# Yorkshire Dales

John Lee

THE NEW NATURALIST LIBRARY

# YORKSHIRE DALES

JOHN LEE

WILLIAM COLLINS

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The aim of this series is to interest the general reader in the wildlife of Britain by recapturing the enquiring spirit of the old naturalists. The editors believe that the natural pride of the British public in the native flora and fauna, to which must be added concern for their conservation, is best fostered by maintaining a high standard of accuracy combined with clarity of exposition in presenting the results of modern scientific research.

# Contents

# Editors’ Preface

The Yorkshire Dales, which became a National Park more than 60 years ago, is an iconic English landscape that is long overdue the literary and scientific attention of the New Naturalist series, and so we are delighted that Professor John Lee, an ecologist long familia with the area, has now filled this need with characteristic style and rigour. Readers will find that the natural history of the Dales is known in great detail, even by the high standards expected in these islands and of this series. This is thanks to the unflagging attentions of professionals and amateurs alike. With the universities of Lancaster, Manchester, Sheffield, Leeds, York and Durham arrayed around its borders, the academic pantheon of British natural history has quartered and catalogued these uplands and valleys for a century. Within the borders of the National Park, Malham Tarn Field Centre has schooled and sheltered many thousands of naturalists and students. The area is also the happy hunting ground of the redoubtable Yorkshire ‘Naturalists’ Union. It was even once the haunt o two secret societies of botanists, so clandestine that they were unknown even to each other, though both were dedicated to the same end of protecting Britain’s last surviving Lady’s Slipper Orchids. Al of this and more is unearthed by Professor Lee.

Though in places the landform of the Dales could be described as well-upholstered, in others the underlying geology grins through its surface with bared limestone teeth. Scoured for millions of year by ice and rock, the Dales landscape has also been quarried and mined for centuries by pick and shovel. In fact John Lee suggests that, in part at least, the Dales present a post-industrial landscape. The other human influence to have shaped the landscape is of course farming, which has waxed and waned under the influence of climate since the Neolithic. Place names ending in *–ley* tell us that the first Anglo-Saxon farmers probably created their fields in forest clearings, while place names with th *–ton* suffix were villages founded at a later date. A century later, Scandinavian immigrants named their settlements *–thwaite*, *–sett* and *–scale* and left us the words that have become as evocative of th area as the landforms they describe: *beck*, *fell*, *scar* and *dale*. If you know how to read them, the very stone walls speak: dry-stone walls with a continuous cap of rock forming a ledge that projects away from the field were designed to prevent Wolves leaping them into enclosures full of sheep. The Wolves are long gone, but the sheep remain and the walls now invite you to enter by stile and gate. L John Lee escort you into these rich pastures.

# Author's Foreword and Acknowledgements

My first very brief encounter with the Yorkshire Dales came in 1958 on a coach journey from Keighley with brother Terry and my soon to be sister-in-law Hilary en route to a walking holiday in the Lake District. In those days the old Keighley to Kendal turnpike, now the A65, climbed up Giggleswick Scar on the South Craven Fault before affording excellent views of Ingleborough as it skirted the edge of the then very new National Park. My next encounter came at the end of my first year as an undergraduate in the Botany Department at the University of Sheffield in 1962. After the first-year exams the department organised a series of day excursions to broaden our knowledge of plants and the habitats in which they grow, and one of these was to Malham. For a southerner with a keen interest in plants and landscape, this was a truly magical experience, helped by a glorious early-June day. The beck emerging from the base of the Cove, the steep climb up the side to view the limestone pavements above it, and the walk up the Watlowes dry valley past Water Sinks to the Tarn itself are etched in the memory, as are views of Tarn Moss, the woods and the mires.

It was a day for this southerner to encounter new plants, including Baneberry in the pavements, Jacob's-ladder on the damp screes and, most attractive of all, the mass of pink flowers of Bird's-eye Primrose in the mires and flushes.

Students in the Botany Department and its successor Animal and Plant Sciences Department were and are fortunate to be exposed to a strong ecological tradition cemented when A. R. Clapham succeeded W. H. Pearsall as professor of botany in 1944. By the early 1960s there were not only the soon to be distinguished young ecologists, Derek Anderson, Philip Grime and Ian Rorison in the department, but also outstanding individuals in other fields. This latter group included David Read, John Webster and Harold Woolhouse, all of whom had a strong interest in ecology but a centre of gravity in mycology or plant physiology. The arrival of J. L. Harley, a former research student of Sir Arthur Tansley, as the second professor in the mid-1960s further enhanced the scholarship, immediately making it the centre of excellence in mycorrhizal research that it remains today under t leadership of Sir David Read and Jonathan Leake. Jack Harley was an old boy of Leeds Grammar School and was familiar with the Dales from his youth. His survey of Colt Park and Ling Gill woods in upper Ribblesdale formed the basis of Tansley's account of them in his classic work *The British Islands and Their Vegetation*, published in 1939. But it was John Webster who got me actively involved with the natural history of Yorkshire through encouraging me to join the Yorkshire Naturalists' Union and, in particular, its Mycology (now Fungi and Lichens) section.

Forays were the major part of this section's activities, and one of these provided my first visit to Richmond and the northern Dales. The section at that time contained an admirable mix of expert professional mycologists such as John Webster, Roy Watling and Tom Hering and outstanding amateurs such as Willis Bramley. But it also attracted botanists with more general interests, includin John Lovis and Arthur Sledge. Arthur Sledge was another Leeds Grammar School old boy, but one who spent his whole career in the University of Leeds Botany Department. He was expert in fern taxonomy, but his knowledge of plants in general and of the Yorkshire flora in particular was very extensive. So fungal forays at this period were more than the mere pursuit of mycological specimens and helped me to learn much more about the county's range of habitats and plants.

During this period I was also very fortunate to marry into a Westmorland farming family. Harold Wright farmed an area to the south of the county which included a sheep run over what is now

Clawthorpe Fell National Nature Reserve, covering some magnificent areas of limestone pavement, and ~~he helped me to establish a grazing exclosure study on one of these. This not only taught me~~ abou the rate at which vegetation developed above the gryke surface once sheep grazing was removed, but also demonstrated the extreme sensitivity of the lichens on the clint surfaces to the drip from galvanised wire netting.

