions by both agriculturalists and conservationists, and much useful work, there is still a need to assess the value of lowland agricultural grasslands, particularly leys, as a wildlife habitat and resource in the context of wildlife on farmlands. In many farms, there are still patches of unimproved grassland and these, too, need to be assessed as reservoirs of wildlife. Although there should be no pre-judging of the issue, most conservationists, and some agriculturalists, would expect that modern agricultural grasslands are a poor habitat for wildlife. If this is the case, the next main area of research is particularly relevant.

5.2 The nature of the 'background matrix' for wildlife, ie the countryside—has it been eroded by modern intensive agriculture?

To some extent, this is an approach to the value of agricultural grasslands from the other side. In particular, the question needs to be asked whether 'background conservation' has drifted away from agricultural grasslands to other areas, such as roadside verges, urban grasslands (including gardens), amenity grasslands, military ranges, and the lower echelons of 'protected sites', ie those not managed primarily for wildlife conservation, such as much National Trust land.

5.3 Ecological processes and agricultural impacts

Whilst the first 2 areas of research contain a large element of survey work, the third topic requires detailed ecological investigation. The processes which need to be understood to assess the past, present and future impact of intensive agriculture concern the capture and transfer of energy, and involve a subject which has lost some of the 'fresh bloom of youth' just

Plate 5. The concentration of sheep on the edge of moorland has resulted in the loss of heather dominant vegetation. There is a need to investigate the consequences of certain husbandry practices for future land management and wildlife. (Photograph P J Hudson)

Plate 6. Immature red grouse suffering from louping ill, a virus infection transmitted by the sheep tick Ixodes ricinus. *Although the diseases transmitted by ticks cause serious economic loss to hill farmers and grouse moor owners, the population dynamics of this parasite are poorly understood. (Photograph P J Hudson)*

Plate 7. Agricultural improvement alters the landscape mosaic which, with a high proportion of semi-natural vegetation, has been generally characteristic of marginal upland areas. This trend is seen in a view in mid-Wales. In the foreground, rough pasture is being improved in stages to more uniform boundaries. In the mid-distance, moorland reclamation is dissecting the former heather and bracken hills, with scattered scrub on slopes, into a pattern of ley grassland and small conifer plantations. (Photograph P G Ainsworth)

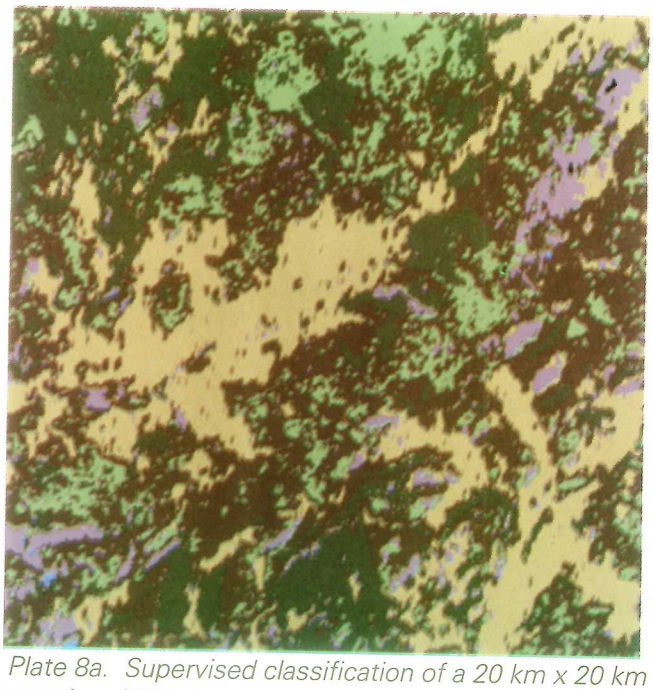

Plate 8a. Supervised classification of a 20 km x 20 km area in mid-Wales

Key: Dark green — woodland
Light green — wetland
Brown — moorland
Yellow — pasture
Blue — lakes
Mauve — scree/rock

