University of Kent

PhD Thesis in Biodiversity Management

Management of gamebird shooting in lowland Britain: social attitudes, biodiversity benefits and willingness-to-pay

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2007

Abstract

Successful conservation of British biodiversity largely depends on privately owned agricultural land that covers over 75% of Britain's surface area. Several centuries of traditional management for land uses like hunting and shooting have shaped the British countryside. However, agricultural intensification since World War II has reduced habitat quality, and resulted in biodiversity losses, for example of woodland and farmland birds. More recently, agri-environment schemes (AESs) have sought to redress these losses, but have not yet realised wider benefits because of adopted inappropriate prescriptions and/or poor execution of these prescriptions. However, many landowners who shoot gamebirds produce high quality habitat that also benefits wider biodiversity. Additional benefits generated by gamebird shooting include job creation, financial benefits for local businesses, and social cohesion among rural communities. Nevertheless, some opponents wish to ban gamebird shooting or introduce regulations. Consequently, many lowland shoots have changed some practices, in particular reducing the numbers of reared and released birds.

This thesis investigates the social attitudes of those who shoot, and the biodiversity benefits and financial viability of these changed practices on a lowland pheasant shoot in Kent. Focal group discussions showed that the four main stakeholder groups placed different values on gamebird shooting, although each group recognised many wide reaching benefits. Equally, discussants emphasised the need to accept change to assure the future of gamebird shooting.

Surveys around a new land management regime designed to increase wild pheasant numbers on a commercial reared shoot showed increases in pheasant brood density and average brood size. This highlighted the feasibility of increasing wild game productivity, even among large numbers of reared gamebirds, through habitat creation, modified gamekeeping and supplementary feeding. Pheasant productivity was significantly related to gamekeeping effort, spring pheasant population composition, and the release of reared gamebirds.

The effects of the new land management regime on wider wildlife were mixed. Butterfly numbers increased and were greater in number than were observed in populations at a site under conventional farm management with no AES. Bumblebee numbers did not increase and were no different to those at the conventionally farmed site. This indicated that grass margins created through the new regime increased habitat quality only for certain species groups. Numbers of butterflies and bumblebees were similar to those on well-established shoots that are predominantly or completely wild, indicating that large numbers of reared gamebirds did not affect butterfly and bumblebee numbers. The number of butterflies and bumblebees was positively related to the cover of flowers and herbs, suggesting that the seed mix sown in field boundaries is important in determining the populations of these two species groups.

The number of insects important as chick food items increased significantly in the grass margins sown under the new regime, showing that these habitats successfully provided rich feeding areas for wild gamebird broods. The grass strips contained more insects than conventionally cropped field edge, highlighting the importance of alternative habitat areas in wild gamebird productivity. Densities of songbirds increased under the new regime, and compared to those on well-established shoots that are predominantly or completely wild. Songbird populations were significantly influenced by gamekeeping effort and the amount of alternative habitat created by field boundaries and AES prescriptions.

The willingness-to-pay survey indicated that shoot owners would lose significant revenue, should the release of reared gamebirds be banned in the future. As many shoots generate little or no money for their owners, or are even run at a loss, it was concluded that a future ban on released birds would result in the closure of many lowland shoots, and the loss of the varied social and biological benefits generated by gamebird shooting.

Acknowledgements

Firstly, I must thank those who financially supported this project and the landowners who permitted me access their property so as to complete the gamebird and biodiversity studies. Without the generosity of both, this PhD would not have been possible. The degree of assistance given by Countess Sondes, Sir John Swire, Mr John Lee Pemberton and the tenants of the Duchy of Cornwall was immense and I cannot express how much I enjoyed and appreciated being able to walk around their beautiful properties. In addition, I must say a special thank you to Elizabeth Deen-Sly, who voluntarily took on a massive supporting role, both of my work and my sanity.

I heartily thank the gamekeepers and land managers associated with the various study areas; their intimate knowledge of the land and their enthusiasm to assist me wherever possible meant the fieldwork was an exceptionally enjoyable and successful aspect of this project. In particular, I must thank Jeff Handy, who regularly kept me company on surveys, welcomed me into his home and his community, and who I now consider a dear friend.

I must also thank all those individuals who helped arrange and who took part in the stakeholder focus group meetings and the willingness-to-pay questionnaire survey; I recognise that they gave up their time to assist and put an immense amount of trust in me by discussing this sensitive issue with a stranger. I hope they feel the trust was justified and that I represented the information they provided, particularly their views on gamebird shooting, with honesty and clarity. With regards the massive amount of information generated by the willingness-to-pay survey, I thank those trusted individuals who assisted by inputting the data.

I thank all those who assisted me with data analysis, who provided advice and help whilst I was writing up, and who took on the unenviable roles of reading, rereading and commenting on each chapter. In particular, I thank Dr. Nick Sotherton and Dr. Rufus Sage of the Game Conservancy Trust (GCT); I know it was a time-consuming exercise, time you could ill-afford to donate, and I appreciate your help, guidance and continued good humour even in the toughest times.

Special acknowledgement goes to my supervisor Professor Nigel Leader-Williams, of the Durrell Institute of Conservation and Ecology (DICE), who has been exceptionally supportive and patient; whose kindness and encouragement has kept me going through what have been some challenging years and from whom I have learnt so much. Thank you Nigel.

Finally, I must thank those nearest and dearest to me. My parents, who have always supported my studies; I know it wasn't easy seeing your youngest child (and only daughter), go off on trips around the world to study the wildlife I love so much. I imagine having me back in Britain, studying in Kent, meant the worry was considerably less but you probably saw just as little of me! Thank you for letting me take over your computer room with my plethora of books, journals and boxes of data sheets.

And to my darling Dan: your support has been unwavering; your understanding and the sacrifices you have made, due to my commitments to this project, have been immense. No words can express how much I appreciate everything you have done for me, so I shall leave it to a simple "Thank you".

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Introduction

1 General introduction

In this thesis, I explore how resource ownership and utilisation can encourage landowners to sympathetically manage their property to enhance conservation and produce social and economic benefits for stakeholder groups. The resource in question is the common pheasant (*Phasianus colchicus*), the most widespread gamebird in Britain, which contributes the greatest proportion of the national game bag and significant revenue for many individuals. The popularity of pheasant shooting, both commercially and privately, means large areas of rural lowland Britain are managed specifically for this species. The major focus of this study was to explore the scope for changing the management of gamebird shooting with regard to stakeholder attitudes and possible repercussions on the financial viability of commercial pheasant shoots. In addition, this study examined the effects of altering land management practices for the benefit of wild gamebird populations; and the potential for generating additional conservation benefits for wider wildlife.

1.1 Systems of Biodiversity Conservation

1.1.1 Global Conservation

Biological diversity is being lost globally at a rate unprecedented since the start of human history (COP, 2002; Delbaere, 2004; Balmford and Bond, 2005; de Heer *et al*, 2005). More species are becoming extinct, while genetic diversity is being lost, because of human actions. The activities of people around the world have disturbed and degraded ecosystems. Direct impacts through harvesting of specific species, the destruction of natural habitats for farming, mining and development, and pollution are just a few of the reasons why extinction rates are believed to have increased in recent years (IUCN, 2004; Balmford and Bond, 2005). As biological communities become small and isolated they lose their ability to adapt to emerging threats such as climate change (Brakefield, 1991; Holdgate, 1991).

As human populations grow exponentially, many conservation biologists believe that designating protected areas is the best way to prevent the ongoing degradation of natural ecosystems and the loss of biological diversity (Pressey, 1996; Lanjouw *et al*, 2000; Terborgh and Peres, 2002; Chape *et al*, 2005). The concept of protected areas is centuries old, but Yellowstone National Park is widely considered the first protected area of the modern era, and was established in 1872. Many more protected areas have since been established throughout the world and their numbers and extent have increased dramatically in recent decades. Indeed, terrestrial protected areas now cover over 11% of the world's land surface (IUCN, 2004).

The establishment of protected areas, however, often results in zones of exclusion, and their supporting legislation is often used to restrict access and so prevent habitat degradation or improper use. Permission can be granted for individuals to visit more strictly protected areas, and payments for access are often required. People from developed countries are often willing to pay for access primarily for recreational purposes, in their own and other countries. However, indigenous peoples from developing countries would find it unimaginable to pay for access to their local protected areas. Indeed, the establishment of protected areas may limit access to local habitats that are regarded as essential for providing resources such as food, medicines and building materials. Although dependent on such areas, local communities have often been prevented from gaining access once these areas were designated as protected (Spellerberg, 1996, Mehta and Kellert, 1998; Curran *et al*, 2000).

It has been recognised in recent years that gaining the support of local communities can determine whether protected areas are successful as a conservation tool (Mkanda and Munthali, 1994; Adams, 1998; Walpole and Goodwin, 2001). Without such support, direct conflict can occur between the actions of local people and the objectives of conservation. For example, strictly exclusive regimes in developing countries can force local communities to undertake illegal activities in order to harvest the resources on which they depend, and they then become 'poachers'. In contrast, 'legitimate' benefits may then only be gained by those involved in running safari and game hunting operations, by tourists and game hunters, and perhaps by a few powerful individuals with the appropriate positions in their local community.

Therefore, the poorest among the local community are expelled from the area with little thought for their future welfare (Homewood, 2004).

The recognising or granting of property or usufruct rights to local people is one way to counteract this conflict (Berkes and Farver, 1989; Mehta and Kellert, 1998). An example of this type of community-based conservation can be found around the national parks of Malawi, where bee-keepers have been permitted access to protected areas. In return, they have accepted the protected area regimes that seek to generate conservation benefits, whilst continuing to harvest vital resources. As a result, poaching levels have been reduced due to the continual presence of the bee-keepers in the national parks (Banda and de Boerr, 1993; Mkanda and Munthali, 1994). By making local communities responsible for the future of such resources, it is hoped they will undertake sustainable harvesting and maintain the resources and the environment in which they exist (Mkanda and Munthali, 1994).

Protected areas are found throughout the world, including in developed countries. However, it is generally the case that most rural areas in developed countries are privately owned making it difficult to create new protected areas. Despite this, some privately-owned habitats are classified protected areas. The scientific community increasingly understands the important role of privately-owned land for the biodiversity conservation. Langholz and Lassoie (2001) noted the importance of privately-owned protected areas, which often accommodate rare species or threatened habitat types without relying on government funds for their establishment or recurrent management costs. However, on privately-owned land, the continued existence of natural habitats and their associated wildlife are vulnerable to the management decisions of the landowner. Encouraging conservation on private areas is difficult, and legislation is generally used to provide protection in the absence of complete control over management (Langpap and Wu, 2004). For example, the Endangered Species Act (ESA) has been introduced in the United States (US) to protect vulnerable species on privately-owned land by restricting the activities of landowners (Bonnie, 1999).

The success of the ESA, however, is not always straightforward. Indeed, there are suggestions that wildlife can be detrimentally affected as a direct result of the legislation (Rohlf, 1991). Because the use of key habitats is restricted, many landowners have been affected financially. This is well illustrated by the case of Benjamin Cone, who lost approximately $2million as a result of being denied permission to harvest 1,560 acres of old growth pine forest that was inhabited by a protected species, the red cockaded woodpecker (*Picoides borealis*). The legislation does not require the US government to compensate landowners. Consequentially, Cone clear-felled the remaining timber on his property 35 to 40 years earlier than usual to prevent it becoming suitable habitat for the woodpeckers, resulting in a loss of high quality habitat for both the protected species and wider biodiversity (Innes, 2000).

The case of Benjamin Cone is not unique. The US Fish and Wildlife Service noted increased rates of Douglas Fir timber harvest in the Pacific Northwest by landowners concerned that their trees had the potential to become suitable habitat for the protected northern spotted owl (*Strix occidentalis caurina*) if left to mature. Similarly, Texan wildlife officials have recognised disproportionate levels of habitat loss as a direct result of two species, the black-capped vireo (*Vireo atricapillus*) and the golden-checked warbler (*Dendroica Chrysoparia*), being listed under the ESA (Innes, 2000). These examples highlight how legislation designed to protect endangered species can perversely encourage the destruction of their habitat, because the current ESA legislation does not provide landowners with any positive incentives to protect the important habitat they own (Polasky, 1998).

Although legislation designed to protect threatened species and their habitats can be a valuable tool for conservation, in certain circumstances such legislation can be ineffective. The examples outlined above show that individuals who use the habitat need incentives for such methods to succeed. Failure to do so can see increased rates of habitat degradation and species loss as a direct consequence of these conservation attempts.

1.1.2 Commercial consumptive use of wild species

Ecosystems have the potential to generate a number products and services that can be of economic value, and the economic benefits so gained can be classified as use and non-use values (Balmford *et al*, 2002; Massey, 2005). Use values include the most obvious and direct uses upon which monetary values can be easily placed, and include those that can be derived by extracting resources such as timber, or animals and plants, from their ecosystems. Use values also include some on which a direct value can be placed but that do not extract resources from the ecosystem, such as tourism and recreation. Non-use values afforded by an ecosystem are also varied but are less obvious and less easy to quantify in monetary terms (Freese *et al*, 1996). Non-use value can refer to ecological functions such as flood control and ability to cycle nutrients, but also to the psychological worth place upon the ecosystem or resources within it and are sometimes known as existence and bequest values. Existence values are derived from the satisfaction that individuals gain from knowing that the ecosystem, or a particular species within that ecosystem, exists. Bequest values are derived from the philanthropic aspect of an individual's personality, the satisfaction gained from knowing that an ecosystem, or its resources, will be available for future generations (Aylward, 1992; Bateman and Kerry Turner, 1993; Edwards and Abivardi, 1998).

Successful resource management should generate incentives that sustain both the resource itself, as well as maintaining, preserving and even improving its ecosystem (Hutton and Leader-Williams, 2003). The commercial consumptive use of resources can produce financial benefits for those with direct control over that resource and its ecosystem. When managed on a sustainable basis, the utilisation of a species can be beneficial not only to its conservation, but also to the habitat in which it resides, and so to other associated biodiversity (Joanen *et al*, 1997). Tietenberg (1992) succinctly iterates this point: "One approach to the protection of biological species is to rearrange economic incentives so local groups have an economic interest in their preservation".

The quote, however, continues: "Unlimited access to common-property resources undermines these incentives" (Tietenberg; 1992). This second part highlights the foundation for making the system work. When access to the resource is limited, perhaps because it is privately owned, the individuals who own it recognise a reason to utilise the resource in a sustainable manner. Remove the exclusivity of access to the resource and, as others start to exploit the resource, those who manage the ecosystem to maintain the resource will invariably cease their efforts. When this happens, free-riders exploit the resource and a Tragedy of the Commons ensues (Hardin, 1968; Berkes and Farvar, 1989).

Wildlife in the majority of countries around the world is publicly owned, even if it exists on privately-owned land. This was the case for many southern African countries. However, Namibia became the first of several to privatise wildlife in 1967, providing landowners with ownership of the wildlife on their land. Commercial consumptive use of wild species, particularly large game, has thrived following this mass privatisation. Prior to this, landowners primarily used their land for ranching livestock. Consequently, large game was seen as either competition for grazing or direct threats to livestock through predation or disease, giving little incentive for landowners to preserve the wild species or maintain the habitat (Freese, 1998). Privatisation allowed communal landowners to harvest wild species on a commercial basis. Sport and trophy hunting, and game-viewing tourism, became established alongside ranching, producing a multiple-use approach to land management. In turn, this allowed landowners to ranch in a less intensive manner, whilst encouraging conservation and preservation of wildlife and habitat (Cummings, 1990; Luxmore and Swanson, 1992). This resulted in an increase in game populations on many of these African ranches, highlighting how receiving direct benefits from wildlife resources can stimulate those who manage those resources to utilise them sustainably and, ultimately, to conserve both species and habitats.

1.1.3 Calculating the value of wildlife resources

The total economic value of a resource is calculated by totalling both the use and non-use values (Freese *et al*, 1996). Use values are relatively easy to calculate, especially where the resource is sold in the commercial sector and financial records detail the revenues from the sale of products (Morton, 2000). In contrast, non-use values are less easy to value as they concern aspects perceived as beneficial but that do not have a conventional market value placed on them (Bateman and Kerry Turner, 1993). It is very difficult to account for the total value of an ecosystem, and so it is the more easily calculated direct use values that tend to be considered when valuing an ecosystem (Morton, 2000).

Contingent Valuation Method (CVM) is a technique that investigates the potential value of a resource by constructing a hypothetical scenario and asking individuals within a target population about their willingness to pay (WTP) for access to that resource or their willingness to accept (WTA) change to that resource. It is this construction of hypothetical situations that has led to the phrase "contingent valuation" (Bateman and Kerry Turner, 1993; Perman *et al*, 1999). CVM is considered a direct method of valuing a resource, as it requires the researcher to approach individuals to obtain the value they place on a resource. The indirect method obtains the actual valuation of the resource from the market information following purchases and sales. CVM provides a way to calculate both use and non-use values, a significant advantage over the indirect method of valuation which does not include non-use values of a resource. WTP and WTA surveys within CVM also allow for the investigation of *expected* resource values in the event of future change (Pearce and Moran, 1994; Perman *et al*, 1999; White and Lovett, 1999).

1.2 Conservation in Great Britain

1.2.1 History of conservation in Great Britain

In Britain, conservation was first promoted to maintain quarry and opportunities for hunting (Isaacson, 2001). Since the 11th Century, many areas of rural Britain have been protected for this purpose. In doing so, the early conservationists fashioned the countryside that Britain now endeavours to conserve (Stamp, 1969). The New Forest in Hampshire was reserved in 1079 for William the Conqueror to hunt. Other areas were also conserved for hunting: ancient wooded areas of the Midlands were reserved as sites for fox hunting; and, heathland and forest of the uplands were reserved for grouse shooting and deer stalking (Green, 1981). As a consequence many areas of Britain still exist that would otherwise have been developed, and they remain managed today almost exactly as when they were first reserved for country sports (McKelvie, 1991).

At the end of the 19th Century, the general public sought greater access to rural areas and several non-governmental organisations (NGOs) formed through a desire to protect wildlife and its habitats. The Royal Society for the Protection of Birds

(RSPB) was established in 1891 in response to the mass trade of feathers for the millinery industry that resulted in the killing of large numbers of wild birds, and today remains the most subscribed of these NGOs. The National Trust for Places of Historic Interest or Natural Beauty, or the National Trust (NT), was established in 1895, to preserve landscapes and associated wildlife, and cultural heritage. These two NGOs have become huge conservation bodies in Britain, and both own and protect large areas of land (Green, 1981; Evans, 1992).

By the start of the 20th Century, it was evident that the British government was doing little to conserve wildlife and the environment. In 1915, a group of NGOs presented the government with a list of potential sites for nature reserves. However, the National Parks and Access to the Countryside Act was not passed until 1949. It was only then that the government properly arranged for the establishment of state-run protected areas, modelled on the infamous Yellowstone National Park that had by that time existed for over 70 years. Therefore, provision was finally made to conserve wildlife in Britain, along with supplying the general public with access to natural areas (Green, 1981; Evans, 1992; Spellerberg, 1996).

1.2.2 Current methods of conservation in Great Britain

Britain has been described as "having the most comprehensive and the most advanced system of nature conservation in the world" (Vesey-Fitzgerald, 1969). However, because it is such a densely populated country, conservation regularly comes into direct conflict with human requirements. The majority of rural Britain is privately owned, representing most, if not all, habitat types (Evans, 1992), although some areas are owned and/or managed by the government or non-government organisations, primarily for the purposes conservation and of providing access for the general public (Stratham, 1994). Such areas generally fall into one of the national designations of protected area (PA) deemed appropriate for these purposes, for example national park (NP) and national nature reserve (NNR). A total of 14 National Parks (NPs) have now been declared in Britain, and cover a total area of 19,400 km^2. Along with national nature reserves, country parks and other such PAs, these cover only approximately 10% of terrestrial Britain (Evans, 1992; Oldfield *et al* 2004). As a result, protected areas in Britain are generally highly isolated (Langholz and Lassoie, 2001), increasing the vulnerability of threatened species. This vulnerability is further compounded because many protected areas are small in size: the average size of National Nature Reserves (NNRs) is approximately 1 km^2, while Sites of Special Scientific Interest (SSSIs) are approximately 0.2 km^2 (Oldfield *et al*, 2004).

In addition, the distribution of PAs in Britain exhibits the common problem of "representation gaps", with only a few habitat types adequately covered (Dudley and Parish, 2006). For example, English PAs are predominately in upland areas: approximately 113000km^2 (87%) of England is classified as lowland (≤200m above sea level or less), yet only 3.5% of this land is a PA; in contrast, approximately 353.7km^2 (0.3%) of England is highland (over 600m above sea level) and 65.8% of this land is classified as PAs (Oldfield *et al*, 2004). Therefore, the majority of lowland habitats in Britain are privately-owned and the quality of habitat is dictated by the land management regimes adopted by the owners, which has fundamental implications for the biodiversity found there.