The Yorkshire Dales National Park is only a short drive from Clawthorpe, and my wife Barbara an I began to make excursions there from the mid-1960s onwards. In 1967 I was appointed to an assista lectureship in the Botany Department of the Victoria University of Manchester. There I had the great good fortune to have D. H. Valentine as my first head of department. David Valentine was a plant taxonomist with an extensive knowledge of the northern Pennines, particularly of the Teesdale flora. He had arrived from Durham the year previously and was keen to promote plant ecology in the department. I also had the great good fortune to share an office with Clive Stace for my first three years in Manchester, and to have John Tallis as an ecological colleague. Together they taught me much about the British flora and vegetation history. In those less pressurised academic days it was possible occasionally to fit in brief excursions to familiarise ourselves with the flora of northern England and Wales, and three of these took us to see *Cypripedium calceolus*, *Dryas octopetala* and *Saxifraga oppositifolia* in flower in the Dales. There were also day trips with student parties to vario sites in Ribblesdale and Chapel-le-Dale, including Scar Close and Colt Park.

As my career developed, much of my UK research became centred on the Peak District, which was closer at hand than the Dales, even when I moved back to Sheffield in 1994. But one friend in particular, Kathleen Firth, encouraged me to take a much greater interest in the Dales again. When Kath retired from teaching in Altrincham, she moved to Langcliffe and got actively involved in volunteering for English Nature at Colt Park. Although I was not able to renew my interest in the Dales immediately, my retirement to the Lyth Valley in south Cumbria gave me the opportunity, but alas not before Kath had died.

This book is the result of many happy hours spent exploring the Dales in recent years, discussions with scientists, land managers and fellow Dales enthusiasts and, of course, reading the extensive scientific literature on the region. It begins with a chapter introducing the Yorkshire Dales National Park, its climate and its soils, as well as describing briefly how legislation has affected both land use and conservation since the Second World War. It is followed by two chapters describing the landscap and how geological history and human activities have shaped the National Park the visitor sees today A series of chapters essentially describing the major habitats follows, with diversions to consider the most iconic plant of the Dales, the Lady’s Slipper Orchid, and some important animal groups. The emphasis in these latter chapters on birds, mammals and Lepidoptera is on change, and the book concludes with a chapter looking to the future. Although I have concentrated on the National Park, no least because the facts are most easy to assemble for its habitats, I have also strayed to take example from both further north and south within the Pennine chain when published ecological studies are no available from within the park. I have also strayed occasionally into Nidderdale and the North York Moors for other examples.

I could not have completed this work without the generous help and support of many people and organisations. In particular I am most grateful for the unstinting support of Ian Court of the Yorkshir Dales National Park Authority, Colin Newlands of Natural England, and Peter Welsh of the National Trust. They have provided me with many leads, introductions and literature, as well as patiently answering my many questions. In addition, Ian and Colin have greatly improved the drafts of several chapters. I am also very grateful to all those who have given me permission to reproduce figures and tables from their publications, especially to the Field Studies Council, which has been so important i promoting and publishing research on the Dales, and to Robin Sutton at the Malham Field Centre for helping me with several enquiries.

~~Much of the fun in writing this book has come in the form of field excursions, some organised~~, suc as those that formed part of the Flora of the Dales and Swaledale festivals, and some informal. In the latter category I am particularly grateful to Roger and Pauline Meade and to Alistair Headley for sharing with me many ecological delights. Alistair and Roger have very considerable ecological knowledge and experience, which I have endeavoured to mine, and they have also commented on, corrected and markedly improved early drafts of several chapters. Roger has also kindly provided several photographs.

Many people have given me much help in preparing and/or commenting on individual chapters. Simon Bottrell commented on and much improved an early draft of the Geology and Geomorphology chapter. Tom Lord kindly allowed me to reproduce his work on medieval dry-stone walls and his photograph of the barbed point of a reindeer antler, one of the earliest pieces of evidence for human activity in the Dales. He also helped me understand the possible effects of future changes in agri-environment schemes on the Dales. Colin Newlands allowed me access to Natural England's documents on the Ribblesdale and Wharfedale woodlands, and I had most helpful discussion, with Donald Pigott on woodlands in general, and on the status of lime species in the Dales in particular. Tim Laurie kindly provided me with information about the relict woodlands of Swaledale, and gave me access to an unpublished pollen diagram from Ellerton Moor. Ian Court provided valuable information on both Red Squirrel and Dormouse investigations.

The Lady's Slipper Orchid chapter has benefitted from input by Margaret Hartley of the Wharfeda Naturalists Society, including information on the group of naturalists around Arthur Raistrick. Elizabeth Shorrock generously trawled through unpublished documents and letters in her possession for relevant information, and allowed me to quote from a letter to her and her husband Brian about th rediscovery of the orchid. I am also much indebted to John Lovis for providing information about Arthur Sledge, the secret society formed to protect the orchid, and early attempts to obtain seed from the surviving plant. Philip Oswald kindly provided further illumination of the strict secrecy used to protect the orchid in the early post-war period, and how this secrecy was broken. He also made valuable comments to improve the text. Colin Newlands showed me letters which have recently come to light from the son of Willie Jarman, the person credited with rediscovering the orchid in 1930. Thanks are due to Rob Petley-Jones, who guards the voluminous files on the orchid held by Natural England, for allowing me access to them, and particular thanks go to Peter Corkhill, not only for answering so many questions about his considerable involvement in the efforts to conserve the orchic but also for saving me days of labour by helping me search the files. Donald Pigott also most helpful provided much background information about early attempts to conserve the orchid, and his great wealth of knowledge on the ecology of the Dales was always made readily available, to my considerable benefit. Andrew Watkinson provided reminiscences of his time as a temporary warden for the orchid when he was a student at the University of York in 1972, as well as making valuable suggestions to improve the chapter. Lastly, my colleagues David Read and Jonathan Leake helped to clarify the current position of the orchid's mycorrhizal fungi. Jonathan also considerably improved my description of soils in Chapter 1.

Colin Newlands allowed me to browse the voluminous documents on the Ingleborough limestone pavements at Colt Park Barn, and also commented on the chapter describing them, as well as providing access to unpublished research on hay meadows. I am also very grateful to Ashley Lyons and her colleagues at Edge Hill University for allowing me to quote some of their unpublished result on the effects of grazing on the biodiversity of calcareous grasslands, and to Kevin Walker of the Botanical Society of Britain and Ireland and Mark Lynes, both of whom kindly answered a number o questions, including on the status and distribution of *Alchemilla minima* and *Dryas octopetala* in thes grasslands. David Baines of the Game & Wildlife Conservation Trust answered many questions on moorland management and bird populations, and Roger Meade much improved my description of the blanket mires.

