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The Sussex Study: 50 years of monitoring an agricultural ecosystem

In Changing Planet, Wildlife Tags The Game & Wildlife Conservation Trust April 4, 2018 0 Comments

Gillian Gooderham

From inauspicious beginnings in a Sussex barn to policy-changing science, the Sussex Study aims to reverse the decline of wildlife on Britain's farmland. This is the story of a unique and impressive set of data gathered by the Game & Wildlife Conservation Trust (GWCT) and its predecessors during the past 50 years over an area of farmland in West Sussex, UK.

Rudyard Kipling (1865 – 1936) wrote of this area in southern England in his 1906 poem *A Three-part song*, which starts:

I'm just in love with all these three,
The Weald and the Marsh and the Down countree.
Nor I don't know which I love the most,
The Weald or the Marsh or the white Chalk coast!

The Sussex Study was originally called the *Partridge Survival Project* and began in April 1968. Its inception represented an extraordinary effort by Chris Hunt, a Member of the Game Research Association's Council, Managing Director of North Farm, Washington, Sussex and founding Chairman of the GWCT. Dr Dick Potts had just been appointed as Project Officer to investigate the effect of pesticides on the grey partridge, an iconic game bird species of the British countryside. Dick had just completed work on the effect of organochlorines on the breeding success of seabirds[1]. Dick was also the son of a Yorkshire farmer and this background helped to pave the way for the project. Access was granted to 62km^2 of farmland by the landowners and farmers who worked on the area. Their support, and that of the generations that followed them, has now endured for 50 years. The primary aim of what soon became known as The Sussex Study was to investigate reasons behind the declines in the breeding success of grey partridges, especially chick mortality[2]. A conscious decision was made that the Sussex Study would simply monitor the effects of the land management decisions taken by the farmers and gamekeepers in order to reflect developments in cereal farming in England. Results from the monitoring would then feed into experiments elsewhere in cereal growing areas of the UK, testing ways to improve game and wildlife conservation and finally into management on farms.

The Study area is bounded to the west by the flood plain and water meadows of the Arun valley, and to the east by the Adur valley. (This area lies merely 30 miles to the south and west of Ashdown Forest, the home of A. A. Milne's famous bear *Winnie the Pooh* and friends.) The northern boundary is defined by the South Downs scarp slope which is thickly wooded, predominantly with beech, ash, or hawthorn scrub, and rises to approximately 220m above sea level. Wooded areas form the southern border, together with villages and coastal conurbations such as Littlehampton (where the yacht of the children's author Arthur Ransome was built and which he named after one of the key

characters in his series of stories starting with *Swallows and Amazons*) and Worthing (to the west of Brighton, the favoured sea-side retreat for many Londoners). The landscape is one of open landscapes of rolling hills of freely drained, thin chalk downland soils. The area is bounded on the west by the Cathedral City of Arundel and is contained within the UK's newest National Park, the South Downs National Park. This area was used for military training (by the Canadian Army Second Division) between 1939 and 1945, and much of the scrub was cleared and ploughed from 1947 to 1954. Arable farming superseded sheep grazing, and the traditional grass ley farming and rotation practices were in decline by the time the Sussex Study began[3]. At this time the light soils and open landscapes were a stronghold of the UK's native partridge species, the grey partridge. (Richard Adams sets his best-selling novel *Watership Down* in such a landscape.)

Dick and his team began a system of annual monitoring with partridges counted in the spring as breeding pairs, and again in late August/early September to monitor breeding success. Annual surveys of the occurrence of arable weeds and abundance of invertebrates in cereal fields were undertaken in June to coincide with the time of peak grey partridge chick hatch. Earlier work at Imperial College, University of London by other researchers had identified the importance of insect-rich diet for rapid grey partridge chick growth and feather development. Monitoring chick-food resources in cereal fields was combined with detailed monitoring of the use of pesticides in the same fields[4].