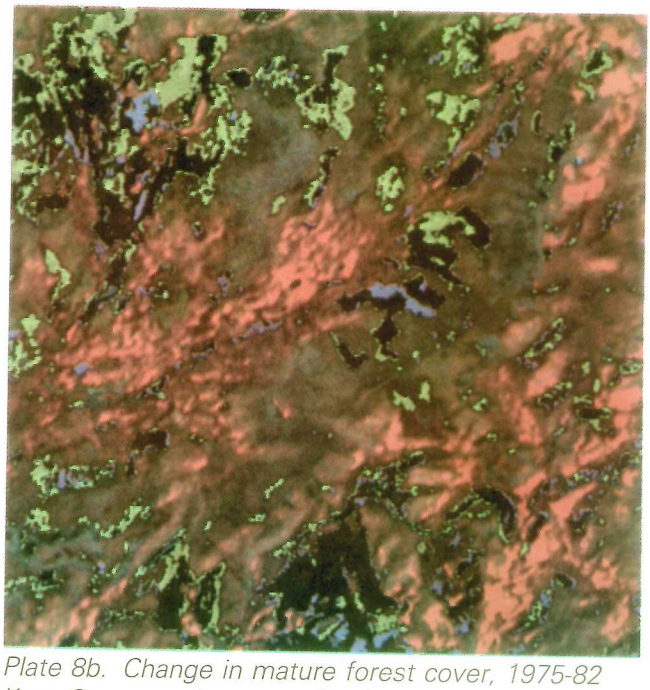

Plate 8b. Change in mature forest cover, 1975-82

Key: Green — increase in forest cover between 1975 and 1982
Blue — reduction in forest cover between 1975 and 1982

(Photographs: R J Parsell)

recently—ecological energetics. The ecology of crop production in energy terms is the key issue. Almost equally important are studies of the processes in which fertilizer use affects wildlife, though probably the importance of other farm chemicals lies with herbicides rather than insecticides, insofar as grasslands, in particular, are concerned.

5.4 The prospects of alternative conservation scenarios in the late 1980s and beyond

In the view of most wildlife conservationists, the intensification of agriculture, and the changes it has produced have reached a point when the traditional view of farmers as the 'guardians of our wildlife heritage' can no longer be substantiated, despite the influence of Farming and Wildlife Advisory Groups generally, and the influence of individual farmers in specific cases. The most popular proposals are ones which have received considerable exposure recently: in effect, agriculture must change radically to conserve not just wildlife but landscape and the wider countryside, in the interests of the public at large. The proposals differ in their details. Some aim to bring agriculture within the framework of planning controls. Others have the objective of developing social and fiscal structures which, at least to some extent, take away the need for farms to respond to market forces, on the one hand, and to partly artificial stimuli (such as the CAP) on the other. Whatever the detail, many conservationists are saying publicly that agriculture 'must' change, though the public and political will to do so has not been demonstrated. A particular concern is the fate of SSSIs under the 1981 Wildlife and Countryside Act. Already there are signs that the Act is not operating effectively, and that, in some respects, it may be having some reverse effects from those intended, eg in pushing up the prices of SSSI land.

A minority considers a very different scenario. It is clear that, if agriculture does not change radically, then some very different attitudes towards wildlife conservation may have to be adopted. In particular, nature reserves and other 'protected areas' will have an enhanced status, and their management and manipulation (for instance in establishing plants and animals on them) will become much more important. The management of grassland reserves has already attracted some research, but more is needed.

Another exciting field is the re-creation and reconstruction of ecologically diverse and interesting biotopes on devastated land. This is an area which has been neglected in conservation texts on grassland (eg Duffey *et al.* 1974), but given prominence by others (Bradshaw 1977). Although the difficulties in approaching 2 antagonistic areas of prediction for the future of agriculture and conservation are immense, the problems will have to be faced in the context of research. In many ways, a prediction that agriculture will change radically seems unrealistic. Studies of the functions of nature reserves and their manipulation will never be entirely wasted, but their practical value will be reduced if such radical changes do occur. It is clear that these problems involve not just ecologists and agricultural scientists, but economists, social scientists and many others.

6 Summary

Agricultural grasslands are efficient machines for producing food; 'waste', as wildlife, is becoming scarcer. Traditional grasslands have been destroyed, some by conversion to arable land, others to leys. Current invertebrate research is on management of protected sites and their fragmentation and isolation, vegetation structure, and nitrogen availability. Four broad themes for future work are: the degree to which agricultural grasslands conserve wildlife, the nature of 'background conservation' and its relation to protected sites, ecological processes, and realistic conservation scenarios for the late 20th century.

7 References

Bradshaw, A.D. 1977. Conservation problems in the future. *Proc. R. Soc. Lond. B,* **197,** 77-96.

Duffey, E., Morris, M.G., Sheail, J., Ward, L.K., Wells, D.A. & Wells, T.C.E. 1974. *Grassland ecology and wildlife management.* London: Chapman & Hall.

Morris, M.G. 1971. The management of grassland for the conservation of invertebrate animals. In: *The scientific management of animal and plant communities for conservation,* edited by E. Duffey & A.S. Watt, 527-552. (Symposium of the British Ecological Society no. 11). Oxford: Blackwell Scientific.

Thomas, J.A. 1983. The ecological status of *Thymelicus acteon* (Lepidoptera: Hesperiidae) in Britain. *Ecol. Entomol.,* **8,** 427-435.