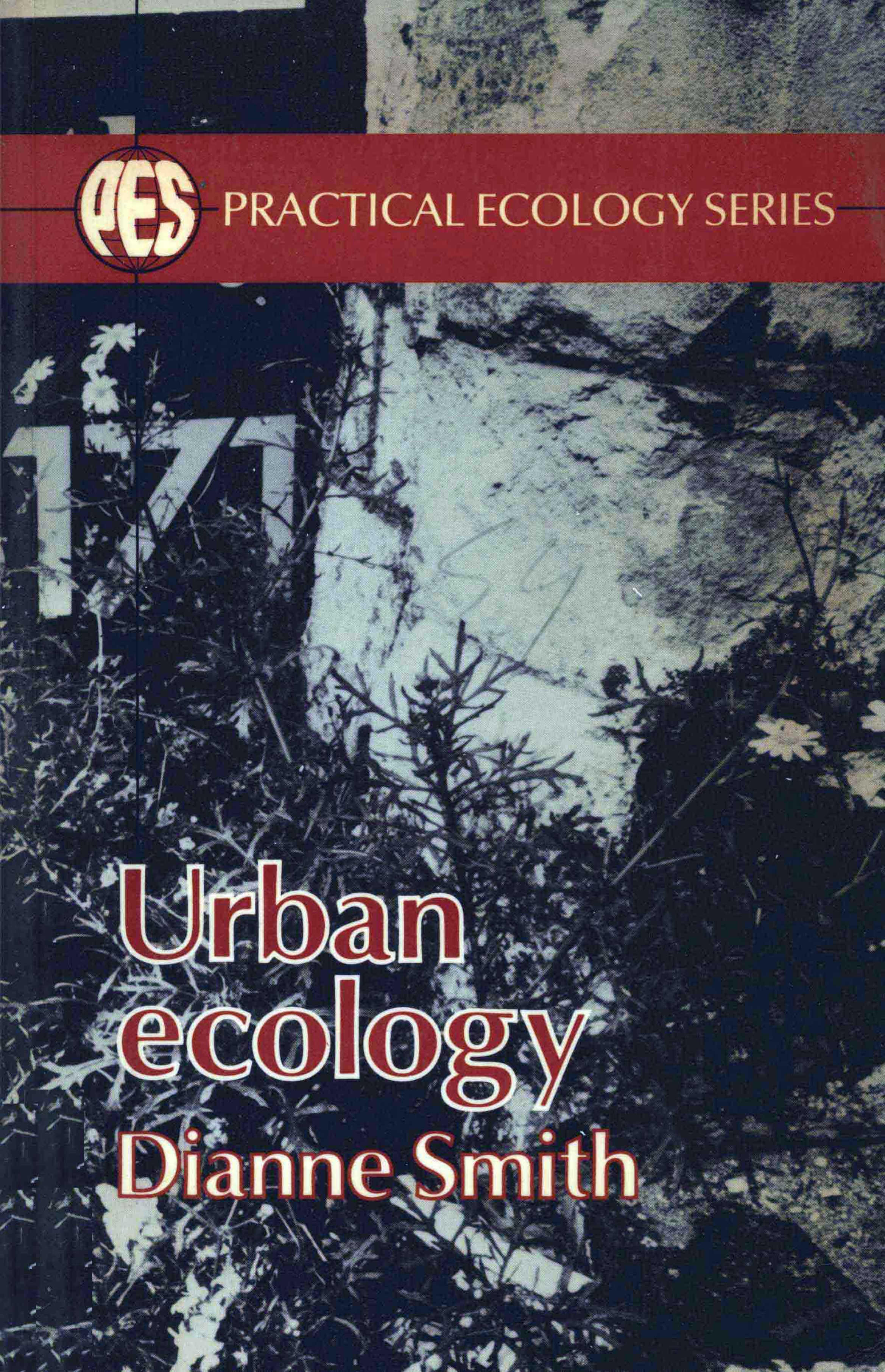
PES PRACTICAL ECOLOGY SERIES



Urban ecology

Dianne Smith

PRACTICAL ECOLOGY SERIES

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Foreword

The aim of this series is to provide students and teachers of Advanced level biological science with ideas for a practical approach to ecology. Each book deals with a particular ecosystem and has been written by an experienced teacher who has had a particular interest in organising and teaching field work. The texts include:

(a) an introduction to the ecosystem studied;
(b) keys necessary for the identification of organisms used in the practical work;
(c) background information relevant to field and laboratory studies;
(d) descriptions of methods and techniques used in the practical exercises;
(e) lists of materials needed for the practical work described;
(f) realistic suggestions for the amount of time necessary to complete each exercise;
(g) a series of questions to be answered with knowledge gained from an investigatory approach to the study;
(h) a bibliography for further reference.

