MANAGING FIELD MARGINS FOR THE CONSERVATION OF THE ARABLE FLORA.

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ABSTRACT

The margins of arable fields are of great value for the conservation of endangered plants. Changes in farming practices during recent years have resulted in the severe decline of many species including some which were once very common, and some have even become extinct. There is therefore an urgent need for guidelines for the conservation management of these species and their communities. "The Wildflower Project" carried out between 1987 and 1990 showed that herbicide and nitrogen use were very important factors that could be easily manipulated within modern farming practice. The second phase of this project is designed to test these factors in practice and to provide some indication of the costs of management for the conservation of endangered arable plants.

INTRODUCTION

Since the revolution in arable farming since 1945, many species of arable weed such as *Scandix pecten-veneris* and *Ranunculus arvensis* which were once common, have become very rare. Others such as *Arnoseris minima* and *Caucalis platycarpos* have become extinct. In addition to the progressive restriction of many species to sites with conditions that are favorable to annual plants of mediterranean origin near the edge of their climatic range in Britain, most species are also becoming restricted to the extreme edges of arable fields where agricultural inputs are less efficient and crop yields are reduced (Wilson, in press).

Britain's arable field margins still contain populations of a number of threatened plant species. These include 25 that are classified as "Nationally Scarce" (recorded from fewer than 100 10km squares), and 24 "Red Data Book" species recorded from 15 or fewer 10km squares (Perring & Farrell, 1983). At least five further species are now of "Red Data Book" status. Of these "Red Data Book" species seven are now extinct, and ten others no longer occur in strictly arable habitats. Nine now receive full legal protection, although only two of these still occur at all in arable habitats (Wilson, 1994).

There is an urgent need for the conservation of these endangered species and the communities within which they occur, however until recently, little information has been available on which management can be based. It has also been difficult to persuade many conservationists that the arable habitat is of any importance.

THE WILDFLOWER PROJECT - PHASE 1.

A three-year research project was started in 1987 with the aim of investigating factors in the biology and ecology of a range of uncommon arable weeds which may be manipulated within the context of modern farming. Some of the findings are summarised below.

Germination periodicity and performance in relation to crop sowing time.

As a result of the germination periodicity of individual weed species, crops sown on different dates can support very different communities, even when the seed-bank is similar. Differences are greatest between autumn- and spring-sown crops, but can also be large between early and late autumn sowings and early and late spring sowings (Table 1). Changes in crop rotations and sowing times may have affected species with narrow germination periods.

TABLE 1. Mean numbers of plants in 4m² plots of cereal sown on seven dates. Significance levels: *** P<0.001, ** P<0.01, * P<0.05.

Crop	Winter barley			Winter wheat			Spring barley			
Date	29:9	13:10	2:11	13:10	2:11	19:11	16:2	9:3	28:3	P
Agrostemma githago	20.2	6.1	0	7.3	0	0	0	0	0	***
Petroselinum segetum	4.3	8.0	5.0	6.1	3.0	0	0	0	0	***
Torilis arvensis	8.1	12.4	14.4	8.0	12.2	8.0	0	0	0	***
Scandix pecten-veneris	1.4	5.4	5.2	5.6	5.0	4.2	0.4	0.1	0	***
Ranunculus arvensis	2.5	10.3	13.0	12.4	16.5	5.4	0	0.1	0	***
Buglossoides arvensis	3.7	14.6	16.6	17.4	17.3	9.6	2.2	9.5	8.7	***
Adonis annua	0.1	1.7	3.7	3.3	5.7	7.1	0.2	0.9	0	***
Papaver argemone	0.1	0.6	2.8	0.2	4.9	5.9	0.7	2.0	1.3	**
Valerianella rimosa	2.6	5.2	9.5	0.9	6.0	12.7	4.4	7.4	5.1	*
Papaver hybridum	0	0	2.4	0	2.7	13.5	2.1	4.8	3.5	***
Chrysanthemum segetum	3.4	0	0.2	1.0	0	0.4	5.7	9.7	8.9	***
Silene noctiflora	0	0	0	0	0	3.6	6.6	7.1	15.5	***
Misopates orontium	0	0	0	0	0	0	0	0.3	4.8	*

Effects of crop type.