I have had much help with the chapter on Tarns and Wetlands. George Hinton has most kindly allowed me to present his latest research on macrophyte productivity and inorganic carbon uptake in Malham Tarn. Deborah Millward helped me with questions about Semer Water, and Emily Alderton kindly allowed me to quote some of her unpublished data on Otter spraints at Malham Tarn. Allan Pentecost answered various queries about Malham and Fountain’s Fell tarns, and made valuable suggestions to improve the chapter. My colleague Philip Warren made a number of very helpful suggestions on the manuscript, as did Roger Meade, all of which greatly improved the end result. Brian Shorrock answered questions on bird populations on Malham Tarn as well as informing me of the discovery of a population of Small Pearl-bordered Fritillaries on Ha Mire. Paul Ashton and Clive Stace helped me understand the current status of *Carex flava* in the Malham fens. Alistair Headley commented on an early version of the manuscript, and also most kindly provided me with access to unpublished information on Swarth Moor. Graham Proudlove made many helpful suggestions and corrections to improve the chapter on Rivers and Caves.

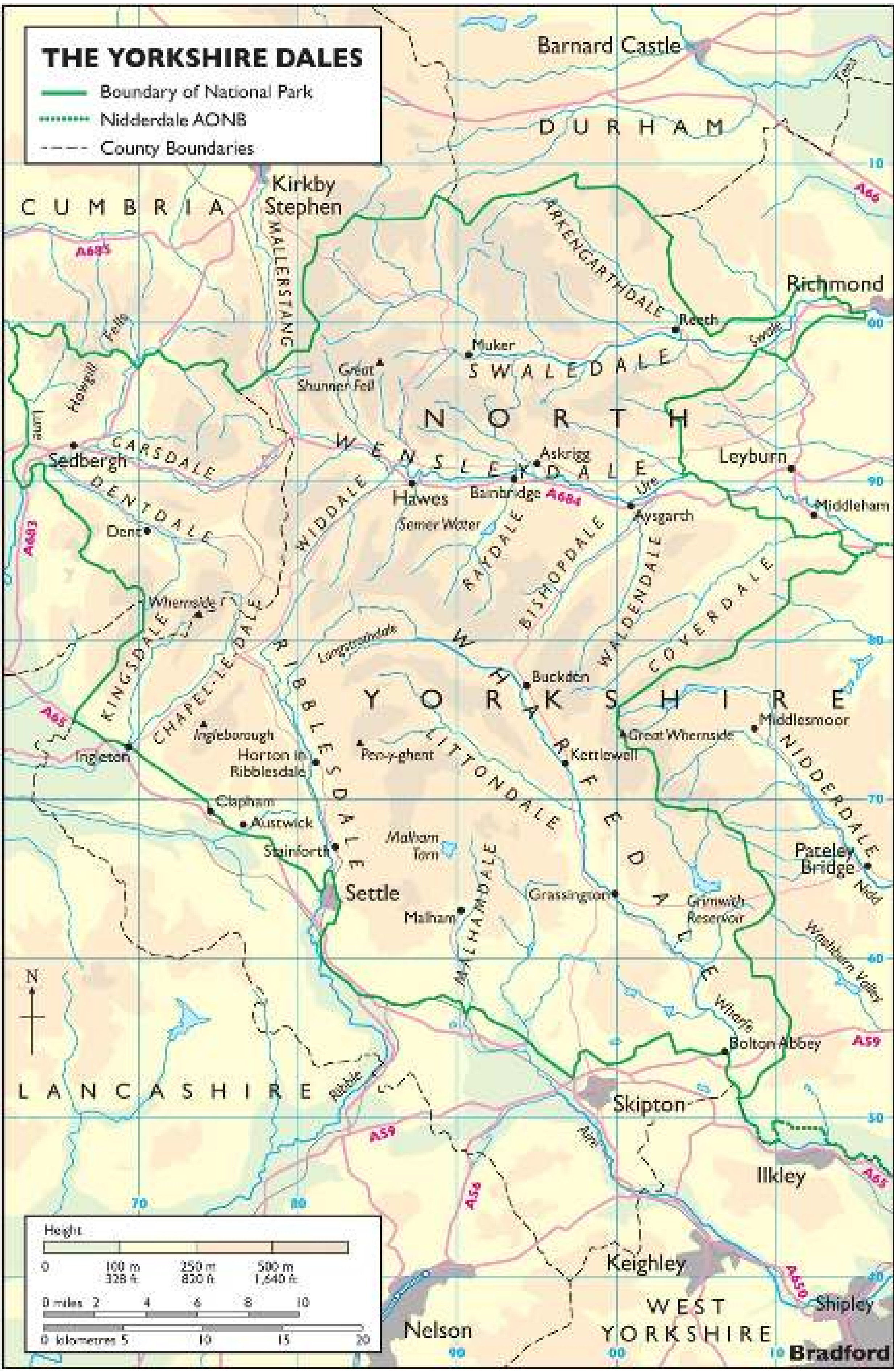
I am greatly indebted to Brian Shorrock for answering my many questions on bird populations and how these have changed over recent decades. Both he and Ian Court provided many suggestions for th improvement of this chapter, as did my colleagues Tim Birkhead and Ben Hatchwell. Ian Court also provided many vital inputs to the Mammals, Moths and Butterflies chapter, and Colin Howes and Charles Fletcher have also been invaluable, providing me with a wealth of information and giving me many suggestions on how to improve the chapter. Paul Millard and Terry Whitaker have also most kindly provided unpublished information on their ongoing studies, Paul of moths in Wharfedale and Terry of both butterflies and moths at various sites in the Dales.

I am very grateful to all those who have kindly allowed me to reproduce their photographs, including Phillip Cribb and Falgunee Sarker.

I have received much encouragement and support from friends, including Sheila and Donald Pigott and Margaret and Martin Wilson. Martin read through much of the text, and made many suggestions for its improvement, but sadly died before he could see the book in print. I am also particularly indebted to Julia Koppitz of HarperCollins for her help and advice at every stage, and to Hugh Brazier and David Price-Goodfellow for their efficiency and for the many suggested improvements to this book during the publication process, all of which have greatly enhanced the end result. But of course, despite all this expert help in the preparation of the book, any errors and omissions are entirely due to me.

When I told Sir John Lawton, the then Chairman of the Yorkshire Wildlife Trust, that I was considering embarking on a New Naturalist on the Dales, his immediate response was that it would take a year out of my life. Over many years I have always found John to be right on most things, but can report that the book has taken rather longer than one year.