Throughout the series emphasis is placed on *understanding* the ecology, rather than on compiling lists, of organisms. The identification of types, with the use of keys, is intended to be a means to an end rather than an end in itself.

Morton Jenkins
Series editor

Preface

This book introduces the student to the wide range of ecological studies possible in the urban habitat. Towns offer the ecologist a unique opportunity to investigate a variety of interesting ecosystems within a small area. This is particularly helpful to the school biologist whose time and opportunity to travel is usually severely limited. Many of the investigations in this text can be carried out in the school grounds, or their immediate vicinity.

The methods described in the book have been well tested, and although aimed primarily at sixth formers, many can be carried out successfully by younger students. In some of the exercises permission will be required beforehand. Please note that where it has been suggested that specimens be removed for further analysis, the number should be strictly limited, and if possible, they should be returned.

Dianne P. Smith
December 1982

Acknowledgements

A number of people have helped in the final production of this book, and I would like to express my sincere thanks to those few mentioned below.

First I must thank my husband, Dr Robert Smith, not only for his constant support and encouragement, but also for supplying the photographs and undertaking the unenviable task of typing the manuscript.

I am indebted also to Dr Diane Hughes for her excellent illustrations and her very helpful, frank advice.

Many of my sixth formers, past and present, have been involved in the groundwork for this text, and it is these unknowing guinea pigs who have proved the practicability of many of the exercises. I would like particularly to mention Robert Spanswick, from whose original idea Exercise 19 was developed.

I would also like to thank my colleagues of the Biology Department at Tomlinscote School, Frimley, for their helpful comments and advice.

I am grateful to the literary executor of the late Sir Ronald A. Fisher FRS, to Dr Frank Yates FRS and to Longman Group Ltd, London for permission to reprint an extract from Table XXXIII, pp. 134–9, from their book *Statistical tables for biological, agricultural and medical research* (6th edn, 1974). I would like to acknowledge B. W. Barrett and J. E. Chatfield for permission to use their key to some common wall bryophytes.

Finally my grateful thanks go to Dr P. Morris of Royal Holloway College, and Morton Jenkins, the series editor, for reviewing the manuscript; and to my publishers, particularly Miles Jackson, for his patience and encouragement.

Introduction

In Britain only a few isolated habitats, such as the tops of mountains and inaccessible shorelines, remain unaffected by man. Many apparently natural habitats would be better described as semi-natural, or man-modified. These have all undergone some form of transformation, so that one ecosystem is replaced by another which supports different organisms. This transformation may involve merely the replacement of one habitat by another, e.g. woodland by farmland, or the apparent total destruction of the habitat, as in urbanisation, which is the concern of this book.

In the past, the urban environment was disregarded because of its seemingly minimal ecological value. The traditional green spaces of towns, the public parks and recreational grounds, tend to be thought of as wildlife deserts, being little more than sterile monocultures of rye-grass. However, we know that they support a specialised flora and fauna of their own, which together with buildings and roads have displaced a large part of all the pre-existing flora and fauna.

During World War II, the catastrophic aerial bombardment of many of this country's larger cities illustrated the great resilience of nature. A rich flora and fauna sprang to life amongst the rubble and water-filled craters. These pre-urban species had either lain dormant or were able to colonise from outside. Many species continue to find sanctuary in the towns and cities. The corn cockle, a once common agricultural weed, now virtually eradicated by modern farming methods, has made an appearance on open waste ground in London.

The urban ecosystem works on the same principles as any other ecosystem. Its main characteristic is its continual exposure to drastic and rapid change, caused by the demolition of buildings and the redevelopment of the site, in quick succession. Although this constant threat of change poses a severe challenge for wildlife, there is no shortage of species which are able to adapt to and exploit these specialised habitats.

Roofs and walls of buildings provide niches for pioneer plants to colonise. Several bird species accept buildings as man-made cliffs for nesting; whereas many aquatic invertebrates are common inhabitants of the garden pond. The rich pickings from dustbins attract numerous scavengers, such as foxes, which are known to rear their families in the hearts of some cities.

While city life may offer advantages, including warmth (towns are on average five degrees warmer than the surrounding countryside), a longer growing season, and fewer food problems, for many species the disadvantage of higher levels of pollution can outweigh these benefits. Pollution in towns has a wide variety of sources, e.g. sulphur dioxide is released into the air from domestic and industrial chimneys, inhibiting the growth of numerous plant species, such as lichens. Rivers, streams and ponds collect rubbish, organic wastes and oily runoff from roads. In many city centres only pollution-tolerant plants and animals remain. This growing scarcity of unpolluted habitats is reflected by the reduction in the number of frog colonies in central London.

