Chapter (non-refereed)

Heal, O. W.. 1984 Report on the discussions of the syndicate on uplands. In: Jenkins, D., (ed.) Agriculture and the environment. Cambridge, NERC/ITE, 185-188. (ITE Symposium, 13).

actions, eg leaving bands along field boundaries untreated by herbicides and pesticides, may have little impact on crop production, but major beneficial effects on landscape and wildlife.

8 Recommendations

8.1 More advice should be provided, as soon as possible, on minimizing the impacts of agriculture on wildlife. This advice should be drawn from existing ecological knowledge and disseminated through the FWAGs and the advisory/extension services of MAFF, and the Colleges of Agriculture, Scotland.

8.2 An integrated data base should be established, at national and regional scales, of existing land cover, land use and landscape; this data base should form the basis against which future changes can be monitored.

8.3 'Island' biogeographical studies need to be made of the sizes and patterns of distribution of wildlife habitats that could enable selected species and assemblages of species (plant and animal) to be sustained in areas dominated by different types of agriculture.

8.4 Autecological studies of key species (plant and animal, mobile and sedentary) are required, taking particular note of water relations (the impact of land drainage) and the flow of nutrients.

8.5 On the basis of present knowledge, and as improved by 8.3 and 8.4, experimental work should aim, so far as possible, to re-create habitats, and their associated plant and animal assemblages, which have been lost as a result of recent agricultural developments.

8.6 Consideration should be given to the establishment of a series of dispersed trials to test the effects of agricultural practices, changes in these practices, and the results of habitat loss and re-introduction, on the abundance and diversity of wildlife.

8.7 Accepting that the interests of productive agriculture and conservation need not always conflict, it is mutually desirable to know more about wildlife as a possible reservoir of pests and pathogens of domesticated plants and animals, and *vice versa*.

8.8 Desk studies should be made to predict possible regional impacts on landscape and wildlife of agricultural changes that could follow a modified CAP approach to agricultural production within the European Community.

8.9 If interests in agriculture, wildlife, and landscape are to be harmonized, it is essential that effective mechanisms are established by which environmental impacts can be predicted in advance of potential changes in land use and in management methods.

Reference

Stanley, P.I. & Hardy, A.R. 1984. The environmental implications of current pesticide usage on cereals. In: *Agriculture and the environment*, edited by D. Jenkins, 66-72. (ITE symposium no. 13). Cambridge: Institute of Terrestrial Ecology.

REPORT ON THE DISCUSSIONS OF THE SYNDICATE ON UPLANDS

O W Heal, Reporter

An initial basis for assessing research priorities is to identify those areas of the uplands in which agriculture is likely to change and where such changes will influence wildlife, either directly or through consequent changes in other land uses. This basis is provided by Eadie's (1984) scenarios, which also serve to emphasize the need to recognize the variability in the climate, soil, vegetation and land use within the uplands*. The most likely pattern of agricultural development is given below.

i. In the higher and remote Hill farms, agricultural production as a primary land use objective will continue to decline. Management for nature and landscape conservation and for recreation may depend on artificial maintenance of farming and manpower.

ii. On Upland farms, particularly those with relatively high proportions of sown pasture, agriculture will remain strong, intensification is likely to continue, and wildlife objectives will have to be incorporated within farm management.

iii. On the better Hill farms in the less remote areas, the options for change are greatest, and potentially most controversial. The extent of conversion of indigenous pasture to sown grassland will depend on economic incentives and social priorities, but with associated control of the indigenous vegetation through grazing management. Forestry is a major alternative in these areas, again with the potential to minimize conflict through collaboration in defining objectives and through sensitive management.

This generally accepted scenario identifies the broad variation in land use, related to land type, and shows the combinations of user interests which characterize the uplands. The background papers and discussions

*The general term 'uplands' is used for land on which farming is dominated by sheep or sheep and cattle rearing. In Eadie's scenario, the distinction is made between the higher Hill farms where sheep rearing is dominant, and the Upland farms, on lower or better land, with mixed sheep and cattle rearing. This distinction is applied to England and Wales as well as to Scotland.

identified a very wide variety of research topics, which are considered under 4 headings: (1) strategic planning problems, (2) specific aspects of management, (3) general problems, and (4) ecological principles. Additional comments about the research are grouped under (5) practicalities and implementation.