It was also possible to compare fruit production in winter wheat and winter barley in the experiment described above. *Agrostemma githago, Buglossoides arvensis, Papaver hybridum, Ranunculus arvensis* and *Scandix pecten-veneris* all produced significantly more fruit per plot in winter wheat, while only *Valerianella rimosa* produced more fruit in winter barley.

Herbicides.

Many uncommon species are susceptible to a wide range of herbicides (Wilson, 1990), and it is likely that the introduction of modern herbicides from 1945 onwards has been a very important factor in the decline of many species. Species are however differentially susceptible to different herbicides, and even some uncommon species are non-susceptible to commonly used compounds (Table 2).

TABLE 2. The susceptibilities in relation to unsprayed control plants of seven uncommon annual plant species to four commonly used herbicides as determined in an experiment using pot-grown plants. Significance levels: *** P<0.001, ** P<0.01, * P<0.05.

	Chlor-toluron	Mecoprop	MCPA	Ioxynil/ Bromoxynil
Buglossoides arvensis	*	*	ns	**
Chrysanthemum segetum	*	ns	ns	*
Misopates orontium	-	***	*	*
Papaver hybridum	**	***	*	*
Ranunculus arvensis	*	**	-	-
Silene noctiflora	*	*	-	***
Scandix pecten-veneris	**	***	**	*

TABLE 3. Number of plants per m^2 present at harvest time in plots of cereals to which nitrogen was applied at three levels. Significance levels: *** P<0.001, ** P<0.01, * P<0.05. - = not significant.

	Nitrogen Level (Kg/ha^2)			
	0	75	150	
Misopates orontium	0.9	0.02	0	***
Myosurus minimus	0.3	0	0	**
Arnoseris minima	0.2	0	0	***
Papaver hybridum	1.2	0.6	0.06	***
Filago pyramidata	3.2	0.9	0.3	***
Valerianella rimosa	3.0	1.7	0.6	***
Papaver argemone	0.7	0.3	0.2	*
Scandix pecten-veneris	1.8	1.1	0.8	-
Chrysanthemum segetum	1.2	0.9	0.6	-
Silene noctiflora	2.3	2.0	1.2	-
Ranunculus arvensis	3.0	1.8	1.6	**
Buglossoides arvensis	2.0	1.3	2.2	-

Competitive ability in relation to crops at different levels of nitrogen application.

Mean levels of nitrogen applied to arable crops increased by over 600% between 1943 and 1988 (Chalmers et al, 1990), and the cereal cultivars that are now grown tend to be highly responsive to these high levels (Fischbeck, 1990). Most of the weeds which have decreased most rapidly are relatively slow-growing annuals which might be expected to compete poorly with a fully fertilised crop. In experiments, levels of nitrogen similar to those applied to modern cereal crops suppressed the growth of many weeds almost as effectively as herbicides (Table 3).

THE WILDFLOWER PROJECT - PHASE 2.

Phase 1 of the Wildflower Project identified several potential reasons for the decline of some arable weeds, but did not investigate the effects of manipulating any of these factors on existing populations, or the costs of conservation management to the farmer. The second phase which started in 1992 was designed to test options for the management of endangered arable weeds and their communities within the context of modern farming.

Ten experiments were set up in both winter and spring cereals in the south of England during 1992 and 1993. In these the effects of omitting herbicide and nitrogen on the numbers and seed production of a range of common and uncommon arable weeds were studied. Preliminary results suggest that omission of both nitrogen and broad-leaved herbicides result in the greatest floristic diversity and number of uncommon species (Table 4).