Even within British protected areas, much of the land is privately owned and is used primarily for agriculture. Authorities do not try to alter the land use of these areas, instead encouraging sympathetic management through programmes such as subsidy schemes for undertaking desired work and planning restrictions to prevent detrimental alteration of habitat (Milner-Gulland and Mace, 1998). However, such methods do not guarantee protection of habitat quality and conservation of wildlife. Many areas, particularly SSSIs, are being managed inappropriately with regards to conservation. Records show that, since 1981, approximately 5% of SSSIs annually suffer damage. Since 2000 continued assessment of the condition of nearly all SSSIs in England found that 55.8% were in an unfavourable condition, with 17.03% continuing to decline in condition and only 12.95% were considered to be recovering in condition (Anon, 2003).

1.2.3 Conservation through management of British farmland

In total, agricultural land covers over 75% of Britain's surface area, and the remainder comprises forestry and urban areas, in approximately equal proportions

(Evans, 1992). Although protected areas are undoubtedly useful, the fact that they only account for 10% of the land surface, and much of that in upland areas, emphasises that agricultural land, and particularly in the lowlands, holds the key when considering the preservation of rural areas and wildlife in Great Britain.

Throughout the last few centuries, management of agricultural land has shaped Britain's countryside (Green and Burnham, 1992; Hellawell, 1994), and produced a suite of wildlife species intimately associated with agrarian habitats (Dobbs and Pretty, 2001; Donald *et al*, 2002). Many habitats that are cherished by conservationists and the general public alike arise as a direct result of man's actions, produced from years of traditional management (Krebs *et al*, 1999). Preservation of these habitats in turn depends on continued intervention at a certain level (Hanley *et al*, 1999; Sutherland, 2004).

After World War II, British agriculture needed to become more efficient and produce higher yields of cheaper food to feed the victorious nation (Kleijn and Sutherland, 2003). Farmers successfully met this challenge, and the production levels of many crops increased three-fold, while milk yields have doubled since 1950 (Pretty *et al*, 2000). This was achieved, in part, through the development of new technologies. Many farming operations were mechanised and machinery became increasingly efficient and powerful. Agro-chemicals were created that increased crop yields and controlled competing weed species, insect pests and disease. Alternative cropping regimes were developed that shortened cultivation times and crop rotations (Sheail, 1995). Another factor that influenced intensification of agricultural systems was the introduction of the Common Agricultural Policy (CAP) by the European Union (EU) (Sheail, 1995; Krebs *et al*, 1999).

The CAP was originally designed to increase the income of farmers, while concurrently increasing food production. The CAP sought to provide farmers in the EU with guaranteed minimum prices for their produce, and delivered refunds for goods exported to the world market, whilst also requiring levies to be paid on imported goods. This kept prices artificially high but stable, which in turn increased the incomes of farmers (Green and Burnham, 1992; Krebs *et al*, 1999). It also encouraged agricultural intensification as farmers took advantage of the guaranteed high prices, and produced greater yields to maximise their income (Donald *et al*, 2002). The original aim of producing higher yields was achieved, but production exceeded expectation and a food surplus was created within the EU (Sheail, 1995).

Although these policies succeeded in producing greater crop yields and initially increased income for farmers[1], agricultural intensification over the last 60 years has severely diminished the quality of agricultural habitat for wildlife. Alterations in land management techniques such as changes to the timing of farming practices including ploughing and grass cutting, cultivation of pasture and grassland for growing crops, changes in livestock management, and the mass input of chemicals have considered to have effectively sterilized many agricultural plots (O'Connor and Shrubb, 1986; Sotherton, 1998; Chamberlain *et al*, 1999). The resulting loss of wildlife in Britain has been well documented (O'Connor and Shrubb, 1986; Sotherton, 1998; Chamberlain *et al*, 1999; Macdonald and Johnson 2000; Critchley *et al*; 2004). For 10 farmland bird species alone, the populations are estimated to have decreased by approximately 10 million breeding individuals over the last 20 years (Krebs *et al*, 1999).

Since 1992, EU member states have been encouraged to use CAP money as an incentive for environmentally-orientated farming, instead of maximising productivity (Sheail, 1995; Peach *et al*, 2001; Carey *et al*, 2003). Set-aside schemes were created to tackle the issue of surplus food production whilst maintaining the incomes of farmers, and these were also recognised as having possible conservation benefits (Green and Burnham, 1992; Kleijn and Báldi, 2005). The scheme required farmers to take a proportion of their arable land out of production in return for subsidy payments (Firbank *et al*, 2002). Originally, the scheme comprised little more than benign neglect in the abandonment of land (Sotherton, 1998). Reform, including introduction of management requirements, meant set-aside scheme options provided favourable habitat for many wildlife species. Thus, rare arable plants germinated from dormant seed banks, whilst bird and mammal species preferentially used set-aside areas (Sotherton, 1998; Tattersall *et al*, 2000; Firbank *et al*, 2002).

[1] Primarily, CAP succeeded in elevating the incomes of British farmers. However, since the late 1970's, these incomes have decreased annually. Today, the average income for farmers is estimated to be £8,500 (Sutherland, 2002).

Although set-aside provided some solutions to the issue of surplus food production (Firbank *et al*, 2001), its potential to make gains for conservation was limited (Fry, 1995; Sotherton, 1998). This was due, in part, to the attitudes of farmers, who generally created set-aside areas to receive their CAP payments, rather than to conserve wildlife (Green and Burnham, 1992). Therefore, continuing concern surrounded the lack of conservation gains, and this forced further CAP reform (Carey *et al*, 2003). Regulations were adopted that diverted financial assistance away from commodity support, which encouraged continued agricultural intensification, and moved that assistance towards incentive schemes that paid landowners to manage land in an environmentally beneficial manner (Ovenden *et al*, 1998; Peach *et al*, 2001). In turn, this led to the formation of agri-environmental schemes (AESs) that were, and still are, considered the best way to tackle the conservation problems associated with agricultural intensification (Kleijn *et al*, 2001). Ovenden *et al* (1998) stated that "agri-environmental scheme prescriptions can realize generic benefits for biodiversity conservation; the decline in habitat condition caused by intensification or neglect can be arrested, and in many cases enhanced". Furthermore, AESs remained as "key tools" for farmland bird conservation (Vickery *et al*, 2004).

AESs encourage farmers to reduce the intensity of their management regime, with payments to compensate for the resulting loss of income (Wilson, 1996; Ovenden *et al*, 1998). In England, AESs commenced in 1987 with the Environmentally Sensitive Areas (ESAs) scheme. Limited to 22 key areas, such as the Lake District Dartmoor and Norfolk Broads, ESAs were designed to protect landscapes, wildlife and historical features threatened by modern land management practices (Carey *et al*, 2002). In 1991, the Countryside Stewardship Scheme (CSS) was created to protect land not encompassed by ESA schemes, although limited funds meant that acceptance onto the scheme was not guaranteed. The Ministry of Agriculture, Fisheries and Food (MAFF), which became the Department for Environment, Food and Rural Affairs (DEFRA) in 2001, operated AESs and targeted applications that included areas under traditional farming systems, areas of high biodiversity, those with key historical features and areas important for public access and recreation (Ovenden *et al*, 1998).

Despite the introduction of other schemes, all retained the general aim of conserving wildlife and enhancing habitat (Hanley *et al*, 1999; Peach *et al*, 2001). The ESAs and CSSs are the most common schemes, and approximately 90% of the money spent on AESs is devoted to these two schemes (Lobley and Potter, 1998; Morris *et al*, 2000). Reform to the CAP, the introduction of the set-aside scheme, and development of AESs have, to some extent, conserved wildlife and preserved landscape features (Pacini *et al*, 2004). However, the success of these management regimes has been somewhat limited[2] (Evans and Morris, 1997; Macdonald and Johnson, 2000; Vickery *et al*, 2004).

1.2.4 Alternative management of British farmland

Another large-scale regime adopted for managing agricultural land in Britain is through country sports, and gamebird shooting in particular. The practise of these alternative management regimes depends on the sporting interests of the landowner, the topography of the land, and the habitat contained therein. Indeed, gamebird shooting and its associated gamekeeping have been cited as the start of modern conservation in Britain (Stamp, 1969). Generally, alternative features are protected, enhanced in quality or created to provide habitat for game species. Involvement in country sports significantly increases the probability that a landowner will undertake land management that will produce conservation benefits (Robertson, *et al*, 1988; Cox *et al*, 1996; Macdonald and Johnson, 2000; Oldfield *et al*, 2003).

Studies have compared biological diversity, habitat quality and extent of beneficial habitat types on farms owned by individuals both involved and not involved in country sports. Woodland managed for pheasant shooting contained a greater abundance and diversity of butterflies compared to unmanaged areas (Robertson *et al*, 1988). The most beneficial management was the widening of rides and clear-felling small patches of trees, which broke up the thick woodland canopy and encouraged the growth of ground flora. These are the two most common types of management undertaken to enhance woodland quality for pheasant shooting,

[2] The conservation benefits of AESs are analysed in Chapter 4.

highlighting the significant indirect benefits that certain types of gamebird management can have for other wildlife.

Questionnaire surveys of landowners have shown their considerable motivation to be involved in certain land management techniques. Landowners involved in country sports were more likely to take land out of agricultural use to create copses, shelterbelts and woods (Macdonald and Johnson, 2000). In an agricultural landscape, such non-productive habitats can produce significant conservation benefits for both game species and native wildlife. Farmers with an interest in hunting have also been shown to remove the least amount of hedgerow (Macdonald and Johnson, 2000; Oldfield *et al*, 2003). Furthermore, those involved in country sports are more likely to manage established woodland, plant new woodland and hedgerows, and adopt AESs, compared to those not involved in country sports (Oldfield *et al*, 2003).

The desire to benefit wildlife and increase habitat quality is an important motivation to farm in a responsible manner. Hence, the wildlife value of hedgerows was a major reason why farmers had retained these features. In contrast, farmers who proclaimed little interest in wildlife had removed the most hedgerows (Macdonald and Johnson, 2000). Nevertheless, it is farmers who partake in country sports who are most inclined to be actively involved in beneficial land management enterprises (Oldfield *et al*, 2003). Therefore, these recent results support an earlier suggestion that to remove the rights of landowners to be involved in country sports would be a threat to the quality of the British countryside (Rackham, 2000).

1.3 Commercial consumptive use and economic importance of wild species in Great Britain

In Great Britain, game was originally defined in law by the Game Act of 1831 and has remained fundamentally unchanged. The majority of game is bird species: pheasant, partridge, grouse (or moor game), black (or heath) game or ptarmigan, although hares, rabbit and deer are also included (Wildlife and Countryside Act, 1981). Aside from fishing, gamebird shooting has always been the biggest country sport, both in terms of the number of people involved in the activity and the amount of money generated (McKelvie, 1991). Following the ban of hunting with hounds in

2005 (Hunting Act 2004), gamebird shooting is now the last remaining traditional country sport practised in lowland Britain and there is considerable concern for its future. A ban on gamebird shooting would mean the direct and indirect losses of many jobs.

It is difficult to calculate the total amount of revenue that has been generated through country sports given their many different multiplier effects. As well as the most obvious financial benefits, such as the revenue earned by landowners from selling gamebird shooting, hunting and fishing, job creation such as gamekeepers and ghillies, and trade for hoteliers from visiting sportsmen, less obvious financial benefits are derived for those such as gun dealers, dog breeders, farriers, and animal feed dealers (Cox *et al*, 1996). The Standing Conference on Countryside Sports commissioned a study to investigate the economic significance of country sports. The report estimated that direct expenditure on country sports totalled £3.8 billion in 1996, while indirect expenditure was calculated at £2.4 billion for the same year (Cobham Resource Consultants, 1997).

1.3.1 History of gamebird shooting in Great Britain

Guns were first used in British field sports during the 15th Century, to dispatch animals caught in nets. It was not until the latter part of the 17th Century that guns were regularly used to shoot gamebirds. Therefore, gamebird shooting has been practised as a traditional country sport in Britain for over 300 years (Hare, 1949).

During the 17th century, shooting rights were only granted to landowners, although these could be extended to those whom the landowner chose to invite to shoot on their land. However, in response to the disappearance of wildlife stocks, the Game Act of 1671 prohibited gamebird shooting and hunting of hares by all except a few 'qualified persons'. Owning land did not automatically ensure the shooting rights of individual landowners. Instead, only those who owned land worth over £100 per year were eligible to shoot. Likewise, the eldest sons of esquires, knights and nobles were also granted the privilege to shoot, as were their gamekeepers. The Game Act of 1671 was poorly constructed and contained many irregularities. For example, the purchase of game was legal, but not the selling of it, even if it had been lawfully killed. Not including gamekeepers, around 20,000 individuals were qualified to shoot game at this time, and it was clear that the Act had been passed to protect the shooting rights of those privileged individuals who had formulated the Act (Trench, 1967).

The Game Act of 1671 coincided with major changes in farming practises, which improved crop yields and altered farming systems from ones of subsistence to profit. However, these profits were constrained as the increasing numbers of gamebirds, rabbits and hares ate the crops (Martin, 1987). With no means of controlling game numbers to stem crop damage, landowners not qualified to hunt, tenant farmers and labourers took to illegal hunting or turned a blind eye to poaching. Dogs were encouraged to kill hares and gamebird nests were destroyed. At the time, it was noted that the "surest way to preserve game would be to give farmers the right to shoot on their own farms" (Chitty, 1949 in Trench, 1967), in other words to provide individuals with property rights over wildlife resources in an attempt to create incentive to conserve wildlife.

The Game Act of 1831 abolished the majority of the restrictions in the Game Act of 1671, by removing the 'qualification' system and permitting the shooting of gamebirds by anyone who possessed a game licence. The sale of gamebirds also became legal. Poaching continued, although changes concerning the sale of gamebirds meant that the illegal trading of game was greatly diminished. The legalities of gamebird shooting have changed little since the Game Act of 1831 was introduced. However, a new attitude towards gamebird species accompanied this new Act, as the right to partake in country sports became increasingly accessible (Trench, 1967; Martin, 1987).

1.3.2 Gamebirds as a sustainable resource in Britain

Historically, the over-hunting of game species in Britain has been a problem that has repeatedly occurred and, in same cases, aided the extinction of certain species. Along with factors such as habitat loss, hunting pressure has led to the extinction of wild boar (*Sus scrofa*) in the 17th Century and of the capercaillie (*Tetrao urogallus*) during the 18th Century (Clutton-Brock, 1991; Tapper, 1999).

Towards the end of the 17th Century in Britain, the development of light flintlock guns, and the desire to partake in fashionable country sports, greatly increased the number of people involved and the number of gamebirds being shot increased rapidly (Trench, 1967). Sustainability of game stocks was often not a priority. As mentioned previously, disappearing gamebird stocks initiated the Game Act of 1671, which limited the number of people who could shoot. The motivation behind the Act was the preservation of the gamebird populations into the future, although it was obviously passed to maintain gamebird populations for an elite few. In reality, and as described above, the effects of restricting who could shoot gamebirds had the opposite effect and gamebird stocks were dramatically affected by the actions of landowners and tenants who had been legally forced to relinquish their rights to shoot game on their property (Trench, 1967).

The new Game Act of 1831 reinstated the rights of landowners to utilise the game on their land, which restored the motivation to conserve game species, to utilise them sustainably and to preserve habitats that would have otherwise been lost to agricultural practices (Trench, 1967; Tapper, 1999). This new Act meant that Britain is now somewhat unique in that game located on privately owned land is the property of the owner (Tapper, 1999).

The Game Act of 1831 appeared to come at a time when both attitudes and game management were better suited to maintaining gamebird populations. The experience of diminishing gamebird stocks in the 17th Century and over half a century of highly restrictive hunting laws meant that, once landowners regained property rights over game on their land, many undertook sympathetic land management to enhance gamebird populations. Gamekeepers were employed to control predators, improve habitat quality and establish new habitat to provide sites for over-wintering, nesting and feeding.

It was not until the 20th Century that land owners started to generate money selling shooting on their property, driven by the increasing costs of managing the shoot. The sporting and financial benefits gained from gamebird shooting encouraged individuals who owned land to manage the game species sustainably, ensuring these benefits would continue for subsequent years (Martin, 1990).

During the first half of the 20th Century, the number of gamekeepers declined as a consequence of two world wars and economic recession. This loss of game management, in addition to agricultural intensification after World War II, significantly affected wild game populations (Martin, 1990). Gamebird numbers declined to such an extent in some areas that many landowners became dependent on the release of captive reared gamebirds for shooting (Hill and Robertson, 1988). Today, there is a trend towards the enhancement of wild gamebird populations, and many estates manage to encourage wild game populations along side their reared counterparts (Tapper, 1999).

1.3.3 Economical importance of gamebird shooting

Traditionally, it was landowners and their guests who undertook gamebird shooting. Lack of access to land on which to shoot prevented others from becoming involved. However, at the turn of the 20th Century, and particularly after World War II, the sport became a marketable commodity as people paid for access onto land in order to shoot (Martin, 1990). The release of reared gamebirds, which became increasingly popular at the end of the 19th Century, guaranteed birds when selling a day's shooting (Trench, 1967; Cox *et al*, 1996).

In recent years, there has been a dramatic decline in the economic income of many rural communities (Lobley and Potter, 2004; Convery *et al*, 2005). Farmers receive less financial return than they did 50 years ago when the agricultural revolution dramatically increased crop yields and CAP guaranteed high prices. Today, gamebird shooting has the potential to generate large sums of money (Cox *et al*, 1996; Cobham Resource Consultants, 1997) and is often used to subsidise low agricultural incomes. In the past few decades the establishment of new gamebird shoots has noticeably increased. Reared gamebirds allowed shoots to be established on land that was not previously associated with shooting because their habitat did not produce sufficient numbers of wild gamebirds (Cobham, 1993). Gamebird shooting has the potential to generate income in an agricultural landscape at a time when diversification is necessary if landowners are to endure (Cox *et al*, 1996).

It is difficult to calculate the total amount of revenue generated from gamebird shooting. However a study in the early 1990's estimated that it was between £22.6 and £25.8 million in England alone (Cox *et al*, 1996). A later study of the economics of countryside sports calculated that the total expenditure on shooting and stalking in Great Britain exceeded £650 million per year (Cobham Resource Consultants, 1997). This figure combines direct and indirect expenditure within shooting and stalking but highlights the immense amount of money that can be generated by such country activities.

1.3.4 Conservation benefits of gamebirds in an agricultural landscape

Gamebird management is extremely important for the conservation benefits it can generate for the wider wildlife of Britain. Management of woodlands and field boundaries, and establishment of brood rearing cover and game crops, are undertaken over large expanses of agricultural land for the benefit of gamebirds. Creation of new habitat and management of existing habitat to enhance its quality can improve the breeding success and survival of adult gamebirds and their chicks. Furthermore, supplementary feeding and predator control also improve gamebird survival and breeding success. These management tools also have considerable benefits for other wildlife within the agricultural environment (Stamp, 1969; Stoate and Szczur, 2001).

Conservation headlands were originally designed to improve the breeding success of gamebirds. The decline of the grey partridge (*Perdix perdix*) arose primarily from the loss of food for chicks in arable environments (Potts, 1986). In the first few weeks of life, partridge and pheasant chicks require a protein-rich diet, making them reliant on insect food. Insecticides can directly remove the insects from the crops and applications of herbicides can deplete the host plants of insects (Boatman *et al*, 1989). As a result, the Game Conservancy Trust (GCT) created the idea of conservation headlands (Fry, 1995). By limiting the application of chemical sprays over the first six metres of crop in a field, insect numbers at field margins increased, and these provided valuable supplies of protein to chicks with only limited negative effects on crop yields (Boatman *et al*, 1989; Sotherton and Boatman, 1992; Perkins *et al*, 2002). However, the biodiversity benefits of conservation headlands were found to extend beyond gamebird populations. The controlled application of agrochemicals allowed a richer matrix of plant species to develop in these conservation strips. Benefits were also noted for non-target insect species, including butterflies and bumblebees, as was the preferential utilisation of these strips by songbirds and small mammals (Fry, 1995; De Snoo, 1999). Such was the success of the idea of conservation headlands, that these were later included as a land management option within the CSS (DEFRA, 2001).

Other habitat management options for gamebird populations that produce wider conservation benefits include woodland and hedgerow management. Coppicing, maintaining rides and skylights, and improving the shrub layer of woodlands are management practices that were once extremely popular. Originally, woodland was an extension of the farm, providing food and timber for building and firewood (Rackham, 2000). Many wildlife species were dependent on the management techniques that produced specific habitats. However, over the years, the majority of traditional management techniques became redundant. Much woodland was cut down during the first half of the 20th Century as the two world wars caused an increase in the demand for timber. The agricultural boom after the World War II encouraged the destruction of many woods, as land was required for growing crops. At this time, interest in gamebird shooting prevented many woodland areas being lost through grubbing out or general neglect (Rackham, 2000). Wild gamebirds, particularly pheasant, utilise woodlands in winter as they provide shelter, food and protection from predators when there is little cover or food available on arable fields (The Game Conservancy Trust, 1997). The association between pheasants and woodland areas motivates many landowners to finance the maintenance of their woodland, and encourages the planting of new wooded areas (Tapper, 1999; Oldfield *et al*, 2003).