1 Strategic planning

Although agriculture is, historically, the major land use in the uplands, its extensive rather than intensive management practices, combined with the natural features of the environment, have allowed and encouraged a mixture of land uses. Nature and landscape conservation, recreation, game management, and water catchment often combine within an area, one or other sometimes being dominant. There is a gradual shift in land use interests, for economic, social or political reasons. For example, in recent years the demand for land for forestry has increased and is likely to continue to increase, and additional uses such as biofuel production may be considered, even if only on a local scale. In this way, the inter-relationships between agriculture and wildlife influence, and are influenced by, other land uses. Because of the intimate mixture of uses, even if not actually integrated on the same piece of land, interactions between agriculture and wildlife cannot be considered in isolation. Although most of the uplands are privately owned and there is no central rural planning responsibility, the various national Departments and Agencies have distinct objectives. These objectives are implemented through a complex combination of financial incentives, price controls, education, advice, etc, as well as by land ownership.

It was recognized that ecological research must be considered within this general framework. Research priorities are influenced by the land use interests, and ecological information is required in assessing possible changes in land use. Three linked aspects of strategic planning were considered to have priority in this area of research.

1.1 Assessment of the compatibility of the objectives of land use interests in the uplands

There is potential conflict (constructive tension) between user interests, particularly in the land identified in Eadie's (1984) scenario as the better Hill farms. Changing patterns of agriculture with related development of forestry are likely to produce greater changes in wildlife and landscape on this land than elsewhere in the uplands, and will affect the social and economic systems. This conflict was identified by the Countryside Commission in their publication *What future for the uplands?* and requires independent research to define the extent to which user objectives are compatible within this zone and to examine options which will provide maximum mutual benefit to user interests. Such research requires the development, and acceptance by users, of methods applicable at national, regional and local scales.

1.2 Interaction between land uses and wildlife

The uplands consist of a mosaic of uses and habitats. Changes in one land use affect adjacent uses, eg stock densities and distribution on indigenous pastures are influenced by afforestation, and many of the more mobile wildlife (insects, mammals and birds) respond to changes in the composition and arrangement of the habitat mosaic. Research has tended to concentrate on effects of specific land uses, and more information is needed on the interactions between land uses and on the wildlife response to the habitat mosaic.

1.3 Efficiency of mechanisms controlling land use

Although outside the direct field of ecological research, it was recognized that further research was necessary to quantify the relationship between change in the target land use to various incentives and disincentives, and to identify the consequent responses of non-target uses, including the application of compensatory controls.

2 Specific aspects of management

2.1 Grazing interactions with indigenous vegetation

From the frequency with which the subject was raised, the response of indigenous vegetation to variation in type and intensity of grazing pressure was regarded as a high priority for ecological research. Grazing is a dominant factor controlling the composition and pattern of upland vegetation. Although the general trends in vegetation change in response to grazing are understood, many of the details necessary to predict change and to define management policies are still obscure. The subject has been developed by Milner (1984) and is applicable (i) to Upland farms where intensification leads to stock changes on rough grazing, (ii) to the better Hill farms where stock density and distribution are modified by changes in the type and pattern of land use, and (iii) to areas with poorer Hill farms where management for nature and landscape conservation may have to be defined, given a decline in agriculture. Central to this research must be the recognition of the adaptive behaviour of mammals.

2.2 Management of indigenous vegetation

Again, although the general principles of vegetation management through burning and draining are understood, variations related to the range of upland climatic and soil conditions and their interactions with grazing still require research. The dynamics and control of dominant species such as bracken, heather, purple moor-grass and mat-grass are focal points in relation to nature and landscape conservation, in terms of both the control of unwanted species and the regeneration of desired communities. Associated with heather management, there is a need for continued research on grouse population dynamics, emphasized by uncertainty on the factors responsible for recent population decline and the role of ticks as disease vectors.