1970s

In the first decade of the Sussex Study, Dick recruited several scientists to expand the work, starting with two entomologists. Dr Paul Vickerman joined Dick in 1972 and set to work investigating the effects of pesticides and cereal field management on invertebrates in cereal fields, then joined by Dr Keith Sunderland in 1973. In 1974, Dr Steve Tapper began research into the effects of stoat and weasel predation on gamebirds. Collaborations were initiated, most notably with Dr Steve Wratten at Southampton University, researchers at the Glasshouse Crops Research Institute in Littlehampton, and The Rothamsted Experimental Station in Hertfordshire. A series of young researchers began

their research careers with the Trust, working on problems identified from the Sussex Study monitoring. The first of these Ph.D. candidates was Nick Sotherton (now Professor Sotherton and Director of Research at the Game & Wildlife Conservation Trust) who started work in 1976 on the beetle *Gastrophysa polygoni*, whose larvae were relished by partridge chicks and required the arable weed knotgrass *Polygonum aviculare* as its host plant.

This early work on the Sussex Study area was pivotal to the establishment of a new branch of ecology that concentrated on the agricultural ecosystem- agro-ecology. The importance of the Sussex Study was highlighted by Amyan MacFadyen, the Editor of *Advances in Ecological Research*, who wrote that the 1974 article by Dick Potts and Paul Vickerman in this journal "was *remarkable for introducing a thorough ecological approach to an ubiquitous but - to the ecologist - unfamiliar system, for the biological breadth of its treatment and for the clear relevance to a number of practical fields which have been ignored by conventional agricultural science*[5]. Until the Sussex Study began, very few scientists had monitored farmland for its value to wildlife. Dick and Paul concluded their 1974 article saying: *"It would surely be prudent to investigate the structure of these ecosystems before adopting the large-scale use of more pesticides and further intensification of cropping."* They hoped that "*the results of their future studies will help to provide data which will allow further increases in agricultural productivity without unnecessarily violating sound ecological processes and without undue environmental costs.*"[3].

The 1974 publication *Advances in Ecological Research* became a seminal work and an inspiration to a generation of conservation scientists who now regard these intensively managed, man-made ecosystems as having conservation merit worthy of our attention. Sussex cereal fields might be man-made but they were some of the first to be cleared in Britain by Neolithic man, following the retreating ice sheets and making the conversion from hunter gatherer to settled farmer. Some of these fields have a history of growing cereals going back 7,000 years.

1980s

The main findings from the first fifteen years of the Sussex Study formed the basis of Dick's book published in 1986 entitled *The Partridge. Pesticides, Predation and Conservation*[2]. This book is one of the cornerstones of agri-ecology, detailing the effect of intensification in land use and particularly the management of cereal crops on numbers of grey partridges through changes in their food resources, nesting habitat and losses due to predation. It is this work that, in 1984, led to the inception of three of the Trust's major research projects. If the Sussex Study was the test-bed of ideas and the birth place of hypotheses to identify why partridges were in decline, these hypotheses were to be tested elsewhere.

The Cereal and Gamebirds Project sought to address the loss of chick-food insects in cereal fields caused by agricultural intensification. Potential management solutions were tested experimentally at the farm scale[6]. The Salisbury Plain Experiment, examined the effect of legal predator control on grey partridge abundance through experimental manipulation using a "crossover design". This consisted of predator control (the treatment) being applied randomly to one of two farms for three years, after which predator control was switched to the control farm and the farm that had been the treatment area became the control[7]. Finally, work on the ideal nesting cover was undertaken by Dr Mike Rands for his DPhil at Oxford University. Mike characterised the nesting cover of partridges, stressing the importance of perennial grass cover and how well these nesting sites on the ground can drain after heavy rain[8, 9].