Besides the great help I have received from so many people, I have benefited greatly from the unstinting support of my family. Richard, Robin and Peter have helped at various times, and at very short notice, with queries about photography, word processing and software. Barbara has accompanied me on many field excursions as well as allowing me unfettered time and space to complete the book. She has kept my spirits up when they have flagged, encouraged me at every stage and helped me in many other ways. I could not have finished the task without her.



THE YORKSHIRE DALES
Boundary of National Park
Nidderdale AONB
County Boundaries
Barnard Castle
DURHAM
CUMBRIA
Kirkby Stephen
MALLERSTANG
ARKENGARTHDALE
Richmond
Reeth
Muker
Great Shunner Fell
SWALEDALE
Swale
Howgill Fells
Lune
NORTH
GARSDALE
Sedbergh
WENSLEYDALE
Askrigg
Leyburn
Hawes
Bainbridge
Aysgarth
Middleham
Ure
DENTDALE
Dent
WIDDALE
Semer Water
RAYDALE
BISHOPDALE
WALDENDALE
COVERDALE
Whernside
KINGSDALE
CHAPEL-LE-DALE
RIBBLESDALE
Langstrothdale
WHARFEDALE
Buckden
YORKSHIRE
Middlesmoor
Great Whernside
NIDDERDALE
Ingleborough
Ingleton
Horton in Ribblesdale
Pen-y-ghent
LITTONDALE
Kettlewell
Clapham
Austwick
Stainforth
Malham Tarn
Pateley Bridge
Nidd
Settle
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MALHAMDALE
Grassington
Grimwith Reservoir
Washburn Valley
Wharfe
Bolton Abbey
LANCASHIRE
Ribble
Skipton
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Ilkley
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328 ft
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820 ft
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0 kilometres 5 10 15 20

CHAPTER 1

# The National Park

The small market town of Skipton is approximately halfway along the Pennine chain which stretches north from Derbyshire to the Scottish border. Immediately to the north of the tow and for some 110 kilometres (70 miles) towards Stainmore, lie the Yorkshire Dales, one of our best-loved National Parks. On the west the Park is bounded by the market towns of Settle and Sedbergh, and on the east by Richmond and Leyburn. All but Sedbergh, the largest town in the National Park, lie just outside its current boundary. The Dales, as they are popularly known, consist o a series of valleys interspersed with often rounded hills rising to 736 metres (2,415 feet) on Whernside, the highest point.

When it was first designated in 1954, the whole National Park was within the historic county of Yorkshire, forming part of the North and West Ridings. Today, following the reorganisation of local government in 1974, the National Park is mostly in North Yorkshire, with the region around Sedbergh including Dentdale and Garsdale, being part of Cumbria. In North Yorkshire, the Dales are further divided into two administrative regions: Craven in the south and west, and Richmondshire in the nort and east. Both have ancient origins. Craven is mentioned in the Domesday Book, where it refers to a much larger area than today's administrative region, stretching as far west as the Lancashire coast. A castle was established at Richmond in 1071 by Alan the Red of Brittany, and his estates around the castle, reaching as far north as the River Tees, became known as Richmond Shire. The National Park does not cover all of either the ancient or the current administrative areas. Essentially it covers the hills and dales of the upland part of the region (Fig. 1), with the lower parts of the famous river valleys of Aire, Ribble, Swale, Ure and Wharfe falling outside, as does Nidderdale on its eastern boundary, which was designated an Area of Outstanding Natural Beauty (AONB) in 1994. A major reason for the exclusion of the moors of upper Nidderdale from the National Park in 1954 was opposition from Bradford Corporation Water Board, concerned that access might provide a risk to public health (Speakman, 2014). The wealth of ecological information available on the National Park forms the basis of this book, but examples are also taken from Nidderdale and elsewhere in northern England where they help us to understand the factors affecting animal and plant populations in the region.

The landscape we see today has been moulded by successive glaciations during the last 2.5 million years, leaving exposures of predominantly Carboniferous-age rocks (359–299 million years old) at th surface, covered in other places by glacial till and wind-blown deposits known as loess from the end of the Last glaciation. What distinguishes the Dales from the Pennine hills immediately to the south that many of these exposed scars and benches on the valley sides are formed of Carboniferous limestone rather than of rocks giving rise to acidic soils. Carboniferous limestone is also exposed much further to the south, in the White Peak of Derbyshire, but this region was not covered by the most recent glaciation, and largely lacks the extensive bare limestone pavements which are such a remarkable landscape feature of the Dales. The pavements, grey scars and many, many miles of limestone walls are attractive landscape features for most visitors today, as are the rivers with their waterfalls which have helped to deepen the valleys following the glacial retreat. But limestone count has a special pull for naturalists over and above the delights of the landscape itself, and the Dales represent the largest exposure of Carboniferous limestone rocks in any region of the Pennines. Their rich ~~diversity of habitats and assemblages of plants and animals have provided a great attraction~~ for naturalists over several centuries.

**FIG 1.** Upper Wharfedale in mid-May, near Buckden, looking south. The village is just visible in the distance on the extreme left of the photograph.

## TOPOGRAPHY AND CLIMATE

Although the National Park is named for the dales themselves, the hills into which they are cut are ju as important. The Three Peaks of Ingleborough, Pen-y-ghent and Whernside near the head of Ribblesdale have been a magnet for walkers for generations, particularly those from Bradford, Leeds and the industrial towns around them. None of these hills is very high in comparison to the nearby Lakeland mountains, but their proximity to one another, and their imposing forms in the landscape, provide an irresistible challenge, particularly for those many people drawn to complete the Three Peaks Walk. And these are just three of 20 hills in the National Park over 600 metres which help to make it a most popular centre for walkers. The Pennine Way traverses the National Park south to nor and includes the summit of Pen-y-ghent. The Coast-to-Coast walk crosses the northern edge of the

National Park over Great Shunner Fell to Richmond. In contrast, the Dales Way, which runs northwes from Ilkley to Sedbergh and beyond, largely keeps to the river valleys.