2.3 Effects of agricultural improvement on wildlife

Within the Upland farms, intensification is likely to continue, with changes in the patterns of sown

pastures along the moorland fringe and in winter feeding regimes. These changes will affect grazing intensities and distribution on the rough grazings, and require research on the relationship of agricultural intensification to stocking characteristics. The selection of areas for improvement can also affect wildlife directly, for example feeding grounds for golden plover, and research is required to identify the type of area which is most sensitive for wildlife and which should be excluded from reclamation schemes on conservation grounds.

2.4 Recreation and wildlife

In the uplands, informal recreation is claimed to conflict with nature conservation and with field sports, eg deer stalking. There is much argument amongst different interest groups as to the correct balance of objectives for upland areas. Thus, there is need for more quantitative information on the nature of the impact of different types of recreation on various forms of wildlife, under the varying upland conditions.

2.5 Interaction of afforestation and wildlife

Afforestation, and subsequent forestry practices do not influence wildlife in isolation but in combination with agriculture and other land uses in the area. A recurrent research theme was for more quantitative information on the effects of varying types of forestry on wildlife, recognizing the diversity of the uplands. The aim is to define distribution and types of forestry which are most acceptable to nature and landscape conservation, as well as being commercially viable.

3 General problems

3.1 Acid deposition

Whilst it was accepted that there was already significant research on 'acid rain', it was emphasized that more factual information was required on the short- and long-term effects of increased acid deposition in the uplands on wildlife, and of particular concern was the extent to which interaction of deposition with forest cover results in soil and water acidification, and also the potential of management practices, eg liming, to ameliorate acidification.

3.2 Upland/lowland interactions

Changes in the wildlife populations of the uplands are influenced by lowland as well as upland agricultural practices, particularly birds and mammals which either migrate seasonally or which feed in the lowlands. Thus, research on upland wildlife must include analysis of the effects of lowland agriculture.

4 General principles

The need to develop basic ecological research and improve the theoretical basis of upland ecology was a recurrent theme in discussions. Specific management problems may be approached by *ad hoc* research, but solutions are likely to be more sound and of wider application if developed from a theoretical as well as a practical base. Although not discussed in detail, the areas of fundamental research most relevant to upland wildlife problems were identified.

4.1 Ecosystems

The essential concept is that the subject influences, and is influenced by, other components of the system. The relationships involve feedback effects which account for responses which are not predicted from more superficial analysis. The principle applies at each level of study, eg a particular species such as bracken, an element such as nitrogen, or a land use such as forestry. In each case, the subject must be considered as part of a wider ecosystem, the research requiring an understanding of processes in other disciplines.

4.2 Island biogeography

Analysis of the principles of wildlife response to the size and spatial arrangement of habitats is particularly important in relation to changes in land use and the resulting habitat mosaic.

4.3 Nutrient balance and soil fertility

Management practices modify the nutrient economy of upland ecosystems and the soil characteristics. Such modifications must be analysed in the context of natural trends in nutrient balance and soil development, and their reversibility.

4.4 Plant community dynamics

Abrupt or gradual increases or decreases in management intensity result in changes in vegetation composition which can be understood in the framework of succession theory. This theory includes understanding of the biological characteristics of species which determine their ability to colonize, establish and survive under varying degrees of competition and stress. In the uplands, 'stress' must be considered in terms of the pervasive influences of grazing, climatic severity, and low fertility soils.

4.5 Animal population dynamics

Conservation of individual species and control of pests and disease vectors are aided by research on population dynamics, recognizing that population regulation in the uplands is often density independent for species at or near the edge of their environmental range, but density dependent for typical upland species. Introduction of new crops and conditions results in population changes that can be related to concepts of succession which require further development.

5 Practical aspects of ecological research

In addition to the priority research topics identified in the symposium, certain emphases in the research and some practical requirements were highlighted.

5.1 National and regional data base

Although many data are available from different organizations and from different parts of the country, there is still a need for a comprehensive national data

base which defines environmental and land characteristics, current (and past) land use, habitats and species distributions. A key feature is for these data to be compatible in resolution and spatial presentation. Such base-line data are not an end in themselves, but provide a basis for planning and for assessment of potential and actual change, and enable local and regional features to be placed in a national context.