Work within the Cereal and Gamebirds Project, chaired by Hugh Oliver-Bellasis of the Manydown Estate, led Nick Sotherton and other researchers at the Trust to develop "conservation headlands" (where the edges of cereal fields receive selective pesticide applications, avoiding both broad-spectrum herbicides and insecticides in spring and summer to promote a weedy understorey rich in insects) and beetle banks (grass banks established across the middle of fields to provide refuges for beetles that are natural predators of cereal pests). Initially this early work on pesticides and their indirect effects on wildlife could not be funded by the GWCT. So the project was independently funded by the UK's cereal farmers who paid a levy of 20 pence per acre to join and support the project. With grants from various charitable trusts, over £1.5 million pounds was raised, worth over £4.5 million today. Funding for both of these methods of mitigating the intensification of cereal management is now available through the UK's agri-environment schemes.

The Salisbury Plain Experiment demonstrated the importance that predation has on grey partridge numbers, particularly through its impact on the number of young fledged per pair. Where predators were controlled, annual young production was twice as high, and breeding density improved 2.6 fold over three years, relative to where predators were not controlled. Throughout all our studies on predation on partridges, our predator control is always seasonal (only during the nesting season, late March to early July) and always legal (taking species with methods that UK law allows). The experiment also verified the ability of legal predator control to restore Grey Partridge numbers against the backdrop of 1980s agriculture.

Towards the end of the 1980s a new development in cereal management on the Sussex Study raised concerns from those monitoring the area. This was the widespread use of the broad-spectrum insecticide dimethoate on the Sussex Study area in 1989. Statistical modelling by Dr Nicholas Aebischer (who had joined the Trust in 1987 partly to computerise the invertebrate and arable flora data collected through the time of the Sussex Study) found that sawflies (Symphyta), whose larvae were another important food item, could take *as many as seven years* to recover from the use of dimethoate in the summer[10]. This work underlined the long-term damage to non-target cereal invertebrates that may occur with the use of insecticides in the summer.

Dick Potts collecting insect samples using a DVac

It was about this time that the UK's government statistics on the status of the UK's breeding birds were analysed and the unhappy results published. The list of farmland birds that had declined by more than 50% in the last 25 years included the grey partridge but also many other once common species such as corn bunting, lapwing, yellowhammer and linnet. Of these the species with the closest association to farming was the grey partridge.