Hedgerows are utilised throughout the year by gamebirds and are particularly important for nesting and brood rearing (The Game Conservancy Trust, 1997; Stoate and Szczur, 2001). The sympathetic management of established hedgerows and the establishment of new hedgerows for gamebirds have far reaching conservation benefits. Species such as passerines and small mammals respond positively to the management techniques implemented for gamebirds in hedgerows, benefiting these species both during the breeding season and winter months (Boatman *et al*, 1989; Stoate and Szczur, 2001). As is the case for woodland, studies have shown that many landowners are motivated to finance the maintenance or creation of hedgerows because of associated benefits for gamebirds (Oldfield *et al*, 2003).

Supplementary food is often provided for gamebird populations. Grain fed by hand or via hoppers during spring and summer months can improve the body condition of hen birds and their subsequent breeding success (Draycott, 1996). Providing grain in the winter months, either directly or through growing game crops, can enhance the survival of gamebirds during a period when natural food sources are limited. Other species, especially passerines, benefit from this supplementary feeding and it has become increasingly important as farmed ecosystems have become increasingly sterile (Stoate and Szczur, 2001).

The control of predators has been used for decades to enhance gamebird populations. Predation by foxes can considerably decrease the number of adult gamebirds, and is particularly harmful if hen birds are lost prior to, or during, the breeding season. Species such as corvids, mustelids and rats can also have devastating effects on the gamebird populations through the predation of eggs and young chicks. Trapping, snaring, poisoning and shooting means that gamekeepers can limit the numbers of predators on a plot of land, thereby increasing the productivity of the gamebird population (The Game Conservancy Trust, 1997). The control of predator numbers has been shown to have benefits for other species, especially for songbirds, as well as for mammals such as the brown hare (*Lepus europaeus*), a UK Biodiversity Action Plan (BAP) species (Tapper, 1999; Stoate and Szczur, 2001).

Although their interest in gamebird shooting can motivate many landowners to undertake management that enhances habitat quality for the benefit gamebird species, the wider ecological benefits cannot be ignored (Stoate and Szczur, 2001; Stoate *et al*, 2001; Oldfield *et al*, 2003). The maintenance and creation of good quality habitats can be extremely costly, even though aspects of gamebird management can be included under AESs for which landowners receive grants.

However, the uptake of such schemes has been limited, and only those interested in promoting game populations are likely to get involved (Macdonald and Johnson, 2000; Stoate *et al*, 2001; Oldfield *et al*, 2003; Morris, 2004). Any gamebird management not covered by AES prescriptions must be financed by the landowner, which can lead to considerable costs.

1.3.5 Stakeholders involved in gamebird shooting

There are well-defined stakeholder groups within gamebird shooting who create an interesting hierarchy within the sport. The four main stakeholder groups who are most directly associated with gamebird shooting are:

- shoot owners;
- 'guns', the colloquial terms for those who shoot;
- gamekeepers; and,
- loaders, beaters and pickers-up.

Many other groups are associated with gamebird shooting but their involvement is indirect and their presence is not necessary on a shoot day. Shoot owners, gamekeepers, and loaders, beaters and pickers-up would have traditionally been those individuals who made up rural communities during the 18th Century. The agricultural revolution and subsequent Enclosure Acts encouraged these individuals to build their dwellings in close proximity, often around a church. In this way, the British village was created (Newby, 1985). The industrial revolution took manufacturing and handicraft away from independent craftsmen in rural locations and into large factories of the towns and cities, increasing the number of people dependent on the land for their livelihood (Horn, 1980; Rose, 1980; Newby, 1985).

Today, there are fewer among the loaders, beaters and pickers-up stakeholder group who are employed in agriculture. Traditionally nearly all these individuals would have been farm labourers, working in large teams to cultivate the land and these individuals would also have worked as loaders, beaters and pickers-up on shoot days, as an inclusive part of their job. As a result of the invention of mechanised farm machinery, there are now far fewer farm labourers. Consequentially, gamebird shoots find it increasingly difficult to attract individuals to undertake loading, beating and picking up. Those that do assume these roles often originate from traditional farm labouring families that have lived in the same village (and possibly the same house) for several generations, but have now moved on to jobs other than farm work.

The shoot owners' stakeholder group has changed little in the last couple of centuries, and contains individuals who own the land and, with it, the game species. Traditionally, the principle employers in their home areas, landowners wield considerable power within their local community. Their home was rarely located within the village, and instead was situated more remotely on their property. Hence, those living within the village, especially the farm labourers, did not consider landowners to be part of the rural community in the conventional sense. As noted by Horn (1980), "landlords, farmers and labourers each played their separate roles within the community". To some extent, this still rings true in many rural communities.

The role of gamekeepers has changed little since this position was invented on the traditional shooting estate. Management of gamebird shooting has always been the main focus of the job, although techniques have altered to some extent (Trench, 1967). The early 20th Century saw a decrease in the number of gamekeeper positions as the outbreak of war took men away for service and landowners often did not have the money to fund gamebird management. As gamebird shooting has come to rely more on reared gamebirds, so the job of gamekeeper shifted from one of habitat management and predator control to that of gamebird rearer. Latterly, it has become increasingly easy to purchase poults from game farms, so landowners often do the rearing work themselves, removing the need for a gamekeeper (Martin, 1987). As a result, this stakeholder group has decreased in size in recent years.

The stakeholder group representing 'guns' has also altered in recent years. Originally, this group would have consisted of those invited to shoots and who were, invariably, shoot owners themselves. A social circuit was established, in which shooting parties consisted of like-minded individuals of a similar social standing. These parties visited each others' estates, often for the weekend, to enjoy what they hoped would be fine hospitality and excellent shooting (Martin, 1987). This gave shoot owners an opportunity to show-off their estate and many attempted to provide ever increasing bags to flaunt the quality of their shoot (Hopkins, 1985). It was not until the 20th Century, and the last few decades in particular, that the sale of gamebird shooting began in earnest. In turn, this increased the number of individuals, and considerably widened participation, in this stakeholder group (Martin, 1987).

1.3.6 Organisations involved in gamebird shooting

Several organisations represent the different stakeholder groups involved in gamebird shooting, although some also cover other country pursuits. Two organisations involved with gamebird shooting frequently appear in the media, namely the Countryside Alliance (CA) and the British Association for Shooting and Conservation (BASC). CA has been extensively involved in the recent and ongoing debates over hunting with hounds, and so has featured frequently in the media. Nevertheless, CA frequently emphasises its involvement with other country sports including gamebird shooting. In contrast, BASC is a single-issue organisation that is not directly involved with other activities such as fox hunting, hare coursing or fishing, although it may offer such country sports some support in certain circumstances. The Game Conservancy Trust (GCT), whose dictum is "Conservation through wise use", is a smaller organisation concerned with the scientific aspects of conservation in the British countryside. The National Gamekeepers Organisation (NGO) specifically supports gamekeepers, although it receives backing from other stakeholder groups, especially loaders, beaters and pickers-up. Each organisation deals with the various aspects of gamebird shooting in their own way, using their strengths in different ways in an attempt to achieve their respective aims.

1.3.7 The future of gamebird shooting in Britain

As stated, gamebird shooting is regarded as producing many benefits, from conservation of wider biodiversity to financial underpinning for many land owners and rural communities. Support directed by the various organisations towards gamebird shooting is strongly based around some, or all, of these benefits (Tapper, 2002; BASC, 2005; CA, 2006; NGO, 2006). Despite these benefits, many believe the future of gamebird shooting is under threat, either as a result of an outright ban or through introduction of regulations that would make the existence of commercial gamebird shoots untenable.

Previous studies of gamebird shooting have neglected the links between its social and ecological aspects and the focus of most previous studies has been primarily concerned with pheasant ecology and the conservation benefits of game management (for example: Robertson *et al*, 1988; Robertson, 1992; Boatman *et al*, 2000; Draycott and Hoodless, 2004). The future of gamebird shooting and the consequences of specific (and realistic) regulations, such as a ban on the rearing of gamebirds to shoot, have been ignored. Should gamebird shooting be banned in a similar way to hunting with hounds (Hunting Act, 2004) it is predicted that many, if not all, the benefits generated will be lost (Suggett, 2001) The consequences of these losses are expected to be magnified by the fact that rural communities have been under increasing financial and social pressures in the last few decades (Burns *et al*, 2000).

1.4 Aims of the research

The research planned sought to combine an investigation of the social, ecological and financial aspects of gamebird shooting in one study. The study commenced with an investigation into the attitudes and concerns of stakeholder groups, with particular reference to the future prospects of the sport and the scope for change within the four main stakeholder groups. The study then moved on to consider three main aspects that were noted during the stakeholder meetings as particular areas of concern:

1) the scale of releasing of reared gamebirds;
2) the conservation benefits of gamebird shooting;
3) the future of commercial gamebird shooting.

More specifically, the study sought to answer the following questions:

- What are the main concerns of the different stakeholder groups with regards to gamebird shooting and to its future? (Chapter 3)
- What is the scope for changing the future structure of gamebird shooting in a bid to protect the future of the sport? (Chapter 3)
- What is the current cost of running a gamebird shoot in Great Britain and does the management regime negatively impact on the farming regime? (Chapter 4)

- Can the productivity of wild gamebirds be increased through land management in the presence of substantial gamebird rearing, with the view to reducing the number of reared gamebirds released? (Chapter 5)
- Does wild gamebird management on a commercially run shoot that supports a substantial number of reared birds produce benefits for wider biodiversity? (Chapter 6 & 7)
- What will be the future repercussions in financial terms for changing the future structure of gamebird shooting? (Chapter 8)

Therefore, following the examination of the social attitudes of stakeholders involved in gamebird shooting, this study aimed to investigate whether conservation benefits could be attained on a gamebird shoot that is representative of many found in lowland Britain, without gamebird management compromising farm yields. In addition, the future of commercial gamebird shooting was examined to determine whether the introduction of a ban on the release of reared gamebirds might change the face of gamebird shooting.

1.5 Thesis Structure

The thesis will examine the aims outlined above in chapter order following an assessment of the study areas and a review of the methodology in Chapter 2. Chapter 3 investigates the attitudes of stakeholders involved in gamebird shooting, documenting the comments made during the focus group meetings whilst discussing aspects concerning the current form of the sport, their feelings towards the other stakeholder groups and their thoughts relating to its future, including the scope for introducing change with the premise or making the sport more acceptable and hence protect its future.

Chapter 4 deals with the management of agricultural land, opening with an assessment of AESs and gamebird management. This is followed by an in-depth examination of the land management regime introduced at the treatment site, with comparison to the land management of the controls, including a breakdown of costings for both the CSS adopted and for the commercial shoot at the treatment site. Chapter 5 examines the scope for wild gamebird productivity alongside a substantial rearing programme through the introduction of wild gamebird management and compares the gamebird productivity level to those of the control sites.

Chapters 6 and 7 investigate the affects, if any, on wider wildlife following the introduction of the new management regime designed to enhance wild gamebird productivity, examining the change in abundance over time as well as comparison between the treatment site and the controls. Chapter 8 deals with the examination of the future of commercial gamebird shooting, using a willingness-to-pay survey to explore possible repercussions of introducing regulations that will alter the form of gamebird shooting in Great Britain. Chapter 9 examines the overall findings of this study. suggesting recommendations for the future form of gamebird shooting and outlining the consequences of introducing regulations that will restrict the scope for gamebird shooting to be managed as a commercial enterprise.

Chapter 2

Study species, study sites and general methods

2.1 The Pheasant

2.1.1 The Pheasant as a Gamebird Species

Numerically, the pheasant (*Phasianus colchicus*) is the most important gamebird in Britain, and makes up 80% of the gamebird bags shot each year (Robertson, 1997; The Game Conservancy Trust, 1997). The practice of artificially rearing pheasants greatly increased during the 19th Century, and this growth was influenced by the growing popularity of shooting gamebirds for sport (Trench, 1967; Martin, 1992). Between 1900 and 1909, pheasants contributed almost 15% of the total game bag of shoots in lowland Britain. Both grey partridge and rabbit contributed greater percentages to the game bag at this time (Cox *et al*, 1996). However, after World War II, grey partridge populations experienced a significant decline, and their numbers fell by 80% in 40 years, due to a combination of factors including: (a) loss of insects that make up chick food through greater use of herbicides and pesticides; (b) increased predation pressure as fewer gamekeepers undertook predator control, when their job descriptions changed to focus on gamebird rearing; and (c) loss of nesting sites in the form of grassy field edges, as hedges and other field boundaries were removed to enlarge fields. The fall of rabbit numbers in the game bag was even more dramatic. In 1954 myxomatosis was introduced into British rabbit populations and reduced their numbers by 99%. Although the species did recover from the epidemic to some extent, the current rabbit population is some 63% lower than it was pre-myxomatosis (Tapper, 1999). Despite its recovery, rabbit lost favour as a game species, because people did not want to eat 'infected' meat (Trench, 1967). Therefore, the pheasant took over as the most important contributor to the modern British game bag. Their contribution was further enhanced by the ease with which pheasants could be bred in captivity for release onto shooting estates (Cox *et al*, 1996). Currently, over 20 million pheasants are reared and released annually in Britain and approximately 12 million are shot each year. Some 70% of the nationwide bag is estimated to be of artificially reared birds (Robertson and Dowell, 1990; Robertson, 1997; Tapper, 1999).

2.1.2 Pheasant distribution

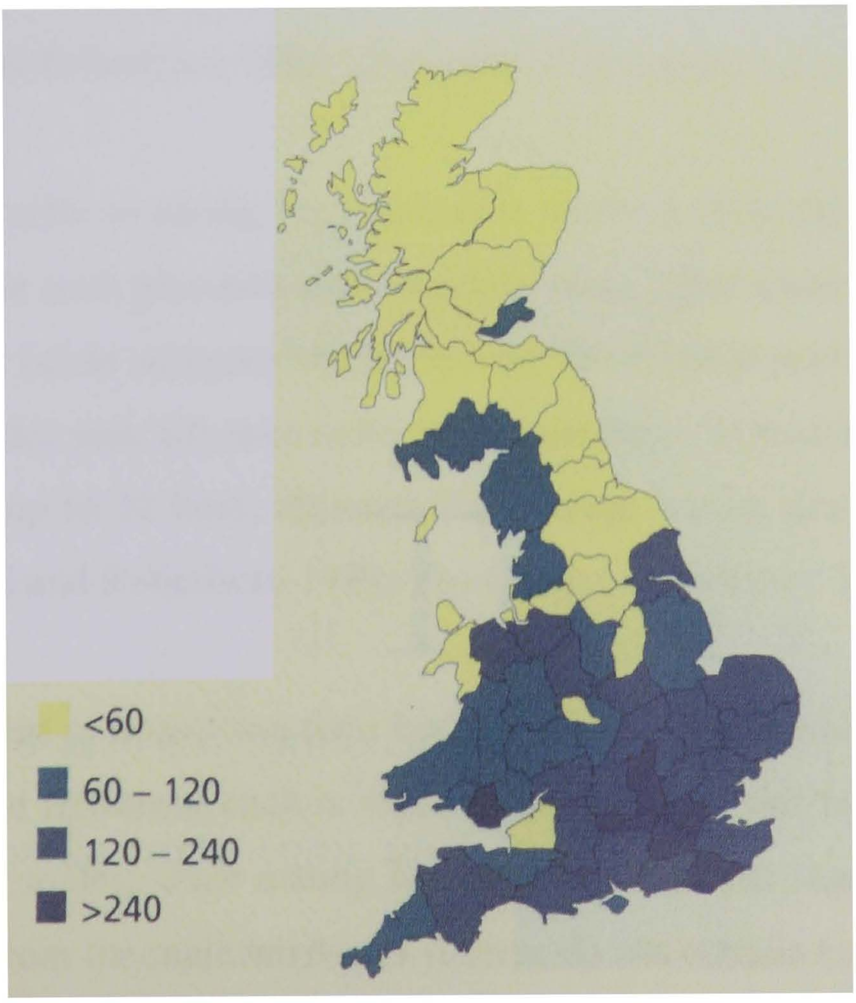
The native range of pheasant species extends from the Black Sea to the Caspian Sea and encompasses the northern slopes of the Himalayas, Manchuria, Korea, Vietnam, Taiwan and the Japanese archipelago (Hill and Robertson, 1988). However, the ecological range of the pheasant has increased considerably due to its widespread and deliberate introduction into non-native habitats (Lever, 2005). Today, the pheasant has one of the widest global distributions of any bird group. The rearing of captive pheasants for release has predominantly influenced its spread throughout the world, and the adaptability of the species has greatly assisted this process (The Game Conservancy Trust, 1997; Robertson, 1997).

2.1.3 Introduction of the Pheasant to Britain

The first common pheasants are thought to have been brought to Britain by the Romans for domestic purposes, and were kept in cages and fattened for the table. It was not until the end of the 11th Century that common pheasants became a wild species, and well-established populations of common pheasants were widespread across England by the 16^{th} Century (Hill and Robertson 1988, Martin 1992). The first pheasant introductions to Britain were of *Phasianus colchicus colchicus*, a subspecies from the Caucasus that became known as the English or black-necked pheasant. Introduction of the Chinese ring-neck pheasant (*P. c. torquatus*) in the 18th Century, the green pheasant (*P. versicolor*) in the 19^{th} Century, and subsequent interbreeding have produced a British population that is an amalgamation of the many different species and sub-species. This hybrid population has dramatic plumage, and the white ring-neck of the original *P. c. colchicus* subspecies remains a common characteristic in English cock pheasants (Hill and Robertson, 1988; Martin, 1992).

Figure 2.1: Habitat most suitable for wild pheasants (green shading) (Game Conservancy Trust, 1997).

Figure 2.2: Number of pheasants harvested per km² per year since 1980 (average by county) (Game Conservancy Trust, 1997).



The large scale release of reared pheasants has resulted in their widespread distribution throughout Britain, even in locations of negligible suitability. The extraordinary extent of the pheasant's distribution across Britain can be appreciated best by comparing those areas of Britain with habitat that is most suitable for pheasant (Figure 2.1) with the numbers of pheasants harvested per km² per year (Figure 2.2) (Robertson 1997; The Game Conservancy Trust 1997).

2.1.4 Pheasant Ecology

Pheasants are polygynous, and territorial males acquire a harem of hen pheasants with which to mate. At the start of the breeding season, cock pheasants disband from their winter groups and locate a breeding territory, usually along a hedgerow or woodland edge adjacent to open ground. They then display in order to attract hens, using a distinctive crow followed by a wing-beat, whilst defending their territory from other cock pheasants. This is necessary as there are generally fewer high-quality territories compared to the number of cock pheasants. Those that do not acquire a territory remain in the vicinity of the breeding territories as non-territorial males. Territorial males are identified by their strutting, puffed out feathers, inflated wattles and raised pinnae (ear-tufts). Hen pheasants are attracted to territorial cock pheasants that crow frequently, which requires a lot of energy and is an indication of fitness. The inflated red wattles located on the face of cock pheasants also attract hen pheasants (Hill and Robertson, 1988; The Game Conservancy Trust, 1997).

In the first few weeks of spring, hen pheasants disperse from their winter flocks in search of a suitable cock pheasant with which to mate. Their choice of male depends on several factors: (a) an adequate source of food; (b) suitable nest sites; (c) fitness of the displaying male; and, (d) successful mate guarding. It is not uncommon for a harem to contain up to 12 hens, although the average harem size comprises two or three females (Hill and Robertson, 1988; The Game Conservancy Trust, 1997).

Whilst the hens feed to improving their body condition in preparation for egg laying and incubation, the territorial cock is vigilant for predators and hens that attract the attentions of other males. Once mating has occurred, the hens search for a nest site, sometimes away from the male territories if these do not contain suitable habitat, and only return to a male territory to feed when she has left the nest (The Game Conservancy Trust, 1997).

Egg laying proceeds from around April and can continue until as late as September (Hill and Robertson, 1988). Generally, clutches contain between 10 and 12 eggs, and clutch size decreases for nests laid later in the season (Hill and Robertson, 1988; The Game Conservancy Trust, 1997). Incubation lasts approximately 25 days. A hen will leave the nest for short periods to feed, at which time the clutch is extremely vulnerable to predation. Hens that lose a nest can re-nest, but if a hen successfully hatches and rears a clutch to fledging, it is unlikely that a second nest will be laid (The Game Conservancy Trust, 1997). The number of nesting attempts made by a hen depends on her physical condition and the how far the breeding season has progressed (Draycott *et al*, 1996). Upon hatching, the hen broods the chicks to keep them warm whilst they dry. After a few hours the hen and brood leave the nest, as the smell of a hatched nest can attract predators. Pheasant chicks are precocious, and can walk and feed themselves straight after hatching, although they rely on the hen for several weeks to keep them warm at night and during inclement weather, as they cannot produce sufficiently body heat (The Game Conservancy Trust, 1997).