5.2 Monitoring

Recurrent debate about the rate and direction of change in land use and associated wildlife and landscape could be more profitable, if the fragmented monitoring schemes were integrated and related to forecasts.

5.3 Prediction

Whilst information on the current state of land use and wildlife and on recent change is important, it is more important to assess the options for change and to predict probable change. Descriptive research tends to dominate, but an essential requirement in planning and decision-making is for ecological research to be more predictive, and to anticipate change rather than react to it.

5.4 Large-scale experiments

The need for large-scale experiments, including catchment studies, arises from the recognition of the interaction between land uses (2.2) and management practices (3.1-3.5) and the importance of an integrated ecosystem approach to research (5.1). Such experiments need not necessarily involve major management treatments, but require a multidisciplinary approach to the study of selected areas. The danger of non-replicated experiments was emphasized, as was the need to link main study sites to the wider range of upland variation through more extensive sites with a lower intensity of research input.

5.5 Communication, interpretation and implementation of research

Communication of research results from research scientists to managers and policy-makers needs to be improved. It requires a willingness on both sides and, in some cases, an intermediate stage of field demonstration through organizations such as ADAS. The efficiency of communication and interpretation may be a key research area in itself, with analysis of the variety of mechanisms involved. There was repeated comment that a wealth of information and experience on upland ecology already exists but that this capital is not being fully utilized, often because of the artificial barriers of technical expression of results by scientists, and resistance to sophisticated methods by planners and managers.

A final point, expressed by many, was that much of the research and its implementation does not usually fall simply within the responsibility of one organization. The research often requires experience from different backgrounds and disciplines and demands both increased collaboration between organizations and more flexible funding arrangements, particularly in the funding of strategic research designed to clarify and solve the problems of tomorrow, rather than *ad hoc* research on today's problems.

References

Eadie J. 1984. Trends in agricultural land use: the hills and uplands. *In: Agriculture and the environment,* edited by D. Jenkins, 13-20. (ITE symposium no. 13). Cambridge, Institute of Terrestrial Ecology.

Milner C. 1984. Some ecological principles underlying hill sheep management. In: *Agriculture and the environment,* edited by D. Jenkins. (139-142). (ITE symposium no. 13). Cambridge: Institute of Terrestrial Ecology.

REPORT ON THE DISCUSSIONS OF THE SYNDICATE ON THE USE OF AGROCHEMICAL

I Newton, Reporter

The aim of this syndicate was to define the research needed for a better understanding of the long-term effects of chemicals on agricultural ecosystems. Discussion was limited to chemicals used in agriculture, and excluded those (such as sulphur) which reached farmland from other sources. As most pesticides and herbicides are not specific, they inevitably affect many non-target species, and thus alter the whole community of animals and plants. Despite the importance of the problem, large gaps in knowledge emerged, probably due to the research needs in this field falling between the traditional remits of existing research organizations (particularly AFRC and NERC), or at best being near the borders of their remits; hence, neither organization has funded substantial work in this field. Discussion centred on the following aspects.

1 Detection of problems caused by chemicals

Monitoring programmes are at present run by MAFF (incident scheme), Water Authorities (water quality and pollution incidents), BTO (bird censuses), ITE (organochlorine and metal residue analyses) and others, while beekeepers and other members of the public have often reported mortalities associated with chemicals. In these schemes, vertebrates are well covered, but, with a few exceptions, invertebrates and plants are not.

More monitoring of invertebrates and plant communities was thought desirable, along the lines of the Game Conservancy's North Farm project, and with the aim of following changes in the whole ecosystem which accompany changes in total chemical use. Such work is costly and time-consuming, and may be best done as a joint project, involving several organizations. One way to begin may be in conjunction with autecological studies of particular farmland species.

In any agricultural system, most of the changes resulting from chemical use may have already occurred, and the best that can be achieved is to follow the further changes as one group of chemicals is