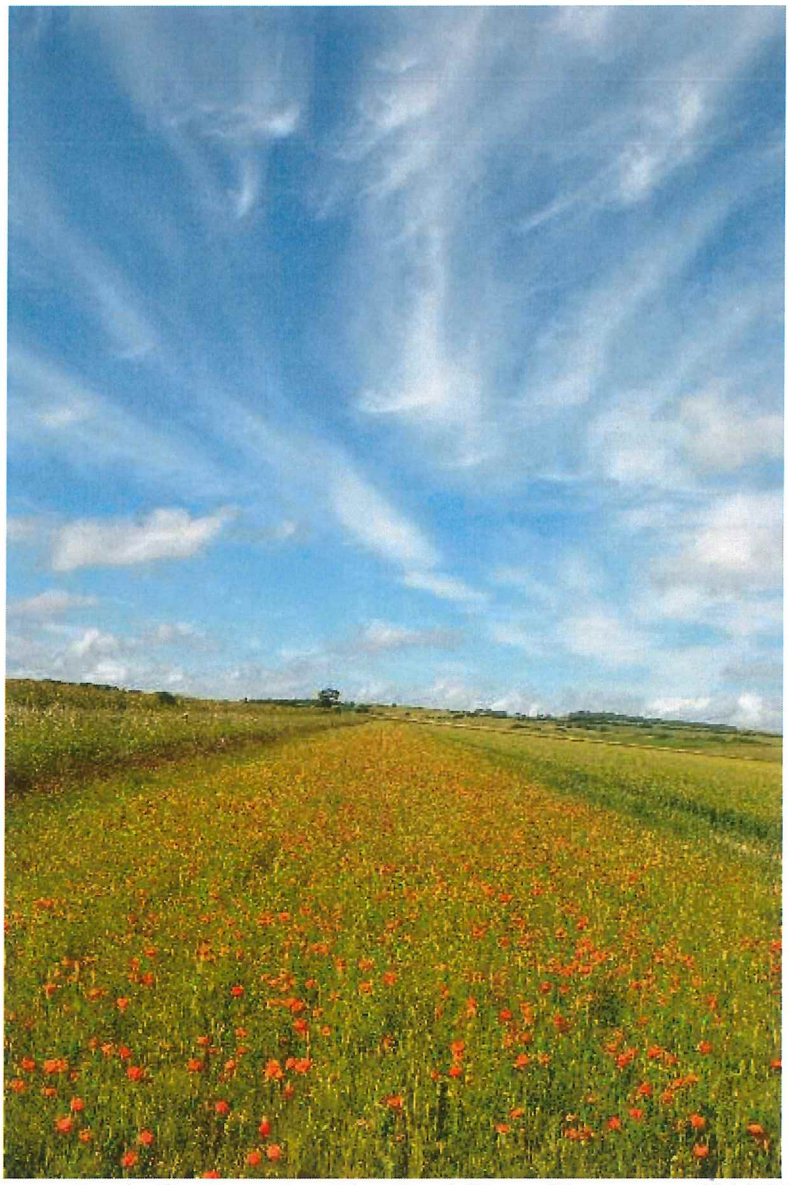
At the end of the 1980s, the UK government began to address the detrimental effects of agricultural intensification highlighted by the emerging field of agro-ecology. This included the introduction of Environmentally Sensitive Areas (ESAs, defined areas of the country where farmers were paid to manage their land in ways that conserved wildlife, landscape and historic features) and voluntary set-aside (initially a measure to curb overproduction but latterly used to provide wildlife habitats). The Sussex Study area fell within the second tranche of ESAs and the farmers on the area took up the funded management options within it, taking land out of cereal production and establishing grass fields to recreate chalk downland over a long time-scale.

1990s

By the beginning of the 1990s the cereal field was being considered as an important area of study for ecologists, not least due to the work of the Trust's scientists both within the Sussex Study and elsewhere. In 1990 the British Ecological Society (BES), and the Association of Applied Biologists (AAB), held a symposium in Cambridge on "The Ecology of Temperate Cereal Fields". The published proceedings of this meeting[11] demonstrated the ecological understanding required by agriculturalists to achieve quality and profitability in cereal production, together with conserving the flora and fauna found in cereal fields. Dick's contribution[12] forms the opening chapter of this publication, backed by two more chapters from the Game Conservancy Trust: by Dr Nicholas Aebischer[13] and Dr Nick Sotherton[14]. All three of these chapters owe a debt to the Sussex Study monitoring, in particular Nicholas' paper presents information on the long-term trends in arable flora and cereal invertebrates monitored in the Sussex Study.

The expansion of agri-environment policy by government continued in the early 1990s. Countryside Stewardship was launched across the country for those areas not covered by an Environmentally Sensitive Area Scheme (ESA) in 1991 and the area covered by ESAs expanded in 1993. It was during this expansion of the ESA that the Ministry of Agriculture, Fisheries and Food (MAFF), provided funds for monitoring of the effects of the ESA. This allowed Nicholas Aebischer and Dr Andrew Wakeham-Dawson to examine the effect of the management undertaken by the farmers across the Sussex Study area (and beyond) on plants, invertebrates and farmland birds. They found that, although the long-term leys established under the ESA had fulfilled their landscape value, their contribution towards conserving arable flora and fauna was minimal[15]. This work led to the inclusion of conservation headlands and undersown cereals (where cereal crops are sown with a grass/clover mix that provides a green cover overwinter following cereal harvest) in the options within the ESA, setting a precedent for in-field habitat management in agri-environmental schemes within the UK. This was the first instance where agri-environment options developed from the results of that early monitoring on the Sussex Study were put in place on the study area. It would not be the last.