2.2 Study area

The southeast of England has long been recognised as prime agricultural land that has an historical association with gamebird shooting. Indeed, both agriculture and gamebird shooting have shaped the structure of rural communities and determined the extent of their economies (Ernle, 1923; McKelvie, 1991), and both still remain important activities today. With London at its heart and many major travel routes, including three London airports and the Eurostar Rail Network within it, the many shooting estates in southeast England are easily accessible for the 'guns' who hire or are invited to shoots (Martin, 1995).

The large numbers of gamebird shoots in southeast England makes this an ideal area to study the effects of different land management techniques on farmland biodiversity. Four estates in north-east Kent, all located on the Kent Downs and lying within the High Weald Area of Outstanding Natural Beauty (AONB), were selected for the fieldwork conducted for this study. The individual estates were chosen to provide 'treatment' and 'control' sites that allowed a study of the interactions between gamebird shooting and biodiversity on the basis of: their varied and evolving land management regimes; their different types of shoot; and the proximity to each other.

2.2.1 The treatment sites: Lees Court Estate

The main study area was the Lees Court Estate, which was coded as Site 1. The estate is approximately 1,800 ha (4,500 acres), and includes 1,200 ha (3,000 acres) of prime arable land, managed woodland and grazed chalk grassland. The land is well drained as a result of being underlain with chalk strata with loamy clay that in turn results in a lack of natural water features. A steep-sided dry chalk valley cuts through the estate, as shown in an aerial photograph of the main area of Lees Court Estate (Figure 2.3). This valley is principally used as grazed grassland and it also runs between the main areas of woodland on the estate.

Lees Court Estate is a traditional estate in both its agricultural practices and its land management techniques. There are six tenant farmers, and one farm manager is responsible for farming the land retained by the landowner under supervision of the land agents, Strutt and Parker. The agriculture mainly comprises arable farming, primarily winter-grown wheat, oilseed rape, peas and beans. However, alternative non-food crops have been grown since 2002 in small areas as part of a diversification programme, providing ingredients for the landowner's alternative business of beauty care products. As their primary ingredients, these products use oils from crops such as *Echium* and *Calendula*, alongside wheat germ oil extracted from the wheat crop.

Several large areas of woodland, both deciduous and old growth plantation, and some smaller copses, cover a total of *c.* 146 ha (360 acres), or some 8.1% of the estate's surface area. The woodlands had remained unmanaged for many years before the 1987 hurricane, which caused extensive damage and the loss of *c.* 25,000 trees. After the hurricane, a Woodland Grant Scheme was adopted. The severely damaged areas were replanted, rides were opened and the plantation has since been cut on rotation (Craythorne, 2001).

Figure 2.3: Aerial photograph of the main study area at Lees Court Estate.

The estate hosts a large-scale commercial shoot that traditionally depended on reared gamebirds. Indeed, the shoot has had a major influence on the past management of the estate (Craythorne, 2001). The steep-sided valley running through the estate (Figure 2.3) provides excellent shooting opportunities and the two large woods on either side are the main stocking sites for reared gamebirds. Most of the shooting is confined to the eastern and southern parts of the estate, where fields are smaller and there is more alternative habitat suitable for pheasants, such as hedgerows and woodland. With its large fields and lack of hedgerows and woodland, the north-western part of the estate is less suitable for pheasant shooting. The village of Sheldwich also borders this part of the estate, which is popular for recreation as it is crossed by several public footpaths. Traditionally, this north-western part of the estate was the primary partridge shooting area, and ancient partridge butts, comprising lengths of hedge behind which the 'guns' stood, are still present on some field boundaries.

Lees Court Estate provided an opportunity to examine the effects of changing land management regimes on resident biodiversity. The management practises for habitats and pheasant rearing traditionally practised on the estate were modified in October 1999, to place greater emphasis on wild pheasants, with the expectation that such a regime would bring benefits to the biodiversity of the estate. Suitable nest site areas were created for pheasants, while cover crops and conservation headlands were sown, primarily on set-aside land and in field margins. Furthermore, the numbers of birds reared and released were gradually reduced to 47.7% of the total released in 1999.

As a result, gamekeepers who previously had mainly been concerned with the rearing of gamebirds for release, now spent considerably more time on activities associated with wild gamebird management. As part of the re-alignment of the land regime, a Countryside Stewardship Scheme (CSS) was adopted, and became effective across much of the retained farmland. In addition a Woodland Grant Scheme was adopted in appropriate areas of the estate (for more detail of the CSS and gamekeeping regime, see Chapter 4).

Four treatment sites were delineated within the Lees Court Estate (Figure 2.4), to encompass most of the farmland retained by the landowner, and to provide examples of the variety of land types found on Lees Court Estate. Treatment sites 1.1 and 1.2 lay to the north of the main valley, and comprise large arable fields with little woodland. Their topography ranges from flat to gently sloping nearing the valley sides. Treatment sites 1.3 and 1.4 lay to the south of the main valley, and comprise mainly smaller fields and a large amount of woodland, both deciduous and plantation. Their topography is more undulating than the study areas to the north of the estate.

Three transects of 200m in length were established within each treatment site, along which insect surveys were conducted (Chapter 6). The transects were positioned in the headlands of arable fields, adjacent to a hedgerow or to a woodland edge where hedgerow length was limited. The transects at Site 1 were located along the uncropped arable field margins that were established as part of the CSS the year before monitoring for this study began (1999/2000). Some margins failed to establish when first sown, and were re-drilled the following year (2000/2001). The structure of the margins also varied greatly, due to variations in soil types, in the shade provided by the adjacent hedgerow, and in the grazing pressure from rabbits.

Figure 2.4: Map of Lees Court Estate (Site 1) with shading to denote the four treatment sites.

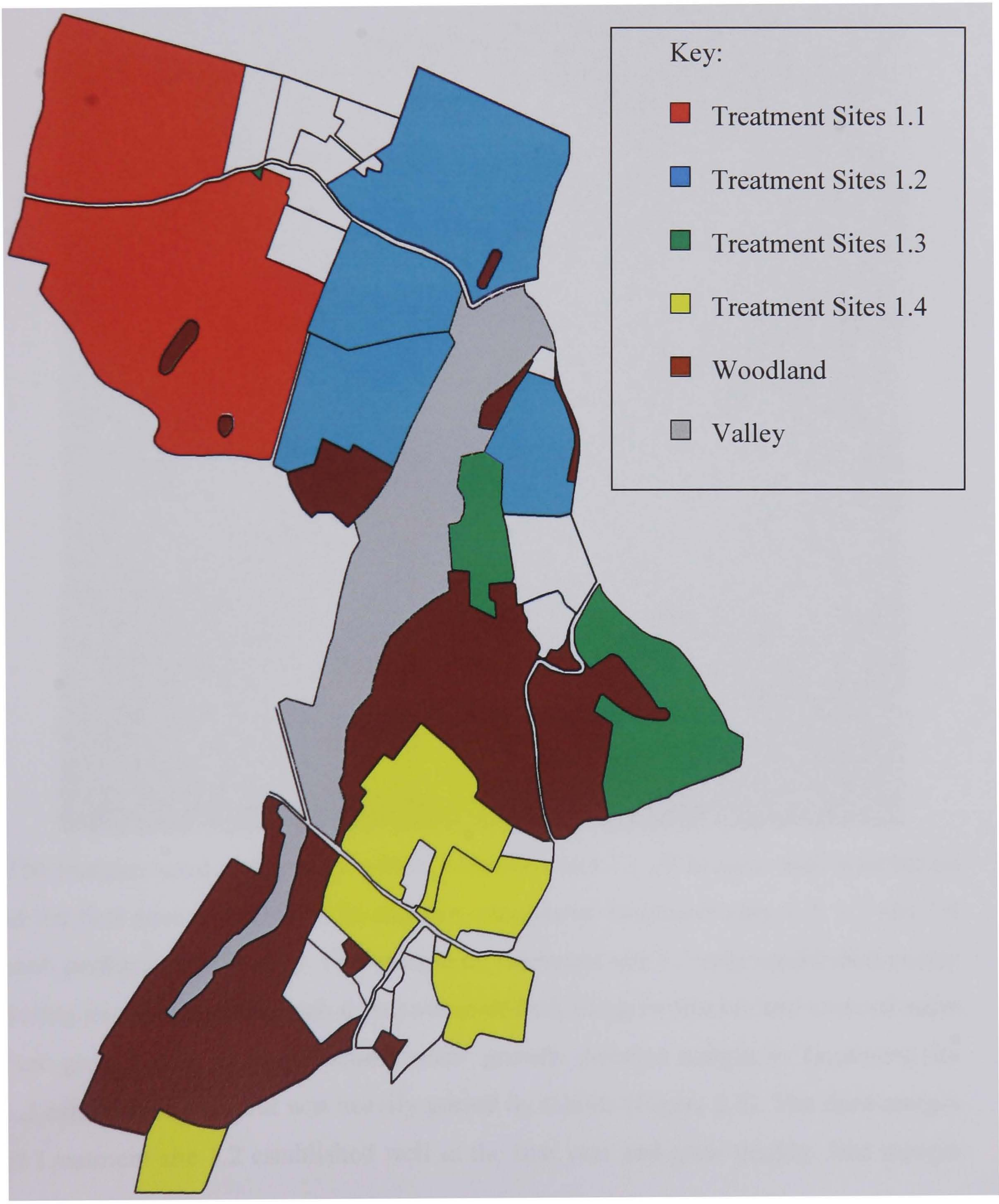


Figure 2.5: Illustration showing a well-established sown grass margin in study site 1.1.

The margins used as transects within Treatment site 1.1 all became well established in the first year (Figure 2.5). In contrast, margins in Treatment sites 1.2, 1.3 and 1.4 each performed differently. One margin in Treatment site 1.2 only established poorly during its first year, although it was not re-drilled, but grew thicker and covered more bare ground with each subsequent years' growth. Another margin in Treatment site 1.2 established well, but was heavily grazed by rabbits (Figure 2.6). The third margin in Treatment site 1.2 established well in the first year and grew thickly. One margin in Treatment site 1.3, established poorly and was heavily grazed by rabbits, similar to Figure 2.6. In another margin in Treatment site 1.3, the sown grasses established poorly but weeds covered most of the remaining bare soil. The third margin in Treatment site 1.3 was re-drilled because the grass established poorly and there was a major weed infestation. However, there was little improvement of this margin through re-drilling and weeds continued to be a major feature. In Treatment site 1.4, one margin was thickly covered with grass in the first year, another margin established less well and had some weed growth, while the third margin was resown as it established poorly, although the subsequent growth had many patches of bare ground and took several years to become well established.

Figure 2.6: Illustration showing a seriously grazed sown grass margin in Treatment site 1.3.

2.2.2 The Control Sites

Three control sites were used for comparison with Site 1. The control sites were chosen on the basis of:

- the different types of land management regimes used to farm the land;
- their use of agri-environment schemes (AESs) and similar land management to create alternative habitats;

- their different types of gamebird shooting;
- their commitment not to radically alter any of their different management programmes during the study; and,
- their proximity to Site 1.

2.2.2.1 Woodsdale Farm

Woodsdale Farm was coded as Control site 2, and lies c. 7.5km to the south-east of Lees Court Estate. The topography of Woodsdale Farm is primarily rolling Kent downland with an underlying geology that is principally chalk. This accounts for the lack of natural water features on much of the land, although the Great Stour River flows through the valley on the western edge of the farm. Woodsdale Farm is one of several owned by a single landowner in the area. Woodsdale Farm covers a total area of 405 ha (1001 acres). Some 344 ha (850 acres) are arable land, 62 ha (150 acres) are grazing land and 30 ha (75 acres) are of woodland. The agriculture is primarily arable, although sheep are grazed on several fields outside the study area.

Woodsdale Farm is tenanted but the landowner has retained the shooting rights on his property. Consequently, the landowner has also retained control over the woodlands and grass headlands that border many of the arable fields, in order to allow these areas to be managed for the benefit of the shoot. An estate manager and two gamekeepers undertake game management and predator control, and maintain the fishing on the river. The shoot is principally reliant on wild gamebirds, but a few reared pheasant and partridge are released each year to supplement stocks for the private shoot.

As with all the control sites, the landowner confirmed that no major changes in the land management regime were to be implemented during study. The arable land surveyed within Control site 2 is *c.* 58 ha in extent (Figure 2.7). The undulating land grades into a steeper slope in the western half of the study area. The habitat matrix is similar to that of Treatment sites 1.3 and 1.4 lying to the south of the main valley at Site 1, and is covered mostly with smaller fields interspersed with hedgerows and surrounded broad-leaved woodland (Figure 2.7).

Three transects for insect monitoring were positioned along the headlands at Control site 2. These margins had been established as sown grass margins under set-aside for several years and were well covered with vegetation (Figure 2.8). One margin had grass that grew thickly and long, resulting in the emergence of few wild flowers and weeds. The second margin was partly grazed by rabbits in some areas, and the shorter grass may have accounted for the greater concentration of wild flowers as they were not being out-competed by a thick sward of grass. The third margin was a combination, with rabbit grazing at one end providing an area where wild flowers grew, whilst the thicker grass sward at the other end meant only the most robust weeds grew within the margin.

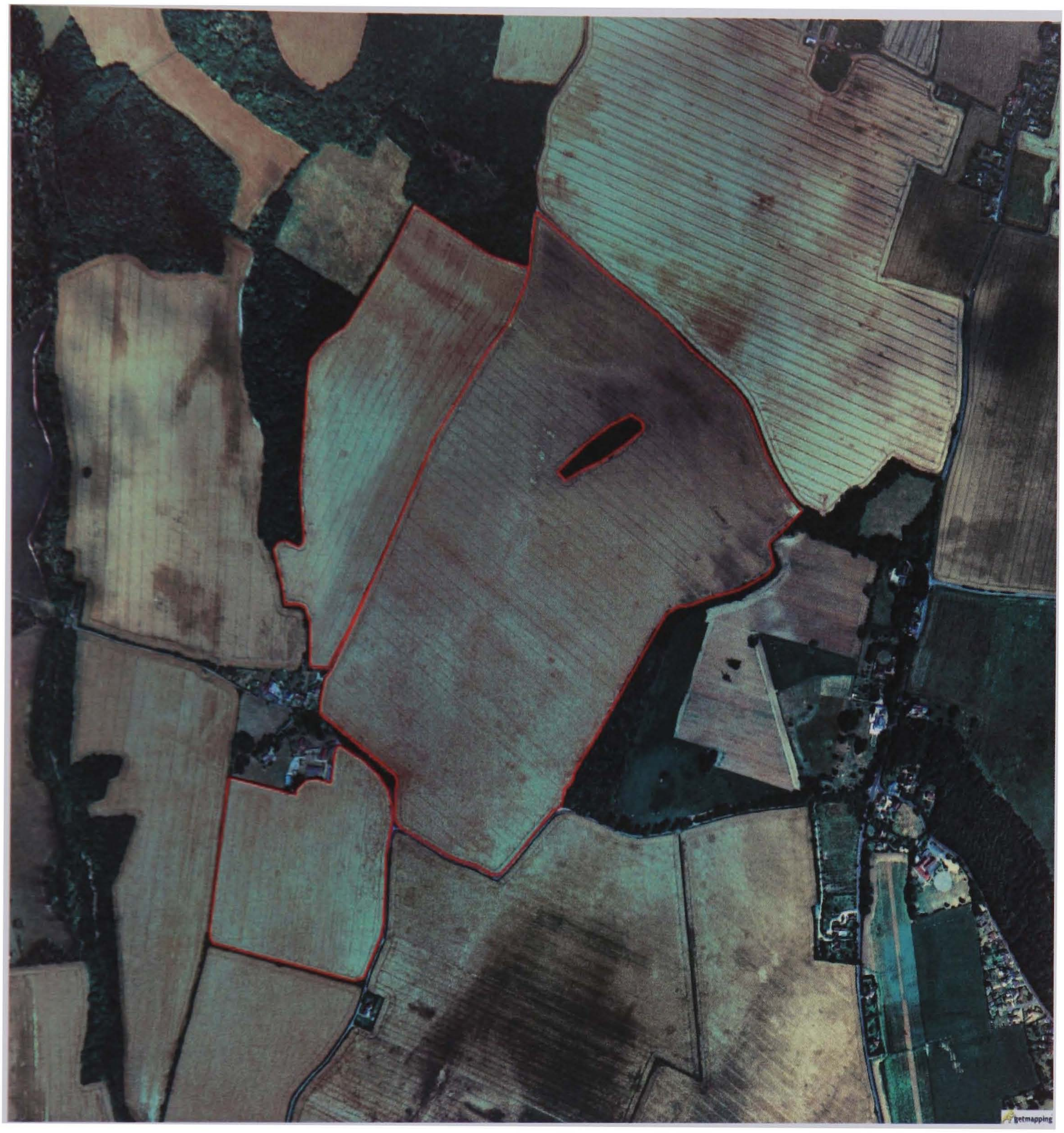
Figure 2.7: Aerial photograph of Woodsdale Farm, known as Control site 2. The study area is outlined in red.

Figure 2.8: Illustration showing the well-established sown grass margin at Control 2.

2.2.2.2 The Duchy land at Wilgate

The Duchy land in the hamlet of Wilgate was coded as Control site 3, and lies directly to the east of the northern half of Lees Court Estate. The topography of the Duchy land consists of chalk soil forming gently undulating large arable fields with small pockets of unmanaged woodland (Figure 2.9). The current farmer tenants the land from the Duchy of Cornwall. The land is managed following the traditional methods of intensive arable farming commonly seen in south-east Britain, in which crops are sown tightly against the field edge. The land management regime was not undergoing any changes at the start of the study. However, an AES was adopted in 2004, after much of the fieldwork had been completed. No gamebird shooting occurs within this area of the tenanted farm, so there is no land management to enhance gamebird populations, and no gamekeeper is present to undertake predator control.

Figure 2.9: Aerial photograph of Wilgate Farm (Control site 3). The fieldwork area is outlined in red.



The fieldwork site has an area of *c.* 55 ha, and the three fields within Control site 3 are sown in rotation with winter wheat or oilseed rape. Control site 3 had no margins between the crop and field edge (Figure 2.10). Weeds and wild flowers were predominantly found at the base of the hedgerows although in some years weeds heavily infested the crop (Figure 2.11), providing a good source of nectar for insects.

Figure 2.10: Illustration showing how the crop was sown up to the hedgerow at Control site 3.

Figure 2.11: Illustration showing the weeds in the crop at Control site 3.

2.2.2.3 Torry Hill Estate

Torry Hill Estate was coded as Control site 4 and lies approximately 12km to the west of Lees Court Estate. Just over 1000 ha (2471 acres) in size, this estate is located at the narrowest point of the north Kent Downs and, as such, encompasses a range of soil types from south facing chalk slopes to brickearth to clay. Because the estate is underlain by such varied soil types, each area of the estate is suited to different types of farming. Therefore, the estate comprises a matrix of: arable fields of 540 ha (1334 acres) in extent; fruit orchards, primarily cherries but also plum, apple and walnut, of 40 ha (99 acres) in extent; grazed grassland, including traditional park grassland, of 150 ha (371 acres) in extent; and, interspersed with woodland, comprising both coppiced chestnut of 200 ha (494 acres) in extent, and managed broad-leaved woodland, of 90 ha (222 acres) in extent.

The estate is managed by the present owner, but the arable operation is partly managed through a contract with a neighbouring farmer. The main livestock comprise sheep, although a herd of cattle are also kept. The orchards are mainly of cherry trees, and the harvesting of the fruit is contracted out. Land management is undertaken with due consideration of the environment. A CSS had been in place for ten years before the start of this study. The shoot is privately run and comprises only wild gamebirds. The land provides good numbers of both pheasant and partridge, due both to the quality of the habitat and to intensive management by the gamekeeper.

The fieldwork area lies to the northwest of the estate (Figure 2.12), and is *c.* 63 ha (156 acres) in extent. The fieldwork area is primarily comprised two large fields *c.* 1km in length. The size of the fields and limited amount of boundary features mean Control site 4 is similar to that found in Treatment sites 1.1 and the northern part of 1.2. The transects at Control site 4 were located along 20m wide margins split longitudinally with the two halves alternately sown every two years. For 2001 and 2003, the 10m margin adjacent to the hedgerow was newly established, but for 2002 and 2004, this margin was in its second year. The seed mix sown along the margin adjacent to the hedgerow was mainly wheat, but was usually contaminated with linseed. Depending on the year, the mix also included phacelia, clover and lucerne, producing a sward less thick than if it was purely a grass mix. All the contaminants were nectar-bearing, as were the weeds that were able to germinate and grow in the open sward of the margin (Figure 2.13).

Figure 2.12: Aerial photograph of Torry Hill Estate (Control site 4). The fieldwork area is outlined in red.