The problems of the urban habitat present the biologist with a unique opportunity to investigate many ecological principles within a limited space.

Contents

Disturbed areas

Plant colonisation of many man-made habitats, such as rubbish tips, waste-land and even neglected gardens, is promoted by the disturbed condition of the ground. These open conditions favour those species that can establish themselves quickly by producing large quantities of seed.

In the initial stages of colonisation, pressure from competition is minimal. This is particularly advantageous to many introduced or alien species, which often fail to compete with indigenous species elsewhere. Usually, colonisation of these habitats rarely proceeds far before the ground is disturbed again. If, however, a succession is allowed to continue, the early pioneer plants, which include many annuals, are soon crowded out by perennials which can spread vegetatively. These may in turn be succeeded by bushes and shrubs, and lastly by the climax community, the trees. This pattern of succession is called a **sere**. The development of man-made seres can be arrested by various factors, such as trampling, so that the climax stage is seldom reached.

Exercise 1: an investigation of the colonisation of newly dug soil

Background

Man's attempts to improve his own environment present one of the greatest challenges to nature. Demolition of buildings, clearing of woodland, draining of ponds, and even the weekend activities of the gardener expose fresh soil. Those plants which can colonise these new territories rapidly are the most successful species in the urban environment.

Aim

To determine the methods of invasion of new territories by active colonisers.

Materials

Fork; spade; metre rule; transparent plastic sheet; four stakes.

Time

This is a long-term project, carried out in the field over a period of several months, and preferably started at the beginning of the growing season.

Method

Select a suitable site, e.g. the school grounds or an area of your garden. Prepare two 3-m square plots, and clear the soil of weeds. Cover one plot with the plastic sheet, using the stakes to position it 8 cm above ground level. Examine the two plots, at weekly intervals, over a minimum period of three months. For each plot, record the number of species and the percentage cover of vegetation.

Compare the data from the two plots graphically.

Questions

(1) What conclusions can be drawn, from the data, about the methods of colonisation of the various species?
(2) Did you observe any evidence of seeds arriving as a result of animal activities?
(3) Many of these species are commonly regarded as weeds. What exactly is meant by the term weed?
(4) What are the characteristic features of weeds revealed by this investigation?

Exercise 2: the investigation of the flora of wasteland

Background

When buildings are demolished, the rubble-strewn waste sites are soon invaded by plants with wind-borne seeds. A successful wasteland plant must be able to establish itself while the ground is still open. The majority do this by producing large numbers of seeds. A good example of this type of early pioneer plant, and probably the most easily recognised, is rose-bay willow-herb (*Epilobium angustifolium*). Once established, the successful weed can colonise the territory quickly, either by prolific seed production or by vegetative propagation, as in the case of coltsfoot (*Tussilago farfara*) which has underground rhizomes.

Amongst our native species there are many aliens commonly found on disturbed sites, giving wasteland flora its cosmopolitan flavour. One of the most familiar is buddleja (butterfly bush) (*Buddleja davidii*), a garden escape introduced from China.

Aims

(a) To analyse the wasteland flora community using subjective and objective methods.
(b) To determine the reproductive capacity of a typical wasteland flower.

Materials

Ranging rods; 50-m tape; ½-m quadrat; table of random numbers (Fig. 1); plastic specimen-bag.

Time

To be carried out in the late spring and summer: 2 h in the field; 1–2 h in the laboratory.

Method

Vegetation analysis
Mark out a 50-m square plot using the ranging rods to pin-point each corner. Walk over the site and make a list of the species using Figure 3 to help with identification. Twenty species will be adequate.

The subjective method of analysing the plant community involves each student walking over the entire area and assessing each species on a five-point scale, the DAFOR scale, as follows:

D, dominant: 5;
A, abundant: 4;
F, frequent: 3;
O, occasional: 2;
R, rare: 1.

add together each student's set of DAFOR results, and taking the species in turn, find the mean DAFOR value for each species.

Quadrats are used to analyse the flora objectively. Taking one corner of the 50-m square plot as the origin (i.e. the bottom left-hand corner), then the horizontal side represents the x-axis and the vertical side the y-axis. The table of random numbers (Fig. 1) lists a series of co-ordinates which can be used, as directed in the table, to place the quadrat at random. Record the presence or absence of each species in your list in 100 randomly placed quadrats. Add the number of occurrences of each species in the total number of quadrats to obtain the percentage frequency.