In addition to research on ESA management, Nicholas secured funds for a Ph.D. student, Nick Brickle, to examine the effect of agricultural intensification on Corn Buntings, *Emberiza calandra*, on the Sussex Study area[16]. The corn bunting has become a rare bird in the UK, unable to deal with changes to cereal crop management. Nick began work on the study area in 1995, determining that the breeding success of Corn Buntings was directly related to the availability of chick-food invertebrates in the cereal crops surrounding their nests. This concurred with earlier work on the Sussex Study area on Grey Partridge chick survival.



Sussex Study Conservation Headland (Peter Thompson GWCT)

In the late 1990s, a report reviewing the evidence for the effect of pesticides on farmland birds[17] for the Joint Nature Conservancy Council (JNCC), stated that work by The Game Conservancy Trust on Grey Partridge provided the most convincing case for the effect of pesticides on farmland birds. Funding was provided by the JNCC for Dr Julie Ewald (who had joined the Trust in 1995 to construct a GIS database of the Sussex Study data) to collate and analyse the effects of pesticide use within the Sussex Study area on both arable flora and cereal invertebrates[18]. The results of this work, in conjunction with Nicholas Aebischer's 1990 modelling work on sawflies, remains the best example of the effect of pesticides on cereal invertebrates persisting into the year following pesticide application.

2000s

As the Sussex Study moved into the new millennium, the results of the long-term monitoring of both the cereal ecosystem and the management decisions of the farmers on the study area started to be appreciated by policy makers in government and elsewhere. Agri-environmental funding increased, with the addition of arable options, including conservation headlands and beetle banks, to Countryside Stewardship. Both are designed to boost the abundance of insects and other invertebrates crucial for the survival of young birds.

The take-up of these measures was poor, however, and it was at this time that the Sussex Study monitoring began to raise serious concerns about the number of Grey Partridges on the study area. The breeding density of birds had fallen from a high of 20 pairs per 100 ha in the late 1960s to less than a pair per 100 ha in 2003. There was a real prospect that the reason the Sussex Study had been initiated in the first place, to monitor grey partridges, might monitor them to extinction. By now Dick Potts had retired from The Game Conservancy Trust, but not, crucially, from the Sussex Study. Retirement gave Dick the time and freedom to respond to a direct request from the Duke of Norfolk, one of the landowners on the Sussex Study area, to restore Grey Partridge abundance on his land. The Duke was incredibly ambitious. He not only wanted to bring back Grey Partridges, he wanted to restore his farm to a sustainable wild Grey Partridge shoot - something it had not been for 40 years.

Work began on the Norfolk Estate in late 2003, initially on an area of 140 ha. Conservation measures (beetle banks resulting in smaller fields, conservation headlands, wild bird cover, reduced pesticide applications, patchwork quilt of cropping) were put in place and legal and seasonal predator control was directed towards controlling nest predation on Grey Partridges Unfortunately, densities of Grey Partridges had declined to such an extent that only one pair remained. Something had to be done and, in the spring of 2004, nine pairs of wild Grey Partridges were translocated to the area. Since then with no further translocation, the numbers have grown to almost 400 pairs of Grey Partridge with a bonus of 150 pairs of Red-legged Partridge. In 2007, the managed area expanded to 1033 ha and sustainable Grey Partridge shooting had been re-established along with a most impressive boost in biodiversity of the flora and fauna.

(Peter Thompson GWCT)

2010s

The long-term monitoring began to attract attention as a resource that allowed ecologists to look at both changes in agriculture and climate change[19, 20, 21]. This work underlined the prolonged negative effects of agricultural intensification on the cereal ecosystem and highlighted the need for continued governmental support for agri-environment schemes.