Figure 2.13: Illustration showing the split-sown margin at Control site 4.

2.3 General methodology

The study examined four main topics of interest:

- social attitudes of stakeholders involved in gamebird shooting;
- changes in gamebird productivity, and in biodiversity, associated with agricultural land under different management regimes; and
- an assessment of the future of commercial gamebird shooting.

The following sections provide a brief overview of the methodologies used in this study. The methods used for the social attitudes, land management, gamebird, biodiversity, and willingness-to-pay, surveys are described in more detail in their respective chapters.

2.3.1 Social attitudes survey

The main stakeholder groups involved in gamebird shooting comprise of: (1) shoot owners, (2) "guns" (those who shoot, whether through purchasing shooting days or via invitation), (3) gamekeepers, and (4) loaders, beaters and pickers-up (those vital for the running of a shoot day). However, the attitudes of these stakeholder groups is little understood, yet their opinions are essential if self-regulation is to be successfully introduced into gamebird shooting in a bid to make it more publicly acceptable. Focus group meetings are a common social science methodology used to gather qualitative data on specific social issues (Patton, 1990; David and Sutton, 2004; Macnaghten and Myers, 2004). Consequently, separate focus group meetings were held with the four stakeholder groups in gamebird shooting, to allow each to air their views and concerns surrounding various aspects associated with gamebird shooting, the scope for change amongst the stakeholder groups, and the attitudes of stakeholder groups towards each other. Recordings of each focus group meeting, along with notes taken during the discussions, were collated and statements were grouped into subjects. This provided a means of establishing commonality and discord between the stakeholder groups, and determined the importance each group related to the separate aspects of gamebird shooting.

2.3.2 Gamebird and biodiversity monitoring

For the gamebird and biodiversity monitoring, Site 1 was established as the treatment site due to the initiation of a new management regime, the three sites experiencing constant management regimes were the controls, providing a means of comparisons.

2.3.2.1 Gamebird monitoring

Gamebirds were monitored to establish whether the radical new land management regime on Lees Court Estate had improved their breeding success, with a view to possibly further reducing the number of reared birds released in the future. The study sought to establish if more gamebirds were successfully breeding on the four treatment sites, compared with the three control sites, where the various land management regimes were not subject to radical change. The gamebird monitoring mainly focussed on the ring-necked pheasant as this was the main species both reared and shot on each of the shoots in this study. However, red-legged and grey partridge were also present at some sites.

The surveys followed the methodology devised by the Game Conservancy Trust for monitoring gamebirds (pheasant and partridge) throughout lowland England (The Game Conservancy Trust, unpublished). Their methods involve undertaking surveys at two times of year, both in spring and summer/autumn. The spring surveys, conducted between the beginning of March and the end of April, were used to estimate the size of the potential breeding population. Starting approximately 30 minutes after dawn or two hours prior to dusk, the sites were examined for the presence of cock and hen pheasants by driving around the field boundaries, along woodland edges and hedgerows, and using binoculars to observe individuals, marking down their position on a map. Cock pheasants were divided into territorial and non-territorial cocks, determined by their physical appearance and behaviour. Hen pheasants in the presence of territorial cocks were considered part of that male's harem. Birds with distinguishing features, such as melanistic (dark) or leucistic (pale) plumage, were also noted. Each site was surveyed three times during the spring survey period and the data were combined onto one map identifying the number of territorial cock pheasants, number of hens, harem sizes, and number of non-territorial cocks.

The second surveys were used to estimate the productivity of the gamebird populations at each study area. The counts were done after arable crops had been harvested, and usually started in late July. Counts were made by driving along boundaries of arable fields and across the stubble in a systematic zigzag pattern to ensure all areas are observed. Cocks and hen pheasants with and without broods were noted, along with the number of chicks and their approximate age to aid cross-referencing between the repeat counts. Individuals with distinguishing features were noted to aid identification. Three sets of summer/autumn brood counts were completed for each site for each year of monitoring.

The pheasant counts were undertaken in a way that allowed the comparison of populations between sites and over time. It was recognised that the method used would not measure the total size of a pheasant population at a particular site. The display behaviour of territorial cocks and the reduced caution of birds in the presence of a vehicle compared to a person on foot made this survey method suitable for counting pheasant numbers. However, it was accepted that there would have been birds that were wary, that would have remained within cover and so were excluded from the surveys. Hen pheasants, by nature, are more cautious than males and their brown colouration makes them more difficult to observe (Hill and Robertson, 1988).

The assumptions for the pheasant count surveys were that the same method was followed at each site and that the pheasant populations behaved in the same manner at each site, in terms of cautiousness and response to the presence of the survey vehicle, regardless of whether birds were wild or reared. As such, these data provided a means of comparing gamebird populations between sites under differing management regimes. Each set of counts were subject to the same limitations and constraints.

2.3.2.2 Wildlife monitoring

Different components of wider biodiversity were monitored to establish whether the new land management regime, and in particular the establishment of new habitat features on Lees Court Estate, was improving the population size of different species groups found during the study. The study sought to establish if wildlife numbers significantly increased on the four treatment sites following adoption of the new management regime and compared with the three control sites, where the various land management regimes were not subject to radical change. The wildlife surveys were concerned with the fauna associated with arable habitats as it was these areas that were subject to the new management regime at Site 1. The surveys involved four different species groups, comprising butterflies, bumblebees, general insects and songbirds, and one habitat, comprising hedgerows and wild flowers. The monitoring was completed over the three fieldwork seasons of 2001, 2002 and 2003.

As with the gamebird surveys, the techniques used to monitor other wildlife groups contained limitations, despite following standard methodology. It was acknowledged that none of the wildlife surveys would provide a total population size for a particular species. Rather, they aimed to produce count data that could be compared between sites and indicate whether there had been any change in numbers over time. The assumptions underlying these surveys were similar to those for gamebird monitoring. The areas for surveys were comparable at each site in terms of ecological category, important as some insects and birds are very specific in the habitat they utilise (Marchant *et al*, 1992; Asher *et al*, 2001), and some habitats support a greater number of species than others (Gaston *et al*, 1999; Asher *et al*, 2001). It was also assumed that the techniques used at each site were the same in terms of method and effort and that populations behaved in an equivalent manner with regards their response to the presence of the surveyor and the ease with which they were observed.

2.3.2.2.1 Butterfly surveys

Surveys were conducted to provide an estimate of the abundance of butterflies within the treatment and control sites. Three transects each of 200m in length were established in the headland of arable fields adjacent to a hedgerow or woodland edge, along grass strip or conservation headland where present, in each treatment and control site. However, Control site 3 did not possess these features, so the transect was positioned between the hedgerow and the crop. Each transect was walked at a steady pace, and each butterfly observed up to 2.5m of either side of the transect line and 5m in front was identified and recorded. The position of each observation along the transect line was estimated by dividing each transect into 10 x 20m sections and allocating it to one of these sections. Starting May 1st, each transect was visited once a week for a total of twelve weeks between the hours of 1045h and 1545h.

In addition to the limitations and assumptions mentioned in the previous section, there were further considerations as a result of the methodology. It was not possible to determine whether butterflies seen during a survey had been observed during a previous count, emphasising that these surveys were not to obtain data on population size but were to provide a means of comparing butterfly numbers between sites and years. Surveys were focused on the butterflies utilising habitat within field headlands and as such was a possible means of investigating habitat quality. Such specificity in transect location would limit the species of butterflies observed during the counts. However, undertaking surveys along the same transects in subsequent field seasons allowed for comparison between years. Recording variables, such as temperature, flower availability and shelter, provided a means of determining the factors that may have caused any variations between data sets.

2.3.2.2.2 Bumblebee surveys

Bumblebee monitoring was conducted concurrently with the butterfly surveys, using the same methodology, to provide an estimate of the abundance of bumblebees within the treatment and control sites. As such, the limitations and assumptions of these surveys mirrored those of the butterfly monitoring.

2.3.2.2.3 Insect surveys

The insect monitoring examined the abundance of insects in the first 6m of the arable field headlands of each transect. The sampling was conducted using a D-vac suction sampler, to collect insects from vegetation along each transect. Three sets of samples were gathered from each transect within the treatment and control sites. The samples were frozen to kill the insects, after which they were identified and counted. The insect sampling was conducted in the first and third fieldwork seasons, during the first few days of July when the weather was fine and the vegetation dry.

As with the other wildlife surveys, it was acknowledged that the insect sampling provided data that allowed comparison between sites and years but that the counts would not give total size of insect populations within field headlands. It was assumed that techniques were uniform between sites and years; that the same individual did the sample collection and analysis reduces the risk of variation due to sampling error between sites or years. There was a constraint in the number of years that sampling could be undertaken; due to the number of transects at each site and the number of samples taken from each transect, considerable time was required to clean samples, identify and count the insects in each sample, which confined the insect surveys to only two years of samples.

2.3.2.2.4 Vegetation and hedgerow surveys

A vegetation survey was conducted to provide an index of wild flower abundance along the transects, as the availability of nectar has been found to influence the abundance of butterflies and bumblebees (Lagerlöf *et al*, 2002). Whilst undertaking the butterfly and bumblebee surveys, observations were made of the numbers of flowering plants within each 20m section of the transect, and the predominant flowering plants were identified. The proportion of grasses and herbs were also estimated, as was the amount of bare ground. The hedgerow structure, a measurement of the width and height, was taken to provide an index of shelter, another factor thought to influence the abundance of butterflies (Maudsley *et al*, 2000). The width of the field boundary (non-cropped area) was also measured.

2.3.2.2.5 Songbird surveys

Songbird surveys focused on recording the density of territories for each bird species in the arable habitat of the treatment and control sites. Using the Common Bird Census (CBC) method, boundary and edge features within each treatment and control site were walked and all birds seen or heard were recorded on maps. Five visits were made to each treatment and control site each year. Observations from each visit were then collated into species maps. Two or more observations of a territorial male were interpreted as a territory; other observations, such as an individual carrying nesting material or food was also interpreted as an indication of breeding and, hence, a possible territory. The density of territories was calculated for each species at each treatment and control site. Undertaking surveys in subsequent field seasons allowed for comparison between years.

As with the other wildlife monitoring, there were assumptions and limitations associated with the songbird surveys. It was assumed that differences in counts between sites represented differences in population size between sites; in addition, it was assumed that changes in the counts between years represented changes in the population size. It was also assumed that, at each site, birds of a particular species responded in the same manner to the presence of the field biologist. In addition, it was assumed that collation and assessment of the count information and, therefore, decisions on the number of songbirds was uniform for each site. As with the other wildlife surveys, it was recognised that the songbird monitoring gathered relative data that would allow comparison between sites and between years rather than determine the absolute size of the songbird population at a particular location.

It was recognised that different habitat types are of differing value in terms of quality habitat for songbirds. For the songbird surveys, the surveys were concentrated on the arable land at each site. However, the land bordering each site varied in its type and use and, therefore, it was assumed it varied in terms of quality. It was impossible to choose areas at each site that had the same type of habitat bordering the areas on which the monitoring was undertaken. As such, it was understood that such variation would impact on the count, but that this was a limitation that affects most monitoring studies where the species being studied is capable of moving across the boundaries of the study area. Comparison of the habitat bordering each study area was not undertaken. However, each study site covered the same area in subsequent years and the majority of bordering habitat remained unchanged in terms of management regime. This would permit unbiased comparison of counts for a site over time without incurring the effects of changes in bordering habitat areas. It was accepted that each site was bordered and surrounded by habitat that was possibly different in terms of type and quality from that surrounding the other study sites.

2.3.3 Willingness-to-pay survey

The use of questionnaires to generate social science data is common practice (Freese, 1997). A postal questionnaire was used to investigate the amount currently paid and the future amounts that 'guns' would be willing to pay for gamebird shooting, following the hypothetical introduction of restrictive regulations that would limit the type of shooting and bag size available on all shoots. Comparison of the two sets of values provide a means of assessing whether commercial gamebird shooting would continue in the future following the loss of reared birds for release. The study also provided an assessment of the current types of shooting, in terms of type of birds and bag size, bought in lowland Britain.

2.3.4 Data analysis

Univariate and multivariate statistical analyses were undertaken to examine the data collected. Parametric and non-parametric tests were used, depending on the distribution of the data, as described by Zar (1996) and following Kinnear and Gray (2002). The *P* value is quoted for statistical results that were not significantly different. For significant results, the *P* values are recorded as either <0.05, <0.01 or

<0.001. For some analysis, P values of <0.1 were recognised as tending towards significance.

The gamebird productivity counts (Chapter 5) and wildlife counts (Chapters 6 and 7) were analysed using repeated measures ANOVA, which examined the variance caused by the differences in the data over time and between sites. Where differences were found, a one sample t-test was used to compare sites to identify between which pairs of factors there was a significant difference (Quinn and Keough, 2003).

Regression analysis was used to assess which environmental variables best explained any differences in the gamebird productivity counts and biodiversity counts. The regression analysis aimed to describe the relationship between the independent variables and the count data, to assess the degree to which the variation was explained, and to determine the magnitude of each effect to investigate which variables appeared to be the most important (Everitt, 1977; Quinn and Keough, 2003).

The categorical data generated by the willingness-to-pay survey were analysed initially using chi square (Chapter 8) to examine the distribution of responses for aspects such as type of shooting purchased and bag size. Further analysis to determine whether there were differences between categories of shoot type and factors such as price per day and bag size used a Kruskal-Wallis ANOVA, a non-parametric test used instead of ANOVA, as the data violated the assumptions of normal distribution and homogeneity of variance despite transformation. Examination of the willingness-to-pay survey to determine whether the amount currently paid is different from the amount stakeholders would be willing to pay in the future was analysed using a paired sample t test.

Chapter 3
Social Attitudes to Gamebird Shooting: Stakeholder Discussion Group Meetings

3.1 Introduction

The country sport of hunting with hounds, traditionally practised in Britain since the 17th Century (Clayton, 2005), has attracted much controversy in recent years (Burns *et al*, 2000). Seen by many as cruel and out-dated, animal welfare groups exerted considerable pressure on the British Government, which successfully led to a ban on hunting foxes, deer and hares with dogs in England and Wales in February 2005 (Hunting Act 2004). Those involved in gamebird shooting believe that their sport could be next on the agenda of those who seek to ban all country sports that they deem as unacceptable (Suggett, 2001). Despite this belief, the British Government has, on numerous occasions denied any desire to ban gamebird shooting (Saffery Champness, 2003), and instead have advocated a system of self-regulation (DEFRA, 2005).

Self-regulation will require those individuals and organisations that represent gamebird shooting to examine sensitive issues within the sport and produce guidelines that tackle those areas of actual and potential controversy in a responsible and sustainable manner. Furthermore, for self-regulation to be successful, all stakeholders must be willing to accept the proposed regulations. In other words, with no legislation to enforce specific practices, a management regime of self-regulation will only be successful if stakeholders support the proposed measures. Therefore, before implementing a system of self-regulation for gamebird shooting, it is essential to consult stakeholders to assess their attitudes towards possible changes that maybe desirable in any new regime for gamebird shooting.

Local attitudes have often been studied as a first step to understanding the approaches and policies needed to promote conservation among rural communities in developing countries (Newmark *et al*, 1994; Gillingham and Lee, 1999). Using social science tools, such as face-to-face interviews and focus group discussions (Bernard, 2001), studies of social attitudes have been extremely useful for investigating the opinion of stakeholders during the procedure of creating new policies. This is particularly the case in developing countries where studies of local attitudes are considered essential in creating successful conservation policy (Roe *et al*, 2000; Mushove and Vogel, 2005). Many rural people in developing countries have no choice but to directly use natural habitats, for activities such as hunting, harvesting wild species and collection of firewood (Robinson and Redford, 1994, Hutton and Leader-Williams, 2003). Many such habitats support rich biological diversity, but are also in most danger of degradation when land is cleared for farming. Conservation programmes are established in such rural habitats to protect this threatened biodiversity. However, local communities are intimately linked to these rural areas and are generally resistant or wary of change (Feldmann, 1994). Protection of these habitats requires local participation and success is more likely if participation occurs from the beginning of the programme (Little, 1994).

Understanding the attitudes of local communities towards a new management regime can ascertain whether it will be successful. Metcalfe (1994) noted how the community-based natural resource management scheme known as CAMPFIRE in Zimbabwe, was most successful in areas where local people were given a voice, rather than being dictated to by rural district councils, thereby providing greater protection for elephants living outside national parks. Conservation programmes that do not ascertain the opinions and attitudes of local communities fail to highlight areas of conflict between these people and the programme. When their concerns and needs are not considered, local communities can be highly resistant to changes, which leads to the programme failing (Little, 1994).

In Britain, new land management regimes affect fewer individuals, as less of the rural population derive their livelihood directly from land-use. There are few "natural" areas in Britain, and most are highly managed or influenced by human activity (Adams, 1997b), which has created high quality habitats that support high levels of biodiversity (Hellawell, 1994). Most of the countryside is owned by relatively few individuals and is used primarily for agriculture; some areas are national parks or nature reserves and managed primarily for conservation and providing access for the general public (Stratham, 1994). Management on privately-owned land is mainly for agriculture and schemes that seek to improve conservation practices on this land (e.g. Countryside Stewardship Schemes) are generally voluntary but with limited financial incentives (Morris and Potter, 1995; Morris, 1997). Indeed "incentives are essential to generate local commitment to environmental management which does not or can not exist otherwise" (Feldmann, 1994).

Changes to land management regimes primarily affect stakeholders who work the land. Constrained by regulation, even if self-imposed through the up-take of a CSS, they may find themselves having to radically alter their land management regimes. Other stakeholders are generally less affected; access to, and recreational use of, rural areas are the most affected aspects (Green, 1981).

Until recently, few studies have assessed the social attitudes of rural communities in Britain to new land management regimes and conservation policies. Urban societies have traditionally received most attention from social scientists (Milbourne, 1997). Not until the early 1990s was the dearth of research on rural societies highlighted in a paper on "neglected rural geographies" (Philo, 1992), resulting in more attention being directed towards understanding the issues faced by modern rural communities. Studies have investigated the social change occurring in rural Britain in the last 50 years, examining the structure of rural communities and the shift in stakeholder groups (Newby, 1985; Shucksmith, 2000). Other work has investigated: the attitudes of farmers after the Foot and Mouth Disease (FMD) outbreak of 2001 (Convery, 2005); diversification within agricultural businesses (Shucksmith and Herrmann, 2002; Walford, 2003); and the attitudes of farmers to agri-environmental schemes (Morris and Potter, 1995; Battershill and Gilg, 1996; Wilson, 1996, 1997). A 'revolt' occurred within rural communities at the end of the 20th century (Woods, 2003), when local peoples and associated organisations compelled the rest of society to recognise rural issues via the Countryside March in 2002. Other developed countries such as in France (Lowe *et al*, 2002) have rebelled over varying issues, although the trigger has always been defence of the rural way of life.

Until the highly publicised debate concerning hunting with hounds (Burns *et al*, 2000), few studies have investigated the attitudes of stakeholders involved in country sports in Britain. The majority of attitude studies on country sports, particularly on hunting with hounds, were conducted as polls directed at the general public, including the British Social Attitudes Surveys and those undertaken by MORI. A small study of those involved in fox hunting was undertaken by Saffery Champness (2003) to assess their attitudes to the sport and the consequences of a ban, should it be imposed[3]. The attitudes of farmers in Wiltshire towards foxes and methods employed to control numbers were assessed by Baker and Macdonald (2000), concentrating on why some farmers consider the fox a pest species and gauging the level of control undertaken. A similar study investigated the attitudes of landowners and the general public to different methods of control used for four mammal species (White *et al*. 2003). Both these studies concentrated on attitudes to the techniques used to control pest species and, although an important issue for animal welfare, these studies ignored other highly complex issues surrounding country sports and predator control, such as the economics and traditions of rural communities, and wildlife conservation.

Another key area of research has assessed the financial importance of country sports to rural communities (Cox *et al*, 1996; Chobham Resource Consultants, 1997). The National Trust (NT) requested a study to investigate the financial impact of two hunts in the south-west of England, with social aspects considered to some extent (Cox and Winter, 1997). Some studies, such as the National Gamebag Census (NGC), have provided comprehensive records of activities on shooting estates, from the numbers of each game species shot per season, to the activities of gamekeepers.

Attitudes of stakeholders involved in gamebird shooting have been largely ignored by social scientists. Many of the social aspects are comparable with those of hunting with hounds, as described in Cox and Winter (1997). There is also a traditional hierarchy within gamebird shooting with clearly defined stakeholder groups; those

[3] This did happen in 2005. It is too soon to assess the consequences of the ban, to examine whether the fears of the stakeholders have become reality. Studies are now required to investigate the total effect of the ban on hunting with hounds, including economic, conservation and social consequences. Ward (1999) concurred with this view, stating that the effects of a ban on the economics of rural communities, and the issue of reemployment for those who lost their jobs, would need monitoring.

involved assert that all social classes enjoy the sports. Indeed, participation is not limited to the upper classes, although those within gamebird shooting contend that participation is wider for their sport compared to foxhunting. The level of involvement is claimed to indicate the dedication of stakeholders (Cox and Winter, 1997), a view also held by those involved in gamebird. Indeed, stakeholders from both sports purport the social importance of their sports within rural communities and in maintaining community cohesiveness. Finally, opinions relating moral standing from those involved in gamebird shooting echo those involved in hunting with hounds: "They are convinced of their own rectitude. But they cannot, at the same time, be unaware that for a great many people their activities place them beyond the bounds of the acceptable" (Cox and Winter, 1997).