To compare the two sets of results, place the plants in rank order (i.e. 1 is the most important in the community, 20 is the least important), first

x	*y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*
98	03	91	50	48	07	33	26	12	72	56	16	42	36
56	06	03	45	71	88	05	53	56	59	31	85	96	18
98	6i	89	41	08	92	98	61	65	100	78	12	66	10
96	06	13	43	38	51	85	13	34	87	98	81	88	77
09	02	71	71	51	83	04	41	70	39	95	66	67	98
54	80	19	28	78	12	33	10	48	21	03	35	95	39
40	69	56	38	68	73	54	08	09	04	u2	93	90	54
100	31	39	27	95	28	68	50	71	30	80	81	22	30
96	74	73	13	82	17	39	90	56	33	85	79	47	19
51	22	81	60	13	38	56	50	97	50	32	25	73	87
94	36	05	62	26	40	59	77	40	33	08	64	69	63
07	15	62	97	48	77	25	19	17	78	97	96	33	56
15	90	31	13	43	15	23	02	39	46	80	66	58	61
04	02	97	38	80	40	55	85	90	14	26	02	78	35
39	37	32	11	96	59	68	45	60	22	03	30	58	70
29	45	81	99	32	24	69	31	35	27	98	59	34	78
28	10	45	74	18	64	37	31	37	11	64	72	47	42
23	26	11	84	43	47	66	42	100	84	98	02	33	11
75	09	14	66	89	58	33	65	12	08	76	66	97	30
46	14	40	25	61	21	76	32	60	97	28	86	60	62
22	17	44	48	55	80	43	33	60	09	53	58	54	80
86	56	41	94	30	85	28	31	67	85	14	96	68	47
91	25	07	12	41	92	97	19	62	95	32	22	13	26
46	66	64	27	62	40	82	80	48	79	24	32	22	17
29	12	80	71	13	50	03	68	88	09	30	28	19	36
29	41	27	06	78	66	65	16	12	75	04	73	16	77
43	30	54	68	51	57	24	65	61	73	42	70	78	43
66	40	02	92	66	86	02	72	48	06	83	27	03	28
96	11	83	52	19	83	79	16	71	42	24	77	93	22
31	89	38	61	51	78	04	75	85	64	82	77	78	76
64	27	01	01	79	68	40	64	48	69	33	14	23	68
34	40	21	66	73	52	06	27	14	83	04	51	15	39
84	39	32	29	63	99	62	40	09	11	50	09	58	71
76	28	04	59	86	28	100	97	54	52	60	73	57	35
61	23	38	64	97	96	50	64	50	58	93	09	48	50
62	48	48	33	93	41	38	54	35	69	91	67	61	96

Figure 1 Pairs of random co-ordinates from 1 to 100. Select co-ordinates systematically; e.g. begin column 4, row 27 and take every seventh pairs. Do not select 'by eye'. *Note:* for a 50 m^2 plot, the co-ordinates are divided by two. (Taken from Table XXXIII of Fisher and Yates *Statistical tables for biological, agricultural and medical research*, published by Longman Group Ltd, London (previously published by Oliver & Boyd Ltd, Edinburgh) and reproduced by permission of the authors and publishers.)

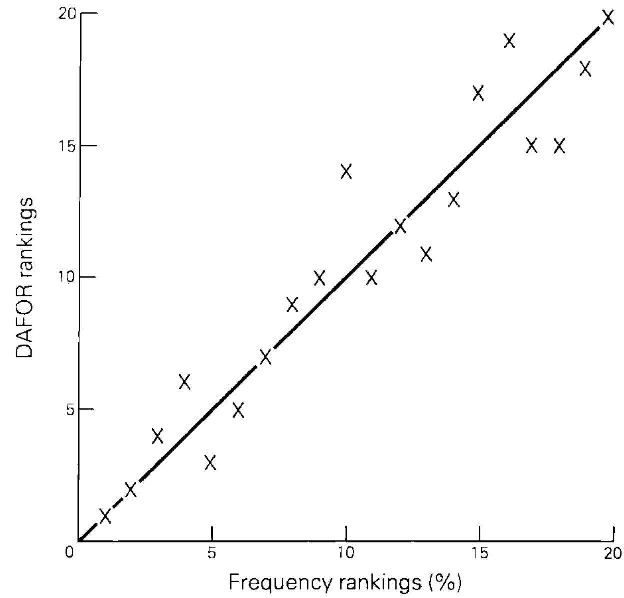


Figure 2 Scatter diagram of DAFOR rankings against percentage frequency rankings. This illustrates the spread of experimental points.

according to the mean DAFOR results and then according to the percentage frequency results.