The new developments on the Norfolk Estate benefitted from the UK government's agri-environmental funding at the offset. In 2005, the UK had launched the Environmental Stewardship programme, with both Entry level (available to all) and Higher level (competitive sign-up) available. The Norfolk Estate successfully applied for funding under the Higher Level Scheme in 2011 but continued to provide habitat management above and beyond the level paid for through agri-environment support. The success of all this, particularly as presented in Dick's book[22] was appreciated not only by ecologists but, more importantly, by policy-makers. It is recognised by farmers and policy-makers as a best-case example of conservation. At the Game & Wildlife Conservation Trust's 2012 Research Conference, following Julie Ewald's presentation on the success of the work on the Norfolk Estate, Natural England staff suggested that the project was a blueprint for how other farmers could undertake conservation. 'Farmer Clusters' (farmers working together for conservation, to gain the benefits of scale) were developed out of this idea. Not surprisingly, the pilot programme for this included a 'cluster' run by the farmers on the Sussex Study.

'Farmer Clusters' were developed as a concept and fed into the UK government's plans for the replacement of the Environmental Stewardship agri-environment scheme. In 2015, the UK government released information concerning the new Countryside Stewardship. As part of the new agri-environment scheme there would be scope for a competitive Facilitation Fund to "*support people and organisations that bring farmers, foresters, and other land managers together to improve the local natural environment at a landscape scale*". The farmers on the Sussex Study, together with others, successfully applied in the first round of Countryside Stewardship facilitation fund applications. Their Arun to Adur Group encompassed the whole of the Sussex Study area.
Looking back on 50 years of the Sussex Study, it is inspiring to think that work begun to answer questions and concerns highlighted through the Sussex monitoring that began in the 1960s is now enabling the farmers on the Sussex Study to conserve wildlife on their land. Surely this is the best measure of how successful the Sussex Study has been. The initial set-up of the project, instigated by farmers and the long-term commitment of what is now the Game & Wildlife Conservation Trust and its staff, in particular Dick Potts, have been crucial. It is, therefore, a cruel misfortune that Dick will not be able to join in the 50th Anniversary celebrations of this prestigious Study as, most regrettably and to the great sadness of all his colleagues at the Trust, he died after a brief illness at the end of March 2017.

The Sussex Study is a brilliant example of the value of maintaining a long-term monitoring programme, keeping it relevant in a changing world and providing practical information for land managers. To end, as we began, with a quote from Rudyard Kipling's poem *A Three-part Song* – its concluding verse:

I've given my soul to the Southdown grass,
And sheep-bells tinkled where you pass.
Oh Firle an' Ditchling an' sails at sea,
I reckon you keep my soul for me!

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Game & Wildlife
CONSERVATION TRUST

The Game & Wildlife Conservation Trust manages research projects in a variety of disciplines encompassing expertise from its scientists in biology, botany, entomology, and ornithology, covering a broad range of environments from moorland, heathland and farmland to wetlands and other riparian territories, which aim to restore and conserve habitats and its wildlife, and to provide a sustainable source of game for future generations. The applied science carried out by the Trust often provides a basis for elements in conservation schemes run by Natural England or Scottish Natural Heritage, (two of the UK's Government Agencies responsible for wildlife) and can be directly applied by farmers and gamekeepers across the UK. GWCT scientists have produced scientific papers in peer-reviewed journals since 1929, and with other work published in books and also in unpublished Ph.D. theses by doctoral students, the total number of scientific articles currently runs at over 1,800.

Full details of the work published by the GWCT can be found on its website: www.gwct.org.uk

The link to the webpages specific for the Sussex Study is:
http://www.gwct.org.uk/research/long-term-monitoring/sussex-study/

Mrs Gillian Elizabeth Gooderham
e-mail: ggooderham@gwct.org.uk
telephone: 01425 651019
GWCT Headquarters, Burgate Manor, Fordingbridge, Hampshire, SP6 1EF.