The major northern dales of Swaledale and Wensleydale lie more or less west to east below the Pennine watershed, whereas the southern dales are orientated approximately north to south. The Ribble eventually flows westwards into the Irish Sea, as do the rivers in the northwest corner of the National Park which join the Rivers Eden and Lune, but all the other rivers and their tributaries flow eventually southeastward into the Humber. The National Park covers essentially the upland areas of these river valleys and their catchments. From the mouth of the Lune it is approximately 40 kilometres down the prevailing southwesterly wind to the summit of Whernside (Fig. 2) with a rise i altitude of over 700 metres. Similarly on the eastern edge of the National Park there is a rapid fall in altitude from the high fells above Swaledale and Wensleydale to the Vale of Mowbray. This means that the climate shows considerable local variation both across and within the Dales, not least becaus of the theoretical 0.6 °C fall in air temperature for every 100-metre rise in altitude, the so-called adiabatic lapse rate effect. In the cloudy oceanic climate of northern England the lapse rate may be even higher at 0.65 °C for every 100 metres. Hill tops are windier than sheltered valley bottoms and receive more precipitation as moist air moving across them is cooled, but the orographic enhanceme of precipitation in the Dales is not as great as in the nearby Lake District with its higher hills and closer proximity to the coast. As well as the major effects of topography on climate, local features ca also have marked effects on microclimates; for example south-facing dale sides receive a greater amount of solar radiation energy and are warmer than north-facing ones, which are cooler and more moist, with often far-reaching effects on the vegetation.

Some of these effects can be seen from records in the Malham region. Early records of precipitatio were made at Tarn House from 1870, but these were discontinued in 1928, and it was not until the Field Studies Council established a field centre there in 1948 that weather recording began again. Th Malham weather station is at 395 metres, and Gordon Manley (1979) estimated that the mean annual temperature recorded there in the 1950s was 0.3 °C above that expected at this altitude by extrapolation from the nearest lowland stations. He attributed this to local topographical features, including the fact that measurements were made on a south-facing slope, only 100 metres from Malham Tarn (Fig. 3). Some shelter from trees around the house also affects air movement, diminishing the fall in temperature on quiet clear nights and, on fine sunny days, increasing the rise i temperature. He concluded that at the Malham weather station this resulted in fewer air frosts than might be expected. Differences in topography can have a marked effect on the incidence of frost, wit for example large saucer-shaped depressions in the landscape making frost hollows in which the incidence of late frosts in their bases is much higher than on their rims. These frosts can have a marked detrimental effect on plants fresh into growth.

**FIG 2.** Whernside (736 metres), one of the Three Peaks and the highest point in the Yorkshire Dales National Park, viewed from Southerscales limestone pavement.

In 1963 Manley established a thermograph on Fountains Fell at 660 metres (Fig. 4), 1 kilometre south of the summit cairn, and 5 kilometres northwest of the Malham Field Centre. Temperature records were made from May 1963 to December 1968. The mean annual air temperature was 2.1 °C colder on Fountains Fell than at Malham, representing an apparent very rapid fall in temperature with altitude of 0.79 °C per 100 metres (Table 1). There was a greater number of days with air frosts at the higher altitude (130 days per annum at Fountains Fell, compared to 80 at Malham), and both locations had markedly more frosts than Ilkley, 30 kilometres away in lower Wharfedale, where there were 57 days of air frosts per annum. Manley also estimated that snow lay on the ground at Fountains Fell for 80 days per annum on average, approximately double the length of snow lie at Malham.

**FIG 3.** The only long-term meteorological station in the National Park is on the south-facing slope above Malham Tarn and immediately below Tarn House.

Temperature has a marked effect on plant growth, and effectively determines the length of the growing season. This is usually taken to be the period in which the air temperature exceeds 5.5 °C, th temperature at which common lowland pasture grasses begin growth. Whereas in mild winters, at sheltered lowlands sites close to the coast, growth can occur almost throughout the year, on Fountain Fell Manley estimated that the growing season was only the 22 weeks between 10 May and 15 October. Temperature has a marked effect both on vegetative growth and on the ability of plants to se seed. Prince (1976) grew barley on similar soils at Lancaster (53 metres) and Malham (495 metres). He found that barley grains attained a much higher maximum weight, and a month earlier, at Lancaster than at Malham (Fig. 5). At Malham the minimum grain water content was not achieved until late September, five weeks after similar water contents were achieved at Lancaster. This is a striking demonstration of the unsuitability of the Craven uplands for the growth of cereal crops, although in the past oats were an important crop on many farms. Other cereals were also formerly grown in the region, particularly in the lower and warmer parts of the dales. Millward (1988) recorde that when the national corn acreage peaked in the 1850s, only 3 per cent of the 18,000 acres (7,300 ha in lower Wensleydale was arable, and the 81,000 acres (33,000 ha) in the upper dale would have had considerably less. Temperature has a marked effect on tree growth too, and woodland is rarely found above altitudes at which the mean temperature does not exceed 10 °C for a minimum of two summer months. Based on Manley's observations on Fountains Fell, tree growth today should be possible almost everywhere in the National Park, and the largely treeless landscape we see today is the result the demands of human populations and their grazing animals.

**FIG 4.** Fountains Fell from Lower Winskill Farm, Langcliffe, showing the ridge on which Gordon Manley established a temporary thermograph in 1963.

**Table 1.** Average temperatures for Malham Tarn House and Fountains Fell (the latter approximate) reduced to the period 1941–197
from Manley (1979).

| | Average temperature (°C) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | D |
| Malham Tarn (395 m) | 0.9 | 1.1 | 2.9 | 5.7 | 8.7 | 11.7 | 12.9 | 12.7 | 10.9 | 7.9 | 4.1 | 2 |
| Fountains Fell (660 m) | −1.0 | −1.0 | 0.5 | 3.0 | 6.0 | 9.5 | 10.5 | 10.5 | 9.2 | 6.0 | 2.0 | 0 |