The data can then be analysed by constructing the following graphs:

(a) a block histogram of percentage frequency for each species;
(b) a scatter diagram of mean DAFOR against percentage frequency for each species;
(c) a scatter diagram of DAFOR rankings against percentage frequency for each species (Fig. 2).

Reproductive capacity
Each student should carefully remove one specimen of a typical wasteland flowering plant with ripe seeds to assess its reproductive capacity. If the plant has a large number of flowering stems, take a random sample of 10, then count the number of seed capsules or heads on these. Then take a random sample of at least 25 seed capsules, open each under a binocular dissecting microscope, and count the seeds. Multiply the results to obtain an estimate of the number produced by the whole plant. Observe any capacity for vegetative propagation in the chosen specimen.

Questions

(1) Ideally, if the subjective assessment was accurate, all the points on graphs (b) and (c) should fall on the 45° lines shown in Figure 2. Draw this line on each graph. In practice, very few points fall on this line. Discuss the reasons for this.

(2) In general, more points coincide with this line in graph (c) than in graph (b). Why is this to be expected?

(3) Comment on the two techniques used here to sample the wasteland flora.

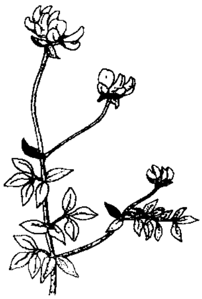
(4) Consider the reproductive capacity of the chosen specimen in relation to its role as a pioneer of disturbed areas.

(5) Many of these characteristic weeds of disturbed areas are ephemerals, e.g. scarlet pimpernel (*Anagallis arvensis*). What does this term mean and what advantage does it confer on the plant?

(6) The seeds of another typical wasteland plant, fat hen (*Chenopodium album*), illustrate a different adaptation to this unstable environment. What is this unusual adaptation?

Figure 3 Identification chart of common wasteland flora (pp. 7–9). Other species include:

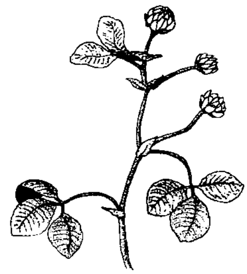
Buddlejaceae:	*Buddleja davidii*, buddleja (butterfly bush)
Caprifoliaceae:	*Sambucus Nigra*, elder
Caryophyllaceae:	*Stellaria media*, chickweed
	Spergula arvensis, corn spurrey
Chenopodiaceae:	*Chenopodium album*, fat hen
Compositae:	*Conyza canadensis*, canadian fleabane
	Tussilago farfara, coltsfoot
	Cirsium arvense, creeping thistle
	Taraxacum officinale, dandelion
	Senecio vulgaris, groundsel
	Artemisia vulgaris, mugwort
	Senecio squalidus, Oxford ragwort
	Achillea millefolium, yarrow
Cruciferae:	Cardamine hirsuta, hairy bitter-cress
Labiatae:	*Lamium album*, white dead-nettle
	Lamium purpureum, red dead-nettle
Malvaceae:	*Malva sylvestris*, common mallow
Onagraceae:	*Epilobium angustifolium*, rose-bay willow-herb
	Epilobium montanum, broad-leaved willow-herb
Papaveraceae:	*Papaver rhoeas*, poppy
Plantaginaceae:	*Plantago media*, hoary plantain
	Plantago lanceolata, ribwort
Ranunculaceae:	*Ranunculus repens*, creeping buttercup
	Ranunculus ficaria, lesser celandine
Rosaceae:	*Potentilla anserina*, silverweed
Umbelliferae:	*Anthriscus sylvestris*, cow parsley
Urticaceae:	*Urtica dioica*, nettle



***Lotus corniculatus*, bird's foot trefoil**

LEGUMINOSAE

Native perennial, height up to 35 cm, has yellow flowers streaked with red; very common with numerous local names



***Medicago arabica*, black medick**

LEGUMINOSAE

Native annual, height up to 40 cm, spreading with yellow flowers which produce black seeds

***Lapsana communis*, nipplewort**

COMPOSITAE

Native annual, height up to 90 cm with yellow flowers which open only on sunny mornings; found throughout Britain except in the extreme northern region

***Matricaria maritimum*, scentless mayweed**

COMPOSITAE

Native annual, height up to 50 cm; common throughout Britain on all types of disturbed ground

***Calystegia sepium*, bindweed**

CONVOLVULACEAE

Trailing perennial with white flowers; introduced species now common in England and Wales

Figure 3 – *continued*