TABLE 4. Mean numbers of species of arable weed per 2.5m² in plots of winter cereals grown under three regimes on three farms in Norfolk, Suffolk and Hampshire.

	Norfolk	Suffolk	Hampshire	Mean
Full nitrogen and herbicide	8.3	3.3	14.0	8.6
Full nitrogen, no herbicide	22.3	16.7	20.3	19.8
No nitrogen, no herbicide	24.3	19.0	25.7	23.0

A further series of experiments have been set up in 1993 and 1994. These have the aims of confirming the results of the previous year's investigations and also studying the effects of the use of selective graminicides on the growth and performance of uncommon broad-leaved species in fields where there are known to be large populations of highly competitive grass weeds including *Alopecurus myosuroides, Avena spp.* and *Lolium spp.*. It is possible that these grasses can have a detrimental competitive effect, especially where nitrogen applications are large. The effects of most of the modern selective graminicides on uncommon species are however not well known.

TOWARDS A MANAGEMENT STRATEGY FOR THREATENED ARABLE WEED COMMUNITIES.

Although the second phase of the "Wildflower Project" is at an early stage, it is possible to make some suggestions for the conservation management of endangered species and communities of arable land based on information gathered so far.

Conservation measures can, in most cases, be directed at the outermost four metres of fields, although there are exceptions where rare species grow outside this area. All broad-leaved herbicides must be omitted from conservation areas, although some selective graminicides may be permissible pending further work. Nitrogen should also be omitted as the competitive effect of a fertilised crop can suppress many uncompetitive species. It is important to drill crops at the correct time, although most species can withstand occasional years in crop rotations when conditions are not ideal. Practically this will mean either autumn or spring drilling, as the precise dates of farming operations are often determined by factors outside farmers' control. Winter wheat may allow better seed production than winter barley, and it is likely that modern crop varieties will be less competitive under low input conditions than older ones.

Some areas are already managed for their arable flora. Four sites have been scheduled as SSSIs by English Nature, although at only two of these are whole fields managed as part of a conventional arable farm. At one of these two sites, fertilisers and herbicides are applied as normal, while at the other no inputs are permitted. The headland only at the third site is managed. The fourth SSSI has recently been purchased by the Somerset Wildlife Trust, who intend to manage the three small fields as a working arable unit with minimal agrochemical inputs. The National Trust in Cornwall are currently managing some of their arable land for its arable flora, a particularly valuable initiative, as they are one of Britain's largest private landowners. Other sites are managed by informal agreement with landowners. One problem which has become apparant at some sites has been the build up of perennial weeds. Research into the selective control of these species will be essential future work.

In some fields where crops are not drilled up to the base of the field boundary, a zone of occasional cultivation exists between the crop and the perennial vegetation of the boundary. On nutrient-poor calcareous or sandy soils this zone can not only be of immense value for the least competitive arable annuals, but is also a habitat for annuals with atypical life-cycles and pauciennials, many of which, including *Ajuga chamaepitys* and *Teucrium botrys*, are now extremely rare. Research into the ecology of this habitat is also essential if the flora of the whole field margin is to be effectively conserved.

CONCLUSIONS.

It is already possible to propose provisional guidelines for the

management of endangered arable plant communities and species, and on completion of the "Wildflower Project - Phase 2", detailed guidelines and costings of conservation management will be available. The implementation of such guidelines on a large scale is not impracticable. The experience of The Game Conservancy Trust with Conservation Headlands (Sotherton, 1990) has shown that given an incentive and soundly researched information, many farmers are happy to manipulate farming practices for environmental benefits (Thompson, 1993). Guidelines for the conservation of the arable flora can easily be incorporated into the management of Set-Aside land (Firbank & Wilson, in press) or the Countryside Commission's Stewardship scheme. Such programmes are already funded over large areas of Germany by local government (Schumacher, 1987), and with the political will, the future of some of our most endangered plants could become considerably brighter.

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