This study aimed to explore the attitudes of the four primary stakeholders identified in gamebird shooting, and determine the issues they felt were most important. Using focus group meetings, stakeholders were provided with a forum to express their concerns and beliefs relating to gamebird shooting. Opinions of other stakeholder groups were voiced, including their view on the scope for change amongst these groups, in relation to specific aspects of the sport.

3.2 Methods and Materials

3.2.1 Focus Group Discussion Meetings

Focus group discussions were used to understand the attitudes of stakeholders towards the future of lowland gamebird shooting. Focus groups are a popular method for gathering qualitative data on social issues (May, 2001; Neuman, 2003; David and Sutton, 2004), such as public opinion on political or environmental issues (Patton, 1990; Macnaghten and Myers, 2004). Focus groups are specific in obtaining information on a designated topic, deriving that information directly from group discussion supervised by a moderator (Morgan, 1996).

There are advantages and disadvantages to focus groups; use of this investigative tool must depend on the research requirements. Focus groups are social events; individuals interact, generating "group effects" that has several benefits: (1) individuals feel empowered by the group, expressing ideas and thoughts they may not have been comfortable conveying in a face-to-face interview; (2) individuals react to statements from the group, querying comments or explaining their own responses, which can produce more information than several face-to-face interviews; (3) groups impose control over 'wilder' responses, verifying and stabilizing answers to prevent false or excessive observations (Krueger, 1994; Morgan, 1996; Neuman, 2003).

The moderator guiding discussion is another advantage. Carefully worded questions or comments allow the moderator to investigate interesting areas of discussion. Less structured focus groups have greater flexibility to explore areas of interest, which is not possible if using a list of questions or when employing self-administered questionnaires (Krueger, 1994; Morgan, 1996).

Several disadvantages to focus groups must also be considered: (1) groups can vary enormously; some are expressive, others introverted. Apprehension can be limited by selecting a suitable venue for the meeting. Selecting a homogenous group of individuals can also mean less hesitant discussion; (2) one or two individuals can dominate the group, inhibiting involvement by other members, although a skilled moderator can intervene, encouraging involvement from all members (Patton, 1990; Bryman, 2001; David and Sutton, 2004); and, (3) it can be difficult organizing a focus group, trying to gather participants at a location for a particular time. Thus, incentives, such as a social occasion, can encourage attendance. Conversely, face-to-face interviews are easier to organize, finding a time and location suitable for individual respondents. Attendance at focus groups is generally high when participants have a proven interest in the subject of the meeting (Krueger, 1994; David and Sutton, 2004).

Focus groups are an advantageous social investigative tool because comments from individual group members are validated and credible, except when the subject could be better investigated using an alternative social science technique (Krueger, 1994). It is essential to establish whether the requirements of the research are satisfied using focus groups. Krueger (1994) amplifies this point, stating: "Focus groups are valid if they are used carefully for a problem that is suitable for focus group enquiry".

Focus groups can vary in structure, depending on the intensity of the moderator's role in guiding the discussion. In intensively managed meetings, a series of specific questions may be asked throughout the session. Less structured meetings may have questions asked only when discussion has lulled or digressed away, allowing a session of exploration to develop. Such sessions are more flexible, and discussion can return to a previous point for elaboration, which is not possible in structured sessions (May, 2001; David and Sutton, 2004). However, the less structured format offers the moderator less control compared with structured sessions or face-to-face interviews, as efforts to control the discussion can be disruptive, although these concerns tend to be associated with tightly structured focus groups that are more constrictive in design (Krueger, 1994; Morgan, 1996).

3.2.2 Stakeholder Groups and their Focus Group Meetings

Although many individuals may be affected by a new regime of self-regulation, it was considered vital to examine the attitudes and opinions of the primary stakeholder groups within gamebird shooting. These stakeholders are the main players in lowland gamebird shooting, as decisions they make will directly affect the future of gamebird shooting and, without their co-operation, it will be impossible to implement any future system of self-regulation.

The primary stakeholders were:

- Shoot owners, owning land on which there is a lowland gamebird shoot;
- 'guns' who undertake lowland gamebird shooting;
- gamekeepers whose work and livelihood depends on lowland gamebird shoots; and
- part-time workers on lowland gamebird shoots, such as those who load, beat and pick-up.

A separate focus group meeting was undertaken for each stakeholder group, held in surroundings each group would find comfortable. For the gamekeepers' and loaders, beaters and pickers-up focus group meetings, individuals associated with different types of gamebirds shoots (small and large, wild and reared) were invited so a mix of shoot types were represented. Most lived in Kent and had occupations that meant they were available to attend the meetings, ensuring each meeting was well attended. Of the 15 or so invited, 11 individuals actually attended each meeting.

Logistically, it was more difficult to organise the focus group meetings for shoot owners and 'guns'. Many such stakeholders have busy jobs and tight schedules and live a long way from London, the most central location chosen for both meetings. Individuals who attended the shoot owners meeting included those from as far away as Warwickshire, Lincolnshire, North Yorkshire and Inverness. Of the 'guns', two individuals were from Belgium and France, one an American now based in this country, and others came from as far away as Devon, Shropshire and Lincolnshire.

Both groups comprised of 14 individuals with all shoot types represented. Some owners run small, private shoots and others have developed commercial shoots with large bags produced from extensive rearing; some have conservation at the forefront of decision-making, whilst others run shoots that a shooting agent with firsthand knowledge of the estates said showed "little regard to conservation". Other individuals had altered the size and type of their shoots, either expanding the commercial aspect to generate more money, or down-sizing the shoot, making it less intensive and more sensitive to conservation issues.

Similarly, the 'guns' had experience covering the full range of available shooting. Some individuals bought large bag days on highly commercial shoots, while others were members of syndicates where the bag was rarely more than 50 birds a day. Several had personally experienced a range of shoot types and sizes, including small private wild bird shoots to which they had been invited.

The same moderator chaired each meeting, encouraging open discussion by individuals as described by Neuman (2003). The moderator was experienced, ensuring discussion ran smoothly and covered all aspects of interest. The focus group meetings were reasonably unstructured, allowing issues to be explored without confining stakeholders to specific subjects. The moderator had a list of questions, covering areas of consideration, which could be consulted should discussion slow. The list was compiled following in-depth reviews of relevant literature, assessment of areas of research interests and through discussion within a committee consisting of representatives from the different stakeholder groups and scientific community. These pre-prepared questions served as a checklist, ensuring all areas of interest were included in the discussions. This approach follows the methodology outlined in David and Sutton (2004), who stress the effectiveness of a "focus group interview prompt sheet".

Separate focus group meetings enabled individuals to comment freely on other stakeholder groups. Close family units were not allowed to participate, although some individuals knew each other on a personal or professional level. Using homogenous groups that exclude individuals with close relationships allows for liberated discussion and more heterogeneous responses (Neuman, 2003). Each discussion was tape-recorded and a second researcher took handwritten notes, following standard methodology for documenting focus group discussions (Krueger, 1994; David and Sutton, 2004).

To start each meeting, the moderator assured stakeholders of their anonymity and that anything said would not be attributed to a particular participant. The moderator outlined the rationale for the meeting; to allow individuals from the same stakeholder group to express their thoughts about, and discuss their attitudes towards, different aspects of lowland gamebird shooting. The moderator emphasised that gamebird shooting was likely to come under scrutiny once hunting with hounds had been resolved in Parliament, stressing that those involved in hunting with hounds were given little opportunity to express their thoughts, feelings and concerns surrounding their sport. The moderator stressed that these meetings were an opportunity to voice concerns regarding practices that made gamebird shooting a target for criticism and were an opportunity to suggest possible changes, express their willingness to accept change, and to comment on the willingness of other stakeholders to change.

The moderator started the discussion and used open-ended questions and statements throughout to introduce new aspects to the discussion. Questions were asked to investigate areas of interest, elicit responses from reticent members of the group and to prevent any one individual from dominating the forum. The focus groups lasted approximately two hours, by which time, points were being reiterated and no new information provided. Focus groups were brought to a close by offering each person the opportunity to make a concluding statement, emphasising that the discussion had been about listening to their comments.

The taped and written records were used to establish which issues of gamebird shooting were of greatest concern to stakeholders. Strength of feeling on different issues was qualitatively gauged into three categories: slight concern/agreement on an issue; moderate concern/agreement; and, strong concern/agreement. This was done by counting how many comments were made affirming support for an issue, whether any comments were made taking the opposite view, and estimating how many individuals in a group (i.e. the proportion of the group) supported a view. For each issue, these three categories were examined and compared to other issues raised during the meeting; strength of feeling was then allocated to each issue.

This technique has many limitations. It is a qualitative method with a subjective quantitative feature assigned to it to allow for comparison between issues. There are major differences between qualitative and quantitative research; unlike quantitative data, qualitative data cannot be put into a format that can be represented formally in graphs or statistics (Trochim, 2000).

Qualitative research is appropriate for investigating a sensitive issue such as opinions of stakeholders with regards gamebird shooting (Trochim, 2000). Research methods that generate quantitative data can be used to investigate such issues but do not permit the thorough understanding in the same way as qualitative research; a detailed comprehension of the issue was desired for this study. Qualitative research is investigative whilst quantitative research has the aim of being conclusive as it is based on measureable data. Qualitative research is founded on observational information and categorises data into patterns for organising and displaying the results. As such, it is difficult to formally assign a quantitative value to qualitative data to allow comparison between subjects (Trochim, 2000; Silverman, 2006). Therefore, the assessment of the strength of feeling within this study was subjective.

Alongside the tables representing the strength of feelings expressed by stakeholders for an issue, quotes have been selected that represent examples of what was said. With traditional analysis of qualitative research, quotes are embedded within the text to support the statements (Roth, 2001). Indeed, quotes are "one of the most frequent ways to introduce the informants' voice into qualitative research" (Wiesenfeld, 2000). Analysis involved examining the statements made by stakeholders, allocating strength of feeling, commenting on the issues covered and then choosing appropriate quotes to illustrate the conclusions made. As such, the analysis of the comments made by stakeholders determined the quotes used, rather than sifting out quotes from the raft of comments made in order to influence assessment of the focus group discussions.

3.3 Results

The focus group discussions revealed broadly similar areas of concern amongst the four stakeholder groups, although some differences were evident. This section summarises the main issues raised, highlighting key similarities and differences of opinion between the four stakeholder groups. A table for each section summarises which issues each stakeholder group thought was important and the degree to which they held these views.

3.3.1 Bag Size on Gamebird Shoots

Table 3.1: Strength of feeling among four stakeholder groups on issues related to bag size, based on focal group discussions.

Key issues	Gamekeepers	Loaders/beaters/ pickers-up	Shoot owners	Guns
Large bags unacceptable to the general public	***	***	***	***
Large bags personally unacceptable/concerning	***	*	**	*
Large bags detrimental to countryside	***			
Guns desire big bags	**	***	*	
Large bags make an enjoyable day out		**		**
Conflicted about bag size		*	**	
Large bags provide greater revenue			**	**

Symbols represent the degree of feeling on an issue, assessed as: * slight concern/agreement on an issue; ** moderate concern/agreement; *** strong concern/agreement.

Bag size was a key concern for all four stakeholder groups (Table 3.1). Most stakeholders felt that large bag sizes were unacceptable to the general public and many voiced the need to revert to smaller bag sizes. Furthermore, most in the gamekeepers' focus group admitted that the release of large numbers of reared gamebirds on certain shoots is probably detrimental to the countryside:

> "It cannot be denied that the releasing of large numbers of birds has got to have an affect on wider conservation. It has got to be bad to put 100,000 birds on 2,000 acres compared to 1,000 birds." (*Gamekeeper*)

Several gamekeepers believed that some 'guns' who purchase shooting only desired large bags (Table 3.1), that those who purchased smaller bag days were more aware of the countryside and its flora and fauna, and better appreciated the quality of the shooting instead of the number of gamebirds shot.

The loaders, beaters and pickers-up had mixed and conflicting views on large bag sizes. Most felt that 'guns' generally wanted large bags (Table 3.1), and believed that 'guns' derive prestige from the numbers of gamebirds shot. Although loaders, beaters and pickers-up believed there was no future for large bag days, they acknowledged that this type of shoot made for a more enjoyable day:

> "I have been on estates that have changed from reared to wild and seen the changes. They affect the beaters as well as the 'guns' and the gamekeepers. The job is different because you are looking for *the* pheasant. There is less enjoyment in wandering through the wood for only a couple of birds, but then there is unease when you go to these really big shoots." (*Beater*)

Shoot owners also differed in their opinions of bag sizes (Table 3.1). Approximately half believed there was nothing wrong with larger bag days, except for public perceptions, whilst others believed they were hugely unattractive and invited attacks from both the government and the general public. Some shoot owners expressed the need to offer large bags as they relied on the revenue generated, particularly since income from farming has decreased:

"Farming has decreased and is costing money. Therefore I have increased the shooting and made it commercial. The let days pay for the family days, the full-time gamekeeper and so on." (*Shoot owner*)

As with the loaders, beaters and pickers-up, several shoot owners experienced conflicting emotions when considering large bag days:

"I would like to reduce my shoot. It is an income of which one is not proud. Unfortunately, I have to sell a lot of days to cover the costs." (*Shoot owner*)

One shoot owner held those who purchased shooting responsible:

"I've run a shoot for 25 years and have never had someone complain that they've shot rather more than they were expecting to, but I've had lots of complaints if they don't get the bag!" (*Shoot owner*)

The opinions of 'guns' differed from those of the three other stakeholder groups. Overall, they did not appear as concerned over the issue of large bag sizes (Table 3.1). Several admitted to shooting what the sport generally considers a large bag (over 500 birds a day) but clarified that high quality birds were also important. The point that quality, rather than bag size, was of primary importance when purchasing a days shooting was reiterated throughout the discussion, with particular reference to the "X factor" of quality birds. Only one 'gun' said that shooting over 500 birds a day was not actually an enjoyable experience. Another 'gun' explained how he had enjoyed shooting both large and small bags. Two 'guns' expressed concern over the ethical issues of large bags, whilst only one spoke negatively of large bags, saying that "big bags are ugly". Like the other stakeholder groups, 'guns' recognised that large bags would most likely be the key point of attack.

At no point did 'guns' suggest that demand from their stakeholder group drove the production of large bag days, as was vehemently claimed during the loaders, beaters and pickers-up focus group meeting and suggested by gamekeepers and shoot owners. Like shoot owners, 'guns' acknowledged that many found it necessary to sell large bag days because of the financial state of farming.

3.3.2 Commercialisation of Gamebird Shooting

Table 3.2: Strength of feeling among four stakeholder groups on issues related to commercialisation of gamebird shooting, based on focal group discussions.

Key issues	Gamekeepers	Loaders/beaters/ pickers-up	Shoot owners	Guns
Money generated essential for shoot owners	***	***	***	**
Money generated essential for rural communities	***	***	*	
Has fundamentally changed the job of gamekeepers	***			
Increased access to gamebird shooting		**		*
Encourages poor practices			**	
Price of a days shooting				**

Symbols represent the degree of feeling on an issue, assessed as: * slight concern/agreement on an issue: ** moderate concern/agreement; *** strong concern/agreement.

All four stakeholder groups agreed that many shoot owners, particularly those who are primarily farmers, relied on the money generated by selling shoot days, essential now that financial returns from farming are decreasing (Table 3.2). Gamekeepers and loaders, beaters and pickers-up also related the importance of shooting revenue to rural communities:

> "Selling shooting is vital to the rural economy; it brings money into the community." (*Gamekeeper*)

Only one individual from the shoot owners' focus group mentioned how commercialised shooting introduced revenue into rural communities:

> "I have gone from mainly farming with a small family shoot to a commercial shoot with very little farming. With 8 guns, we end up with over 16 people because of the guests. The wives go off and spend money in the local shops; the hotels house them. Shooting has allowed a lot more money to go back into the economy than farming." (*Shoot owner*)

Gamekeepers also associated the commercialisation of gamebird shooting with a shift in the structure of their jobs (Table 3.2), adding enormous stress because of concern that the agreed bag sizes will not be reached. The desire to shoot increasing numbers of gamebirds has encouraged the rearing and release of gamebirds on the majority of British shoots. The job of gamekeeper has altered from one of managing habitat and promoting wild gamebird populations, to one concerned primarily with rearing gamebirds in captivity. No other stakeholder group recognised how the commercialisation of gamebird shooting had fundamentally altered the structure of the gamekeeper's job.

Loaders, beaters and pickers-up expressed the belief that commercialisation has benefited those interested in gamebird shooting:

> "Commercialisation has made shooting accessible to more people. Before, it was for the very rich. Years ago, you didn't pay to shoot, you were invited; it was to do with rank and privilege." (*Beater*)

Some shoot owners voiced concerns that the commercialised aspect of shooting brought negative perceptions that were currently getting worse. However, it was agreed that the existing problems with farming were exacerbating the situation, and encouraged shoot owners to manage their shoots with an increasingly money-orientated approach:

> "Shooting for commercial gain is often because the demise of farming means the need for an alternative form of income" (*Shoot owner*).

'Guns' had little to say on the commercialisation of gamebird shooting (Table 3.2). Other than succinct references to the financial gain for shoot owners, the only other benefit recognised was from one individual who made the same point highlighted during the loaders, beaters and pickers-up focus group discussion, that commercialisation of gamebird shooting allowed those who do not own their own shoot to purchase a days' shooting. Guns did make comments on the price of a day's shooting in Britain; several thought that gamebird shooting was expensive, whilst others believed it was a unique experience and worth paying for:

"England is very much value for money in terms of [gamebird] shooting. It's not just the number of birds or how many cartridges shot but the magic, the tradition. It's something that is so typically English! This is a premium." ('*Gun*').

3.3.3 Rearing Gamebirds

Table 3.3: Strength of feeling among four stakeholder groups on issues related to the rearing of gamebirds for shooting, based on focal group discussions.

Key issue	Gamekeepers	Loaders/beaters/ pickers-up	Shoot owners	Guns
Comparable with the rearing of domestic animals	***			**
Some unacceptable practices	**	**	*	
Rearing affects the gamekeepers job	***			
Concern on the numbers reared		**		**
Concern on husbandry/disease		**	*	
Needs to be a code of conduct		*		**
Rearing gamebirds to be shot				***

Symbols represent the degree of feeling on an issue, assessed as: * slight concern/agreement on an issue: ** moderate concern/agreement; *** strong concern/agreement.

The four focus groups held different views on the issue of rearing gamebirds (Table 3.3). Gamekeepers, who are directly involved with rearing, strongly felt this practice did not differ from the rearing of farm animals. Gamekeepers suggested that cattle were often kept at high densities in disagreeable conditions, yet these practices do not face the same public concern afforded gamebird rearing. However, concern was voiced over unacceptable practices occurring on some estates whilst rearing gamebirds:

"There are no regulations on rearing birds and this is where problems occur. We need to devise and follow a voluntary code of practice." (*Gamekeeper*)

The main concern of gamekeepers was how gamebird rearing affects their job (Table 3.3). References were made to the time spent doing jobs on the rearing field, estimated at approximately 120 days per year. The general consensus was that it was monotonous, and most wished instead to be doing land management and conservation work.

Loaders, beaters and pickers-up were critical of certain practices involved in the rearing of gamebirds (Table 3.3), although they did not say they wanted it stopped. Concern was expressed over the numbers of gamebirds reared because of the threat of disease: the majority agreed the number of gamebirds being reared had to be reduced. However, the group recognised that such a process could not be suddenly enforced, but introduced gradually if to be sustainable. Good husbandry was highlighted as essential in preventing disease outbreaks during and there was concern that buying in poults instead of hatching gamebirds from eggs encouraged husbandry problems, as gamekeepers were less likely to devote as much effort to caring for the birds: concern over the amount of drugs administered to gamebirds was also expressed.