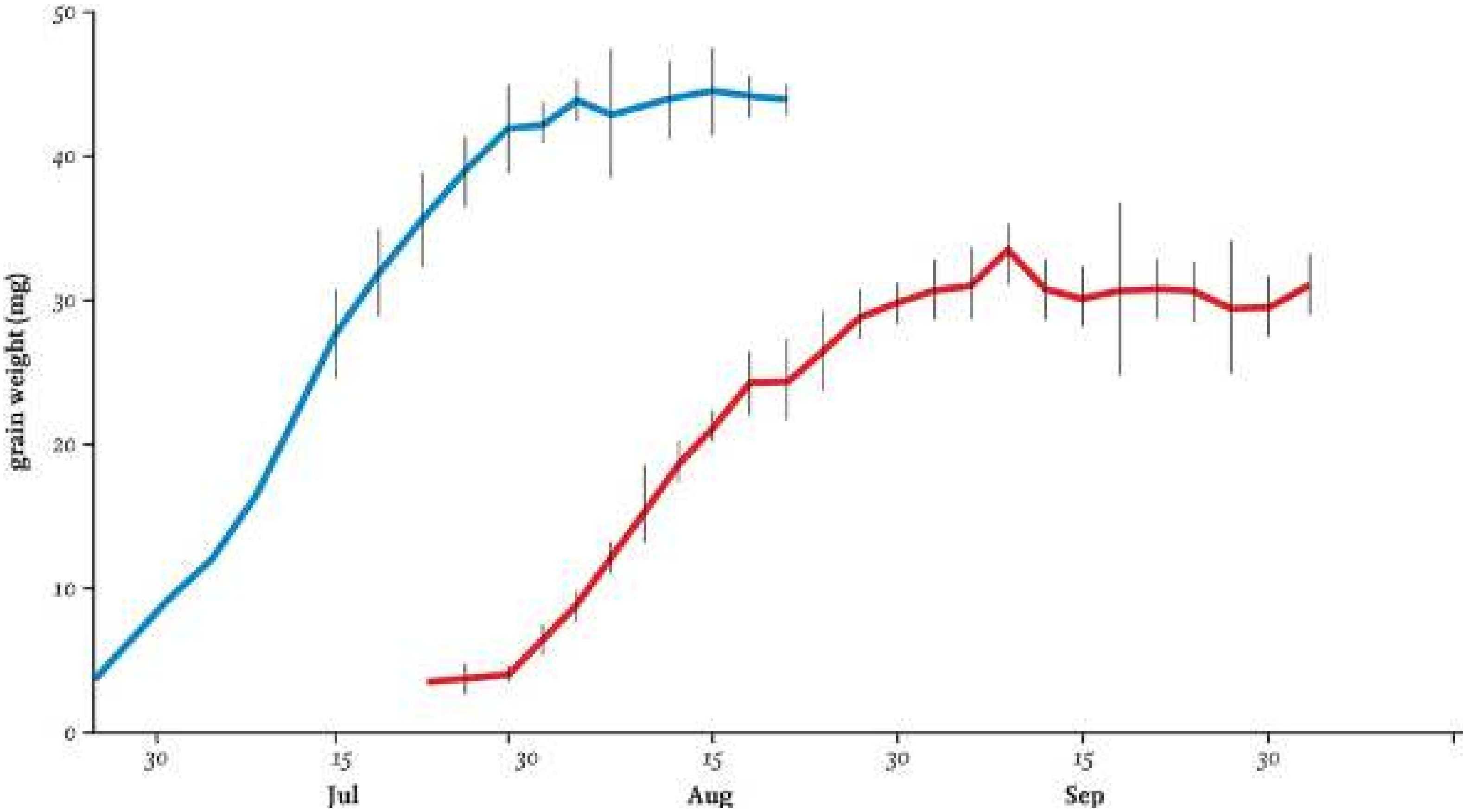


**FIG 5.** Accumulation of dry matter by barley grains from plants grown at Malham (red) and Lancaster (blue) in 1970. The error bar
show 95 per cent confidence limits. From Prince (1976).

In recent decades there has been increasing concern about climate warming. Burt & Horton (2003) analysed the daily weather record made at Malham in the period 1961–2000. They showed that the annual mean temperature increased by nearly 1 °C over the period, with winters showing the greatest seasonal warming. Although the duration of snow lie was not quantified, this almost certainly declin in response to the winter warming. There were fewer air and ground frosts towards the end of the period, but July and August were the only months to remain entirely frost-free since 1959. The warmest year on record was 1997, with a mean air temperature of 8.2 °C. Rainfall records in the late nineteenth and early twentieth centuries allowed these workers to reconstruct precipitation data from 1860 to 2000. This showed an annual average of 1,502 mm, and a trend for the winter months (December, January and February) to become wetter and the summer months (June, July and August) to become drier (Table 2), but no overall trend in annual precipitation over this period. Up until 2011 the wettest year recorded was 2000, with 2,097 mm, and the driest was 1975, with 1,124 mm.

The trend to wetter winters increases the risk of flooding in the river valleys draining the National

Park, particularly because this is the period of the year when evaporation from wet surfaces and plan lea~~ves is at a minimum. The excess of precipitation over potential evaporation determines water~~ movement down through soils and into the aquifers. An estimate of this has been made for Widdyban Fell, at an altitude of 510 metres in the north Pennines. During the period 1968–75 the average annua rainfall was 1,523 mm, very similar to the long-term annual average for Malham. Precipitation exceeded potential evaporation in every month, and in annual total by 1,186 mm. Effectively this means that for every square metre of ground on average at least 1,186 litres percolated through the soil per year (Pigott, 1978). These data suggest that over much of the upland regions of the National Park, even with the slightly higher mean temperatures today, precipitation will continue to greatly exceed evaporation.

**Table 2.** Total winter and summer rainfall at Malham Tarn, and winter : summer rainfall ratio, by decade. From Burt & Horton (2003).

| *Decade* | *1960s* | *1970s* | *1980s* | *1990s* |
|---|---|---|---|---|
| Total winter rainfall (mm) | 3,786 | 4,134 | 4,698 | 4,743 |
| Total summer rainfall (mm) | 3,349 | 3,097 | 3,299 | 3,038 |
| Winter : summer ratio | 1.13 | 1.33 | 1.42 | 1.56 |

The Malham record is the only long climate data set for the National Park, although another recording site has been established at Colt Park on Ingleborough and, most recently, Lee Schofield ha established a network of automatic weather stations across the Dales. However, using the long-term Malham record, some of the variation in climate across the Dales can be judged by a comparison wit similar records from the lowland stations closest to the eastern edge of the National Park, at Dishfort and Leeming. Data held by the Met Office for all three sites for the period 1981–2010 show that both lowland sites (*c*.50 metres above sea level) have similar mean annual precipitation (*c*.642 mm) – less than half that at Malham (1,550 mm). These lowland sites are in the rain shadow to the east of the Pennines, and are warmer than the Craven uplands (annual mean maximum temperatures close to 13. °C as against 10.5 °C for Malham) with fewer frost days (*c*.54 as against 73 at Malham). The climati variation along the west–east lying dales can also be judged from some precipitation measurements made in Wensleydale (Millward, 1988). She records mean precipitation figures ranging from 1,942 mm at the top of Widdale to 764 mm at Leyburn. Weather records were also made by the station-masters at Ribblehead for a period from 1938. The wettest year from these records up until the mid-1950s was 1954, with a total of 2,781 mm (Hartley & Ingilby, 1956).