Shoot owners said little on the issue of rearing (Table 3.3). One shoot owner expressed concern that bad rearing practices undertaken by a few would provide those wishing to ban gamebird rearing with adequate material for their attack. Another shoot owner said the imminent ban on Emtryl, a drug used to prevent disease in gamebirds, would automatically reduce rearing by 50% in Britain.[4]

'Guns' held strong views on rearing gamebirds (Table 3.3), which some considered to be the main line of attack for those opposed to gamebird shooting. They felt the general public were not as concerned with the number of gamebirds reared or shot as with the idea of rearing gamebirds specifically to be killed. However, like the focus group, 'guns' did not consider gamebird rearing to be any different to rearing farm

[4] Although production and sale of Emtryl was stopped in October 2002, the feared outbreak of disease predicted by many has not occurred. This is thought due to several factors: (1) individuals have followed the detailed guides issued by shooting organisations that provided information on husbandry methods designed to decrease the risk of disease outbreak; (2) there has not been a poor breeding season, in terms of conditions that would increase the risk of disease outbreaks (such as wet weather), since the ban was implemented; (3) individuals may still be using Emtryl that has been stock-piled or similar, illegal, Emtryl-type products.

animals and one individual felt a reared gamebird experienced a nicer life than a chicken or turkey.

Several 'guns' considered a code of good practice for gamebird rearing to be essential. Although they believed most shoots were managed responsibly, it was felt all shoots with rearing programmes should be encouraged to follow good practice as instances of poor rearing would reflect badly on the industry as a whole.

3.3.4 Benefits of Gamebird Shooting

Table 3.4: Strength of feeling among four stakeholder groups on issues related to the benefits of gamebird shooting, based on focal group discussions.

Key issue	Gamekeepers	Loaders/beaters/ pickers-up	Shoot owners	Guns
Conservation	***	*	**	**
Financial input into rural communities	**	***	*	*
Maintaining social cohesion of rural communities	**	**		
Financial benefits for shoot owners	*	*	***	**

Symbols represent the degree of feeling on an issue, assessed as: * slight concern/agreement on an issue; ** moderate concern/agreement; *** strong concern/agreement

All four stakeholder groups expressed similar views on the benefits of shooting for conservation in the wider countryside, although the strength of feeling differed between groups (Table 3.4). Land and game management, along with predator control, were seen to produce conservation benefits. Gamekeepers felt directly responsible for producing conservation benefits through their job: (1) supplementary feed for gamebirds also provided food for songbird species; (2) predator control reduced predation pressure on other wildlife species alongside gamebirds; and (3) land management provided higher quality habitat for gamebirds and other wildlife. Gamekeepers also recognised the financial inputs to rural communities as a benefit of gamebird shooting.

In contrast, most loaders, beaters and pickers-up thought the financial input to rural communities to be the primary benefit of gamebird shooting (Table 3.4). Along with the gamekeepers, they also believe gamebird shooting to be very important in maintaining social cohesiveness that's being lost from many rural communities. Loaders, beaters and pickers-up recognised the conservation benefits of gamebird shooting, but to a lesser extent than other focus groups:

> "Wildlife is better off on organised shoots; hunters are the greatest conservationists even though they are killing things." (*Beater*)

Shoot owners agreed that the sale of shooting was a huge economic benefit for rural communities, but in particular for themselves. However, shoot owners expressed the need to stress the wider benefits of gamebird shooting, rather than highlighting the revenue generated for the "wealthy landowner":

> "We need to emphasise that shoots provide employment for local labour. We need to make this a cause; that shooting helps employment, especially in difficult areas, and brings money into the rural community. Also, we need to emphasise the ecological benefits due to the environment being sympathetically managed because of the owner's great interest in field sports. These points show that there are more important factors than the economics of how many birds you release." (*Shoot owner*)

'Guns' believed the revenue generated in rural communities and conservation were both major benefits arising from gamebird shooting (Table 3.4). Indeed, several individuals commented that the future of gamebird shooting could be protected if the general public was made aware of the conservation benefits:

> "We can win the argument because we've got people on the ground managing the countryside and delivering in terms of biodiversity, whereas our opponents, like the RSPB, aren't delivering. If we force the argument through, it could help win the battle." (*'Gun'*)

3.3.5 Proactive Methods to Prevent a Ban on Gamebird Shooting

Table 3.5: Strength of feeling among four stakeholder groups on issues related to proactive methods to prevent a ban on gamebird shooting, based on focal group discussions.

Key issues	Gamekeepers	Loaders/beaters/ pickers-up	Shoot owners	Guns
Appealing to MPs	**	*		
Cooperation between shoot organisations		**		
Reducing bag size/ introducing regulation	**	***	**	**
Working on public relations			***	*
Emphasising benefits				**
Condemnation of bad practices			*	**

Symbols represent the degree of feeling on an issue, assessed as: * slight concern/agreement on an issue; ** moderate concern/agreement; *** strong concern/agreement

The gamekeepers felt that apathy was one of the biggest problems facing the future of gamebird shooting. They felt it important to convince politicians of the benefits of gamebird shooting and to show there was significant support for the sport. However, currently this rarely happens. Similarly, loaders, beaters and pickers-up thought it essential to write to MPs supporting country sports, and for all country sports to come together to support each other:

> "We need one voice for the whole of field sports. There are 5 to 6 million people active in country sports."(*Beater*)

The loaders, beaters and pickers-up also noted that the various organisations involved in gamebird shooting were not working together to protect its future (Table 3.5). In general, it was felt that the sport was not organised and that the arguments supporting gamebird shooting were expressed poorly:

> "On the media, those who are for shooting are waffling and don't have clear arguments whilst the *anti*'s are clued-up and sharp with their speeches. The people who put our arguments across are useless, meaning that we lose more ground than we gain. We may have to employ someone to speak for us because we are not being heard properly." (*Beater*)

For loaders, beaters and pickers-up, large bag days were of greatest concern when considering the future of gamebird shooting (Table 3.5), feeling a code of conduct was required to limit bag numbers making the sale of game meat more sustainable and gaining media acceptance.

The shoot owners' focus group discussion made a similar point:

> "Shooting has to have some kind of governing over itself to ensure self-control, proper levels- although the numbers are difficult to decide- self-regulation and a code of practice to try to stop the excesses."(*Shoot owner*)

Several shoot owners made reference to the need to alter those aspects of gamebird shooting that reflected badly on the sport, and that such an approach could help win future arguments when shooting is attacked:

> "Good housekeeping at home is important. The standards that we rate highly need to be upheld. We will have a lot of problems without this." (*Shoot owner*)

One shoot owner said, and most agreed, that although individuals often criticize bad practices they witnessed, few stand up in public to voice their disapproval.

Several shoot owners placed great importance on protecting the sport's future through winning the public relations battle (Table 3.5):

> "There is an important section of society that now own shoots, Madonna for example. They form public opinion, so we need to use these people effectively for the cause because the public listen to them." (*Shoot owner*)

A 'gun' voiced the same opinion, suggesting using famous people and television more effectively to emphasise the benefits of gamebird shooting. Like shoot owners', 'guns' expressed that changes to specific aspects of gamebird shooting were necessary to protect its future.

"We need to be proactive and take the initiative. Sadly, we need to recognise those who are bad for the sport. We need to self-regulate and be shown to condemn malpractice before the tabloids get in there." ('*Gun*')

Speaking out in condemnation of bad practices whilst promoting the positive aspects of gamebird shooting, particularly the benefits to conservation, were considered by several 'guns' as the best way to protect the future of the sport (Table 3.5).

3.3.6 Perceptions of the General Public

Table 3.6: Strength of feeling among four stakeholder groups on issues related to perceptions of the general public to gamebird shooting, based on focal group discussions.

Key issues	Gamekeepers	Loaders/beaters/ pickers-up	Shoot owners	Guns
Problems with recreational users of the countryside	***			
Education of the general public	**			
Limited access to the countryside (closed season)	***			
No interest in gamebird shooting		**	**	**
Little understanding of rural issues			**	*
Politics of envy ("what we don't have they can't have")			***	

Symbols represent the degree of feeling on an issue, assessed as: * slight concern/agreement on an issue; ** moderate concern/agreement; *** strong concern/agreement

When considering the general public, gamekeepers were strongly concerned with the effects of recreational visitors on rural areas (Table 3.6). They expressed concern at the increasing levels of access being granted to the public and the damage that high densities of visitors can cause. Some thought it would be possible to educate the public, encouraging the use of designated footpaths whilst promoting an interest in, and appreciation of, wildlife. All agreed that periods of limited access were essential, creating a closed season at crucial times to reduce disturbance of the most vulnerable species.

Loaders, beaters and pickers-up believed the general public has no interest in gamebird shooting (Table 3.6), and has limited access to reliable and unbiased information regarding the sport:

> "The public get their image of shooting from telly programmes, such as *Emmerdale*, and it gives a distorted view of shooting and what it takes to get a shoot going." (*Beater*)

Shoot owners agreed that the general public care little about gamebird shooting, and that those who are against gamebird shooting derive their objections from jealousy, a "what we can't have, you won't have" scenario. Shoot owners also felt the general public was not concerned with the problems facing rural communities or recognised the economic benefits generated for farmers from gamebird shooting but do care about the origins of their food:

> "The public perceive a bird that is shot as wild when compared to chickens in battery conditions. If we can get the public to eat pheasant, they'll be eating acceptable food." (*Shoot owners*)

Several shoot owners believed emphasising the production of meat rather than the sport of killing birds would make gamebird shooting more acceptable to the general public.

The 'guns' agreed that the general public care little about, and lacked sufficient information on, the subject of gamebird shooting:

> "Too few people in urban areas have experience of the countryside and the way it works. We're trying to communicate with the majority of the electorate who are divorced emotionally from the real value of the countryside." (*'Gun'*)

The 'guns' also thought it was futile trying to convert the public to supporting gamebird shooting as they had little influence on its future. Rather, it would be more effective spending limited resources (time and money) convincing those (such as MPs) who make decisions that affect the countryside.

3.3.7 Scope for Change

Table 3.7: Strength of feeling among four stakeholder groups on issues related to scope for change within gamebird shooting, based on focal group discussions.

Key issues	Gamekeepers	Loaders/beaters/ pickers-up	Shoot owners	Guns
Reducing bag size	***			
Gamekeepers changing job from rearing to conservation	**			*
Guns not willing to change	**	**		
Guns accepting smaller bags	*	*	**	**
Shoot owners willing to change			**	

Symbols represent the degree of feeling on an issue, assessed as: * slight concern/agreement on an issue; ** moderate concern/agreement; *** strong concern/agreement

The gamekeepers thought it possible to preserve gamebird shooting in the future if each shoot was managed in a more responsible manner (Table 3.7):

> "All shoots could survive by all carrying on rearing but rearing less and shooting less per day. That way, most jobs would stay intact." (*Gamekeeper*)

Most agreed they would alter their jobs from rearing gamebirds to managing the environment to encourage wild gamebirds, if it meant keeping their jobs (Table 3.7), that spending time conserving the environment was preferable to being on the rearing field. However, the gamekeepers were divided on the scope for change amongst those who purchase gamebird shooting. Some felt that those who bought shooting could be taught that quality shoots are about more than bag size, whilst others thought there was little scope for changing the attitudes of 'guns' as they were paying for a specific bag size, and that is what they (the 'guns') consider important on a days' shooting.

Loaders, beaters and pickers-up agreed with the gamekeepers with regards scope for change amongst 'guns' (Table 3.7). Both acknowledged that some 'guns' are responsible and would follow a code of conduct if it would benefit the future of gamebird shooting. However, those interested in purchasing large bag days would not consider purchasing smaller bags even to ensure the future of gamebird shooting:

"There are two types of people: the discerning shooter and the others that don't know much at all, that cannot identify wildlife, and so on. They're the ones dragging the sport down. When shooting is finished, they'll put all their money into something else." (*Beater*)

Shoot owners voiced differing opinions on the scope for changing those who purchased gamebird shooting. Some thought 'guns' would accept limited bag sizes and continue to purchase gamebird shooting in Britain:

"It is encouraging that the shooting fraternity is starting to take all this seriously. We need to put the pressure on for good behaviour and lack of excess. It's a matter of education but there is room for flexibility." (*Shoot owner*)

The high rate of exchange makes shooting in Britain particularly expensive for foreigners. However, several shoot owners believed foreign 'guns' would continue to visit, even if all British gamebird shoots imposed limited bag sizes. The quality, prestige and tradition of British shoots would persuade foreigners to continue purchasing shooting in this country.

Some shoot owners said it was vital that shoot owners encouraged good practice and it was generally agreed there was room for flexibility amongst their own stakeholder group:

"We want to preserve shooting. Therefore, we have a responsibility to influence our own shoots and those of our neighbours and to deal with excesses." (*Shoot owner*)

Several 'guns' said they would buy shoot days with smaller bags, particularly if consisting of high quality birds, referring again to birds with the 'X factor'. Many emphasised that a quality days shooting was not related to bag size, but to memorable birds, beautiful countryside, and the camaraderie of shooting with like-minded people. Many 'guns' also felt that the majority of shoot purchasers would pay more to shoot on an estate that was managed to conserve biodiversity if they believed it would protect the future of gamebird shooting[5].

3.4 Discussion

There has been little previous work on the attitudes of stakeholders towards current gamebird shooting practices, their opinions on self-regulation, or the scope for change. The focus group meetings were successful in exploring the social attitudes of stakeholders involved in gamebird shooting. All issues of interest were covered during each focus group meeting and the researchers felt the groups expressed their true opinions. All the individuals who attended were eager to participate and spoke freely and enthusiastically. Likewise, Oreszczyn and Lane (2000) noted that any apprehension felt by individuals at the start of the meetings dissipated once discussion started, shown by "the way they became 'lost' in conversation" indicating "honesty in their responses".

The stream of discussion meant there was little need for moderator intervention to maintain the flow of conversation, although calculated comments at key moments explored areas of interest as they arose. Utilising the pre-prepared prompt sheet and, as advocated by David and Sutton (2004), the moderator also introduced new subjects in a carefully controlled manner so conversation was not disrupted. This guaranteed all areas of interest were discussed. Therefore, the free-flow of discussion that is characteristic of unstructured focus groups was desired and attained.

The enthusiasm to participate in the focus groups probably arose for two reasons: (1) all stakeholder groups are passionate about gamebird shooting; and, (2) rarely are they given the opportunity to express their thoughts or concerns in a formal forum. Similar findings occurred in another study on the attitudes of different stakeholders towards hedgerows: individuals can have a "strong desire to have a voice", particularly if those individuals feel their views are generally under-represented (Oreszczyn and Lane, 2000).

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[5] This is investigated in Chapter 8.

It was more difficult to arrange the meeting for shoot owners and 'guns', although the number who eventually came to each was more than was expected. Many made extensive arrangements to be there, including several individuals who had travelled from other countries. Of those unable to attend, several expressed regret at not being able to participate in what they felt was an extremely important exercise.

The focus group meetings were a successful exploratory exercise as they allowed stakeholders to express their opinions on issues relating to gamebird shooting in a format that provided a thorough understanding of how these four groups felt about the subject.

3.4.1 Divisions between stakeholder groups

The four focus group meetings highlighted differences of opinion with what each group considered as most important among the various issues discussed (Tables 3.1 to 3.7), a result of the "role" each stakeholder has in both gamebird shooting and the rural community. Divergence in opinions may cause significant problems should the industry try to introduce self-regulation, as it may be difficult to deliver resolutions on each issue that are acceptable to at all levels of the sport.

Different stakeholder groups define the purpose of a policy in a unique manner, as each has their own interests and values; it is these differences that can cause conflict (Abma, 2000). Hence, stakeholder cooperation is crucial for programmes to be successful (Sautter and Leisen, 1999), although there is often unequal consideration of the opinions of particular stakeholder groups (Sundberg, 2003). When constructing policy for new management regimes, the attitudes of all stakeholder groups need equal consideration. Although rarely done in the past, such exercises are now recognised as fundamental to the success of any scheme, particularly within conservation (Little, 1994; Metcalfe, 1994).

Traditionally, conservationists have held sway, if not total influence, over the design of conservation policy. This in turn can often result in severe conflict between these policy makers and other stakeholder groups. Such a situation occurred in Scotland where conflict occurred between landowners, local residents and conservationists concerning the designation of nature conservation sites (Johnston and Soulsby, 2006). Interviews conducted with the landowners and local residents highlighted the doubts that many now hold in the value of scientific knowledge as the primary source of information when constructing conservation policy. Similar disregard for other stakeholder knowledge and opinions was found in the views of farmers and local residents on the subject of conservation schemes (Harrison *et al,* 1998). This study highlighted the importance of local knowledge, including that of both farmers and residents, but found that both groups felt their knowledge was overlooked by conservationists when constructing policy. Other studies have also highlighted the tendency of scientists to ignore the knowledge and opinions of other stakeholders when developing conservation policies (Clark and Murdoch, 1997; Oreszczyn and Lane, 2000). Therefore it appears imperative that local knowledge is considered as an important source of information when establishing conservation schemes and that it was vital for all stakeholder groups to be consulted if such projects are to be successful.

Many studies have highlighted that lack of consideration between stakeholder groups can lead to conflict that can ultimately jeopardise the success of the scheme. Therefore, inclusionary stakeholder participation is necessary to tackle these conflicts and identifying the source of the conflict and what stakeholders expected is fundamental to resolving the problems (Niemela *et al*, 2005).

Misunderstanding and conflict between stakeholder groups involved in gamebird shooting and other countryside sports is not a new phenomenon. Such conflict was the reason why gamekeepers created their own representative organisation (National Gamekeepers Organisation, NGO) in 1997. Five former members of the British Association for Shooting and Conservation (BASC) felt their views were under-represented, resented the lack of understanding for their jobs, and became disillusioned with the level of consideration afforded them. BASC was originally formed, in part, by a gamekeeper organisation: the Gamekeepers Association, originally formed in 1900, and the Wildfowlers Association of Great Britain and Ireland (WAGBI), formed in 1908, joined forces in 1975 to create what later became BASC (Evans, 1992). Therefore, BASC was formed in such a manner that meant a significant proportion of its members would have been gamekeepers. Gamekeepers felt they were poorly represented by BASC, which started to concentrate on the much larger group of individuals who are primarily interested in recreational shooting (Charles Nodder, Press Secretary for the NGO, personal communication). Similarly, in March 2005, the National Organisation of Beaters and Pickers Up (NOBS) was created after the founding members felt the needs of this stakeholder group were not being met by shoot organisations, despite asking many for assistance.

Historically, the majority of those living in villages were farm labourers, which meant the local landowner was their employer (see Section 1.3.5), producing potential for conflict and a situation of "them and us" (Horn, 1980; Newby, 1985). Many landowners live isolated in their country house away from the village, reinforcing the "rigid social hierarchy" within rural communities and the conflict between these two groups (Newby, 1985).

Traditionally, those visiting shoots were themselves shoot owners, so their attitude towards the other stakeholder groups would have stemmed from this primary role. Today, some who purchase gamebird shooting will own their own shoots and will have been introduced to shooting at a young age (Martin, 1987). As such, these individuals often have in-depth knowledge of shooting and their attitudes will have developed through their lifetime of involvement. Those with little prior knowledge of gamebird shooting, usually introduced to it as adults, may develop attitudes towards different aspects of gamebird shooting based on those with whom they share experiences of the sport.

Gamekeepers, employed by the shoot owner, historically experienced a similar relationship with their employer as farm labourers (Martin, 1990). However, gamekeepers were, and are, housed within tied cottages on the estate, separating them from the farm labourers in the village. Furthermore, on shoot days, gamekeepers were afforded authority over farm labourers, who took on the role of loader, beater or picker-up (Martin, 1987). Although gamekeepers were involved in village life, there was always a degree of division between them and other employees. This was heightened during the 18th and 19th centuries, when many farm labourers were involved in poaching on their employers' properties, putting these two stakeholder groups into direct, and sometimes fatal, conflict. Unsurprisingly, this situation made gamekeepers extremely unpopular within rural communities (Trench, 1967; Horn, 1980; Munsche, 1981).

Today, this conflict is still apparent, although to a lesser extent as poaching is no longer prevalent and many farm labourers are permitted access to land, particularly for rabbit and pigeon shooting. In addition, most loaders, beaters and pickers-up no longer work as farm labourers, instead making a conscious decision to work on shoots. Gamekeepers have also experienced significant loss of status as abolition of the "qualification" system means anyone with a licence can now shoot, not just a few select individuals and their gamekeepers (Trench, 1967). In addition, gamekeepers also lost power to enforce the law, creating a more equal balance of power, and reducing the conflict between the two groups.

3.4.2 Bag sizes on gamebird shoots

Individuals within all stakeholder groups expressed concern with the size of bags on many gamebird shoots (Table 3.1), and the general consensus was that shoots offering large bags had no future. Only the gamekeepers voiced unease about the negative effects of high densities of gamebirds on conservation (Table 3.1). Often discussed within shooting circles, it is acknowledged that the primary areas of gamebird release, in and around pens, can experience localised damage (McKelvie, 1991). Stocking densities higher than those recommended have been shown to result in changes to soil structure, vegetation structure and plant species composition in the woodland around release pens (Sage *et al*, 2005). Gamekeepers visit them on a daily basis whilst other stakeholder groups rarely observe the pens, so it is not surprising the gamekeepers highlighted such problems.