## SOILS

Climate exerts a considerable effect on soils, not least through temperature particularly affecting biological activity, and through the excess of precipitation over evaporation. Soils within the Nationa Park vary considerably in depth, from scarcely more than a centimetre deep under plants beginning t colonise bare Carboniferous limestone rocks to peat overlying shales and gritstone which may be several metres deep. They also vary considerably in their chemical characteristics, with shallow limestone soils having a pH close to neutrality (pH 7) as the result of the slow dissolution of the calcium carbonate rock, to bog peat a thousand times more acid with a pH approaching 4. This difference in chemical characteristics also influences the organic matter content and the organisms involved in incorporating plant litter into the soils. Soils close to neutrality and with a high base statu (readily available calcium, magnesium, potassium and sodium ions) contain mull humus. This is an intimate mixture of mineral particles and organic matter produced as the result of the activities of th soil fauna, which in the shallowest limestone soils is mainly composed of mites (Acarina) and springtails (Collembola). Mites and springtails can be staggeringly abundant. In soils at Malham, Wood (1967) estimated densities of these organisms between 167,000 and 282,000 per square metre. In deeper soils, still with a high base status, other groups of organisms become important, including large earthworms. In contrast, in freely drained acidic soils, where the bases are largely replaced by hydrogen and aluminium, plant matter in various stages of decomposition is present, often above the mineral soil, and the resulting humus is not intimately mixed with that soil. This is mor humus, in which faunal activity is low and large earthworms are absent. Where strongly acidic soils become waterlogged, a further restriction on the decomposition of organic matter occurs. The soil becomes anaerobic, restricting the activity of many fungi and bacteria, and organic matter accumulates as peat

The great excess of precipitation over evaporation, particularly in the hills, means that all the soils are subject to a strong leaching tendency, except on slopes where leaching losses may be replaced by down-slope movement of elements from above. If the leaching losses of bases are greater than their replacement from decomposition, weathering processes and inputs from up slope, then the soils become acidic. The thin soils (< 10 cm deep) over limestone are perhaps least susceptible to leaching partly because they are subject to periodic spring and summer droughts which help to reverse the downward movement of water through the soil capillaries. These are rendzinas, in which the black mull humus is mixed with limestone fragments throughout.

Brown earths are deeper soils developed on superficial mineral deposits over the limestone. Where the parent material is rich in calcium carbonate, so-called mesotrophic brown earth soils occur. Thes contain mull humus and are only mildly acidic (pH c.6). Many of the lowland pastures are on mesotrophic brown earth soils, where the soil nutrient losses due to livestock harvest and leaching ar often counterbalanced by liming. Earthworms, potworms (Enchytraeidae) and nematodes are active i completely mixing the organic and mineral matter in these soils, and Moles (Talpa europaea) are ofte conspicuously present. Where the soils are less rich in calcium carbonate, the bases can readily be lo by leaching, and oligotrophic brown earths develop. These contain mor humus and are much more acidic than mesotrophic brown earths (pH < 5). Faunal activity is low in these soils and there is typically no earthworm activity in the upper layers, leading to strong surface accumulation of humus

Podzols are more extreme acidic and leached soils. These are often developed on freely drained soils on coarse sandy material such as over Millstone Grit. They also contain mor humus, and their acidity is linked to the depletion of base cations by intense leaching. The surface layer of the mineral soil is strongly acidic (pH < 4) and appears grey with bleached sand grains as a result of the mobilisation and leaching of iron. Iron and some humus accumulate deeper in the soil, where an impervious iron pan or diffuse ochre deposits can develop. When an iron pan is strongly developed this impedes drainage so that soils can become permanently waterlogged and peat develops. Seasonal waterlogging can affect other soils, particularly those developed on shales or in shallow depressions close to water courses. This gives rise to anaerobic conditions in which respiration by plant roots and soil microorganisms leads to the reduction of iron from the orange-brown ferric to the blue-grey ferrous state, and oxygen release from air-conducting roots leads to localised oxidation. These soils are known as gleys, and often contain blue-grey and orange mottling reflecting their changing reduction and oxidation status.

In some parts of the National Park, mineral veins rich in heavy metals, notably in lead, have been deposited within joints and fractures in the sedimentary rocks. Where these occur at the surface they have mostly been exploited by a mining industry dating back to at least Roman times, so little in the way of natural colonisation and soil development can now be observed. However, there are large area of metal-rich spoil resulting from both surface ore extraction and mining activities, and these are almost always sparsely colonised (Fig. 6). The thin skeletal soils which have developed in some plac on these spoils are rich in lead and other heavy metals and are toxic to many organisms, but have a characteristic, very impoverished flora adapted to this hostile environment.

**FIG 6.** Spoil largely devoid of vegetation at Ox Close Special Area of Conservation near Carperby, Wensleydale, a relic of the once major lead-mining industry.

## THE NATIONAL PARK, AGRICULTURE AND ENVIRONMENT

The National Parks movement had its origins in the late nineteenth century as a means of protecting outstanding landscapes for public enjoyment, but it was only in the period immediately following the Second World War that they became a reality in England and Wales following an Act of Parliament i 1949. The National Parks and Access to the Countryside Act established the National Parks Commission, the body for the designation of National Parks, and for Areas of Outstanding Natural Beauty. The Peak District National Park, established in 1950, was the very first National Park, but it was quickly followed by ten others including, in 1954, the Yorkshire Dales National Park. The Act also established the Nature Conservancy, which was given powers to set up National Nature Reserves (NNRs) to protect the most important habitats, and also to establish Sites of Special Scientific Intere (SSSIs), and to enter into management agreements with their owners or occupiers. SSSIs are areas with significant physical environmental features, such as topographical or geological ones, or with important plant and animal communities.

The post-war period was also notable for another Act of Parliament destined to have a major effec on the early National Parks. In line with successive governments' policy up until the 1980s, the emphasis was on increased agricultural production (Condliffe, 2009). Most of these National Parks were situated in the uplands and therefore much affected by the 1946 Hill Farming Act. This was designed to stimulate livestock production and profitable farming in the uplands, providing subsidies for hill cattle and sheep, and 50 per cent grant aid to improve ‘Mountain, hill and heath land which is suit~~able for the use for the maintenance of sheep of a hardy kind’. Improvements included lime~~ and fertiliser addition as well as drainage. The latter included digging open channels, known as grips, in peatland to improve heather growth for both sheep and Red Grouse (*Lagopus lagopus scoticus*). It wa perhaps not immediately realised that the 1946 Hill Farming Act was to a degree detrimental to some of the provisions of the 1949 Act. However, it was clear by the 1970s that many upland SSSIs were being adversely affected by agricultural practices such as overgrazing and drainage, and further legislation was required for their protection.

The 1981 Wildlife and Countryside Act required owners or occupiers of SSSIs to notify the Nature Conservancy Council in advance of any proposed action aimed at increasing agricultural productivity such as drainage or inorganic fertiliser addition which might damage the site. Under this Act, Nation Park Authorities were also charged with mapping all areas of mountain, moor and heath, which then became ineligible for agricultural improvement grants. The 1980s marked a turning point in upland conservation. For although farmers still received headage-based subsidies from the European Commission’s Common Agricultural Policy (CAP) Less Favoured Areas scheme, which encouraged high sheep and cattle numbers, the 1986 Agriculture Act provided in selected areas for the introduction of voluntary Environmentally Sensitive Area (ESA) agri-environment schemes. The Pennine Dales ESA, including most of the Yorkshire Dales National Park, was designated in 1985 an extended in 1987.

The ESA schemes rewarded farmers willing to farm less intensively. These could be awarded unde three main headings: first, to conserve and enhance the natural beauty of an area; second, to conserve the flora and fauna, and geological and physiographic features; third, to protect buildings of archaeological, architectural or historic interest where particular agricultural practice was likely to ai their conservation. Although these schemes were broadly successful in terms of environmental benefits, they were not always popular with the farming community, and sheep numbers in the Dales continued to rise into the 1990s. They also had the disadvantage that the schemes were not available outside ESAs. In 1991, as a development of the schemes, the Countryside Commission, the successor body to the National Parks Commission, introduced the Countryside Stewardship Scheme (CSS), which was available to all landowners and managers, not just farmers, but with no automatic right of entry. Entry became competitive and based on environmental benefits.

Whilst ESA and CSS schemes offered considerable potential benefits, and were available at severa tiers of entry, giving more money for more restrictions on farming practice, they were not always conducive to maximising environmental improvements and, with this in mind, in 1993 English Natur (the successor body to the Nature Conservancy Council) introduced the Wildlife Enhancement Scheme (WES) for SSSIs. This scheme allowed for specialist site-specific optimal management approaches. The several schemes (ESA, CSS and WES) were subsequently progressively phased out i favour of Environmental Stewardship Schemes. These are available at Entry Level Stewardship and Higher Level Stewardship. Currently 231,439 hectares of the Yorkshire Dales are targeted for Higher Level Stewardship. In the hills, this scheme includes the Uplands Entry Level Scheme, first introduce in 2010 when it replaced the Hill Farm Allowance, which rewards upland farmers with higher payments to provide a greater commitment to environmental management in England’s Severely Disadvantaged Areas, which includes most of the Yorkshire Dales. A new three-tier environmental land management system will be introduced from 2016 to replace the Environmental Stewardship Schemes, providing funding for farmers and land managers to deliver benefits for wildlife, to improv water quality and to create woodlands.

The year 2001 was a watershed in terms upland agriculture in the United Kingdom. It was the outbreak of foot and mouth disease in that year which led to the slaughter of cattle and sheep in many areas of northern England, including in parts of the Dales, and which resulted in a reassessment of th ~~importance of agriculture in the rural economy. Footpaths were closed, and at first visitors were~~ strongly discouraged for fear of the further spread of the disease; this soon began to have an effect or the tourist industry and helped to emphasise that, in several of our National Parks, tourism was much the more important part of the rural economy. It also had the short-term effect of eliminating entirely grazing by domestic livestock from large areas of the uplands, the most obvious initial response of which was increased flowering of many species. In the longer term some farmers chose to re-evaluat their business options, so that, for example, sheep numbers, which had already peaked during the 1990s, began to decline. Another consequence of the foot and mouth outbreak, and the perceived mishandling of it by the Ministry of Agriculture, Fisheries and Food, came in June 2001 when that department was merged with part of the Department of Environment, Transport and the Regions, and small part of the Home Office, to create the Department of Environment, Food and Rural Affairs (Defra); this for the first time brought environmental and agricultural interests into the same ministry A later change saw the merger of English Nature with the Countryside Agency (the successor body of the Countryside Commission) to establish Natural England. Natural England is the government's advisor on the natural environment, managing National Nature Reserves and notifying SSSIs, but als responsible for designating National Parks and Areas of Outstanding Natural Beauty as well as for managing England's green farming schemes. Another important change came with the 1995 Environment Act, which created the Environment Agency in part as the successor body to the Nation Rivers Authority and Her Majesty's Inspectorate of Pollution, with responsibilities including air and water quality, and flood protection.

An international landmark in environmental conservation was provided by the 1992 Earth Summit in Rio de Janeiro at which governments promised to 'develop national strategies, plans or programm for the conservation and sustainable use of biological diversity …' This led to the European Community Habitats Directive of the same year, which required member states to establish a networ of important high-quality conservation sites, Special Areas of Conservation (SACs), to protect specie and habitats of European importance. The Ingleborough Complex, the Craven Limestone Complex, which includes Malham Tarn, and Ox Close near Carperby are three SACs subsequently designated which lie wholly within the National Park, with parts of the North Pennine Meadows, North Pennine Moors and the River Eden SACs also included. The Earth Summit was followed in 1994 by the Unite Kingdom government's publication of the *UK Biodiversity Action Plan* (UK BAP), which encourage the development of local biodiversity action plans. *Nature in the Dales: a Biodiversity Action Plan fo the Yorkshire Dales National Park* was produced in 2000 by the National Park Authority in consultation with the Dales Biodiversity Forum. The key aims of the costed programme were:

*To conserve and, where practicable, enhance:*

*(a) the overall populations and natural ranges of native species and the quality and range of habitats in the Yorkshire Dales.*
*(b) the biodiversity value of nationally and internationally important and threatened species and habitats.*
*(c) the biodiversity value of species and habitats that are characteristic of the Yorkshire Dales National Park.*
*(d) the biodiversity of natural and semi-natural habitats where this has been diminished over recent decades.*

Continuing progress with these aims was provided in 2011 by the publication by the Yorkshire Dales sample content of Yorkshire Dales (Collins New Naturalist Library, Book 130)


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