Except gamekeepers, all the other stakeholder groups noted some positive aspects to large bags (Table 3.1). 'Guns' and loaders, beaters and pickers-up, expressed an enjoyment factor. This is not unexpected as: beaters have a more interesting day if there are plenty of gamebirds to flush out of cover; loaders are kept busy reloading and seeing 'guns' taking large numbers of shots; pickers-up are busy picking up fallen birds and working their dogs; and, for some 'guns', taking shots at many gamebirds determines whether they enjoy the day.

Some shoot owners believed the revenue generated was a key benefit of large bag days (Table 3.1). The price of a shoot is quoted as "per bird" (Martin, 1987). Although the price per bird may be less for larger days, the greater number of birds generally means that larger bag days are sold for more than smaller bag days. In order to cover the costs of running a gamebird shoot, shoot owners often need to provide a large bag to generate sufficient income, otherwise it would be too expensive to produce.

Differing opinions over large bag sizes amongst shoot owners was most likely due to the various types of shoots that each discussant owned. Those who own small, and/or non-commercial shoots tend to dislike large bag shoots, seeing them as cruel and distasteful, or responsible for portraying the sport in a poor light that could eventually result in a total ban on shooting.

3.4.3 Commercialisation of Gamebird Shooting

All four stakeholder groups agreed that the commercialisation of gamebird shooting was important to shoot owners (Table 3.2), providing alternative income for landowners who are struggling financially due to declining farming incomes: "during the last decade, the UK agricultural sector suffered significant problems" and "from the mid-1990s, much of the profitability has drained from the industry" (Convery *et al*, 2005). Pressures, such as unfavourable exchange rates, decreases in world prices for produce and reform of the CAP, have all worked against farmers. Between 1995 and 2001, total farming income was estimated to have fallen by 62% (Lobley and Potter, 2004).

Recently, landowners have recognised the need to diversify if they are to continue to live off the land (Lobley and Potter, 2004). Government grants, such as the Rural Enterprise Scheme (RES), are available to assist farmers in adapting to change in the agricultural world and many have accepted the challenge of generating more diverse sources of incomes from alternative activities (Walford, 2003), which can approve critical in preventing landowners from having to sell their farms (Shucksmith and Herrmann, 2002; Walford, 2003; Lobley and Potter, 2004). Diversification can take many forms, although landowners often want to maintain the character and ambiance of their farm; gamebird shooting integrates well with agriculture (Howard and Carroll, 2001; Stoate, 2002), as well as with wider conservation concerns (Oldfield *et al*, 2003).

Gamekeepers and loaders, beaters and pickers-up repeatedly cited their strength of feeling over how the commercialisation of gamebird shooting was vital for rural communities (Table 3.2), probably because these individuals are integral parts of rural communities. While some who purchase shooting also live in rural communities, many live either in urban areas, or abroad. Some shoot owners live on their estate, often set apart from the main rural community (see section 1.3.5). Furthermore, many have more than one home, residing in urban areas for much of the year (Martin, 1987). Those who are removed from the rural community may be less aware of the wider positive impacts of gamebird shooting.

Some shoot owners voiced concerns regarding commercialisation of gamebird shooting, believing greed was pushing gamebird shooting towards undesirable practices (Table 3.2). As with bag size, those who owned small or non-commercial shoots tended to disapprove of commercialisation of gamebird shooting. Commercial shoot owners may be tempted to undertake unacceptable practices to maximise profits, which can reflect badly on non-commercial shoots. Some shoot owners were annoyed that those who adopt negative practices benefited financially and would not change their ways even if it meant the demise of gamebird shooting. Such individuals were viewed as businessmen, often with little experience of country ways, who have bought into landowning and gamebird shooting as an investment. It was felt these individuals lacked understanding of the land and gamebird shooting compared to those who have grown up in the countryside and have a lifetime's affiliation with the sport. The comments suggested that those with a long association with gamebird shooting are more willing to do anything required to prevent it from being banned in the future.

Little was said by 'guns' on the issue of commercialisation (Table 3.2) with comments reflecting their position: commercialisation provided those who did not own a gamebird shoot with the opportunity to purchase a day's shooting. 'Guns' did mention commercialisation and price. Some believed gamebird shooting in Britain was expensive while others thought the quality justified the prices.

Individuals who pay for a day's gamebird shooting provide important income that keeps the sport running. Should 'guns' decide to no longer buy shooting, a significant portion of gamebird shoots would cease to operate. Therefore, the attitudes of shoot purchasers towards the price they currently pay, and their future willingness to pay, for gamebird shooting is investigated later in this study (Chapter 8).

3.4.4 The rearing of gamebirds

Gamekeepers were the only stakeholder group who said they would accept the situation if gamebird rearing was banned (Table 3.3). They agreed re-focusing their jobs for a wild shoot was preferable to that on a highly commercial shoot with an intensive rearing programme, which is often less satisfying and more stressful as emphasis is placed on rearing large numbers and guaranteeing the 'guns' big bags.

Gamekeepers stated a lack of regulations as permitting unacceptable practices within game rearing. However, there is a code of conduct relating to game rearing: 'The Code of Good Game Rearing Practice', originally produced by BASC, GCT and the Game Farmers' Association. That members of the gamekeeper's focus group were unaware of this code suggests its availability has been poorly publicised. Originally produced without their help, the NGO now supports the code. However, various organisations are involved in producing different codes relating to the various aspects of gamebird shooting, each reflecting the different areas of gamebird shooting with which the organisation is concerned. In addition, not all have been involved with constructing each code, resulting in inconsistencies between codes that's caused confusion. It would be more effective for all major shoot organisations to be involved with producing a single new code, focusing on all areas of game rearing and shooting, and concentrating on those aspects considered as susceptible to unacceptable practices. It would have to be widely publicised, with all stakeholders encouraged to accept the standards it promotes.

The husbandry aspect of gamebird rearing was of interest to loaders, beaters and pickers-up (Table 3.3). This group felt rearing chicks, rather than purchasing poults, encouraged a more responsible attitude amongst gamekeepers and prompted good husbandry. There was concern that many gamekeepers kept bought-in poults in poorer conditions compared with those for chicks reared from eggs as lost poults can be replaced easily. Thus, purchasing more poults should a significant number die prior to the shooting season does not promote conscientious care of birds. Gamekeepers will often order more poults than necessary, pre-empting the loss of any gamebirds before release[6] as the gamekeeper does not need to expend any further effort, since birds can be stocked at higher densities (promoting the outbreak and spread of disease). By rearing from eggs or day old chicks, the effort required increases with the number of birds reared. Therefore, a gamekeeper is unlikely to rear a large excess of chicks, instead relying on good husbandry to ensure acceptable survival rates.

Shoot owners had little to say about rearing (Table 3.3), indicating a degree of detachment from a practice that they rarely observe. Rearing pens tend to be sited away from the main areas of agricultural activity to prevent high levels of disturbance. If possible, they are also kept away from footpaths and roads to avoid curiosity from the general public, which means only the gamekeeper regularly encounters release pens.

'Guns' thought rearing gamebirds was acceptable (Table 3.3), no different from rearing domestic livestock. The majority of gamebird shoots depend on reared gamebirds to provide the stock that is to be shot, and shoots with large bags are particularly reliant on this practice. As most shoot purchasers buy reared or mixed shooting, it is not surprising they find gamebird rearing an acceptable pracice.

'Guns' voiced concern over the general public's perception of rearing gamebirds to be shot (Table 3.3). Responsible for killing gamebirds, and seen to inflict suffering

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6 The loss of some birds prior to the shooting season is inevitable, primarily from predation but also through straying, disease and road kills. Predators, such as foxes, raptors and badgers, can be especially effective at killing a number of birds in release pens. The threat of such an event encourages many gamekeepers to buy more poults than the shoot owner requests, to compensate for any losses that may occur.

and paying for the privilege, it is expected that 'guns' would feel strongly about this issue and it is understandable why they would expressed concern over this issue while the other stakeholder groups did not voice an opinion.

3.4.5 The benefits of gamebird shooting

The stakeholder groups were unanimous in that gamebird shooting was of significant benefit to the conservation of the British countryside (Table 3.4). It is understood by those closely associated with the British countryside that it is a highly managed environment. The book *Future Nature* notes that "most ecosystems in Britain are influenced by people to such a profound degree that it is reasonable to say that they are *made* by man" (Evans, 1997). This is especially true of lowland regions, which have historically experienced the highest levels of human activity; centuries of farming have manipulated the British countryside, forming an ecology that is intimately associated with traditional agricultural and sporting practices (Fry, 1991; Green and Burnham, 1992; Krebs *et al*, 1999). However, modern farming methods have had a significant and negative impact on biodiversity (see Section 1.2.3; O'Connor and Shrubb, 1986; Sotherton, 1998; Chamberlain *et al*, 1999). In addition, the loss of traditional rural practices, such as coppicing, conventional hay-cutting, burning, and stocking densities in many areas has increased the problem of biodiversity loss (Fry, 1991; Hill *et al*, 1996). Indeed, scientists wishing to undertake conservation of the British countryside following World War II, had to "work to maintain (and even recover) artisanal techniques and rural work regimes in order to maintain nature in desired patterns" (Adams 1997a).

All stakeholders extolled the benefits that management for gamebird shooting has on the countryside (Table 3.4), which often includes traditional techniques that provide benefits for wider wildlife (McKelvie, 1991). Indeed, "country sports contribute significantly to the conservation and creation of countryside features" (Cobham, 1993) due to the vast sums of money invested in habitat management each year to enhance the quality of the gamebird shoot (The Game Conservancy Trust, 1997). Habitat creation, woodland and field boundary management, provision of game crops and supplementary feed, along with predator control, are common aspects of land management regimes on shooting estates (Hoodless *et al*, 1999; Stoate, 2002;

Draycott, 2004) that provide significant benefits for wider wildlife (Hill and Robertson, 1988; McKelvie, 1991; Stoate and Szczur, 2001). Landowners involved in gamebird shooting, as well as other country sports, have been shown to be more inclined to create and manage woodlands and hedgerows (Oldfield *et al*, 2003). The stakeholders strongly felt that incentives to invest in such conservation-orientated regimes stem directly from the desire to benefit the quarry of interest. To restrict, or even ban, gamebird shooting would bring to an end many of these management regimes and, with it the wider benefits for conservation of the British countryside.

All stakeholders agreed that gamebird shooting is of huge economic benefit to shoot owners (Table 3.4), who at present are experiencing significant financial problems within agriculture (Section 3.4.3). Economic benefits for rural communities were also recognised, although this point was most strongly noted by gamekeepers and loaders, beaters and pickers-up (Table 3.4), presumably because they are a more intricate part of the rural community so have greater understanding of the wider economic value of gamebird shooting (Section 3.4.3). Approximately 60,000 jobs are indirectly supported by the economic activity that country sports generate (Cobham, 1993). Indirect expenditure (which excludes the sale of shoot days) on gamebird shooting and deer stalking generated approximately £251 million in 1994, covering revenue produced in areas such as public houses and hotels, animal feed and veterinary practices, butchers and specialist clothing (Cobham Resource Consultants, 1997).

Gamekeepers and loaders, beaters and pickers-up also allied gamebird shooting to the more complex issue of community cohesiveness. Following World War II, significant changes have occurred in rural communities, primarily due to the loss of jobs in agriculture. Lack of opportunities and increasing poverty meant many had to leave for towns and cities (Newby, 1985; Cobham Resource Council, 1997; Hodge and Monk, 2004). This migration of rural people has been exacerbated by increasing house prices and a reduction in rented and council properties (Shucksmith, 1991), meaning many cannot afford houses, especially when competing with more wealthy urban dwellers buying second homes (Newby, 1985). Therefore, "many rural areas are becoming increasingly exclusive, in the sense that only better-off people can afford to live there" (Shucksmith, 2000), which has altered the structure of the village community (Newby, 1985).

Many individuals, particularly those from traditionally local families and the old suffer significant social disadvantages through the loss of rural services, lack of mobility through poor transport links, and social isolation (Higgs and White, 2000). New families coming into rural communities tend not to utilise such services meaning local councils find it hard to justify the expense. During the 1990's, 40% of English villages lacked a post office or shop, 75% did not have a regular bus service and many village schools were closed (Higgs and White, 2000), significantly impacting on the standard of living of many within rural communities, and greatly affecting social cohesiveness. Significant proportions of rural populations are disadvantaged but are not identified because "inequalities are obscured by an uncritical notion of consensual, idyllic rural communities" (Shucksmith, 2000).

The loss of the traditional country way of life in Britain has been likened to that suffered by ethnic minorities such as the Bushmen of the Central Kalahari or the Aborigines of Australia (Cobham, 1993), with political, economic and social forces combining to erode their traditions and cultures. Gamekeepers and loaders, beaters and pickers-up saw gamebird shoots as a vital feature of the rural experience, continuing a tradition in rural community life from which many other traditions are being lost (Table 3.4). Indeed, "countryside sports contribute an element of stability to the structure of rural communities at a time of major change" (Cobham Resource Consultants, 1997). The local gamebird shoot provides a focus for the traditional local community and forging bonds as they work at a common task on shoot days.

3.4.6 Proactive approaches to prevent a ban of gamebird shooting

Gamekeepers, and loaders, beaters and pickers-up felt writing to politicians highlighting the benefits of gamebird shooting could be an effective way to help protect its future (Table 3.5). Inviting politicians to well-managed shooting estates throughout the year was seen as a way of highlighting the management and subsequent conservation benefits.

Loaders, beaters and pickers-up also expressed a need for representative organisations associated with gamebird shooting to unite in protecting its future (Table 3.5). At present, certain organisations are failing to take into consideration the views of all stakeholders or those of other organisations when producing new policy or identifying issues on which to campaign (see Section 3.4.1) resulting in conflict (pers. comm., Charles Nodder, press secretary for the NGO). It is vital that all organisations agree on all aspects of gamebird shooting, as disunited stakeholders will be open to criticism by those wishing the ban the sport. As a shooting enthusiast noted: "Provided we present a united front, we are a strong political force able to exercise a lobby which can ensure that our sports remain part of the way of life of the countryside" (Greenwood, 1993).

Self-regulation to prevent bad practices in gamebird shooting, implemented through codes of conduct, was highlighted by loaders, beaters and pickers-up, shoot owners and 'guns' as important. A code of conduct for shooting (The Code of Good Shooting Practice) currently receives support from all the major organisations involved in gamebird shooting, although the extent to which it is read and followed is not known. Many agree that The Code of Good Shooting Practice should be adhered to; indeed, "any departure from those standards into bad practice should be identified and steps taken to ensure compliance. Peer pressure is always effective" (Pym, 1993).

There was concern that self-regulation would mean only those who wished to protect the future of gamebird shooting would adopt new practices. In contrast, those interested in maximising short-term profits on their commercial shoots, would continue to shoot excessively large bags or refuse to alter their jobs to a more acceptable format, bringing the whole sport into disrepute. Shoot owners noted that, when individuals witness practices they deem unacceptable on visits to other shoots, seldom do they protest (Table 3.5) as they feel it necessary to display a united front and not draw attention to the negative aspects of gamebird shooting. However, for self-regulation to work, stakeholders will have to hold those who undertake unacceptable practices accountable for their actions, highlighting the problem and working to solve it. Some recognised that neglecting to deal with these situations could, ultimately, result in gamebird shooting suffering a similar fate to hunting with hounds.

3.4.7 The perceptions of the general public

There was unanimous agreement among the four stakeholder groups that the general public is ignorant on the subject of gamebird shooting (Table 3.6), lacking interest and with little access to reliable, balanced and instructive information, which was exacerbating the problem (Table 3.6). As a result, the general public have little chance to formulate an informed and balanced opinion. The primary source of information circulated to the general public is from welfare organisations, which highlights the cruelty aspects with a view to enforcing a ban, either total or of specific aspects such as the numbers currently being reared and released, and the methods used for rearing.

Most gamekeepers were concerned with the degree of access to the countryside granted to the general public (Table 3.6) as high densities of walkers can inflict considerable damage to rural areas (Bayfield, 1971; Streeter, 1971). Recreational users of the countryside tend to ramble over open areas rather than sticking to paths and roads (Green, 1981). Most in the gamekeepers' focus group had witnessed the subsequent damage that had affected the quality of the habitat. Gamekeepers felt their efforts to promote biodiversity conservation on gamebird shoots would be pointless if the general public have the right to roam wherever they choose. Many thought the public's lack of understanding was responsible for causing damage (Table 3.6) and some felt it possible to explain to the public the consequences of their actions on the habitats they used for recreation.

Gamekeepers also thought that a "closed season" for the countryside, a time when the general public had limited access to specific areas, could protect wildlife when at it was most vulnerable (Table 3.6). Reference was made to the restricted access that occurred during the FMD outbreak, and the benefits this had on the breeding success on various ground nesting birds (Robertson *et al*, 2001) and the altered behaviour and distribution of many mammal species (Hearn, 2001). These changes would have been temporary, but suggest there is potential for significant benefits to wildlife by restricting public access to rural areas. However, a closed season is unlikely to be acceptable to the majority of the general public, now that right to roam legislation has been approved by Parliament (Countryside and Rights of Way Act 2000). Education of the public on the effects of their actions on the countryside is probably the most reasonable solution to this problem.

Should a solution to the problem of public impact on natural habitats not be forthcoming, many gamekeepers stated they would stop the beneficial land management, which in turn could result in the conservation benefits no longer remaining a viable argument for protecting the future of gamebird shooting.

Two stakeholder groups suggested that might tolerate gamebird shooting if the production of meat was emphasised (Table 3.6). Shoot owners in particular voiced the belief that gamebirds shot in the wild might be seen as a more preferable source of meat than poultry reared under battery conditions. At present, the majority of gamebirds shot in Britain are exported abroad and few members of the general public purchase game meat as it tends to be expensive in comparison to chicken and is unfamiliar to many (McKelvie, 1991).

3.4.8 The scope for change

All stakeholder groups acknowledged that the rearing of gamebirds, particularly in large numbers, would be a principal area of attack from those opposed to shooting (Table 3.7), producing a clear need to limit the numbers of gamebirds being reared and released. Gamekeepers were willing to alter the structure of their job from one of primarily rearing gamebirds to that of habitat manager, as the alternative could see them without a job and, for many, the loss of their tied house. As gamekeepers produce the gamebirds that are shot, whether reared or wild, successful changes in gamebird shooting requires the cooperation of gamekeepers.

Loaders, beaters and pickers-up felt the majority of 'guns' would not willingly change, instead leaving gamebird shooting in favour of a different pursuit if large bags were no longer available. This contrasted with the views that 'guns' held of themselves (Table 3.7), who acknowledged that their group would probably be divided on issues such as purchasing smaller bags, but they were of the opinion that many, particularly those who have been around gamebird shooting from an early age, would accept shooting smaller bags if it meant guaranteeing the future of their sport. Shoot purchasers provide the financial input that keeps most gamebird shoots functioning, meaning the future of gamebird shooting is dependent on their willingness to continue buying days, irrespective of the form that gamebird shooting may take. The willingness-to-pay study (Chapter 8) investigates this issue further.

Loaders, beaters and pickers-up did not express any thoughts on their own willingness to change to protect the future of gamebird shooting (Table 3.7), which in turn emphasised their own position within the "hierarchy" of the sport. Although vital in ensuring that driven shoot days function successfully, loaders, beaters and pickers-up have little influence over the day or the structure of the shoot as a whole. Their concerns, thoughts and preferences are rarely taken into account by shoot owners and gamekeepers despite any changes affecting this stakeholder group. However, the formation of NOBS in 2005 shows that members of this stakeholder group are becoming more active in voicing their views and have recognised their importance in creating driven shoot days; as their webpage states "without 'us' there wouldn't be much shooting!" (www.nobs.org.uk).

Shoot owners acknowledged that it was their responsibility to instigate necessary changes to the sport (Table 3.7). Some felt it important for shoot owners and managers to encourage best practice, and not allow 'guns' to dictate factors such as bag size. A complete ban on gamebird shooting would see many shoot owners lose a valuable, and often essential, form of income and the demise of a traditional way of life. This threat may be adequate in persuading the majority of shoot owners to adopt a more responsible management regime for their gamebird shoots.

3.4.9 Overall Conclusions

The attitudes, thoughts and concerns expressed by gamekeepers during the focus group discussion were predominantly centred on how future changes would affect them on a personal level. This was not surprising as gamekeepers are intimately associated with the regime on their shoot in terms of the structure of their job.

Furthermore, gamekeepers are reliant on the sport for their livelihood and tied housing, and so are fundamental to implementing a new regime. As expected, they accepted the need to change gamebird shooting as a whole and expressed a willingness to accept these changes to ensure its future. Changing the future structure of gamebird shooting will rely on gamekeepers accepting a new regime and on their ability to successfully implement it.

Loaders, beaters and pickers-up were primarily concerned with how gamebird shooting affected rural communities, most likely because this relates directly to their rural way of life. This group held a particularly strong opinion that, with some exceptions, those who purchased gamebird shooting would be unwilling to change, even to protect the future of their sport (Table 3.7). In contrast, the 'guns' themselves expressed a willingness to change the type of shooting they bought. However, while 'guns' were generally thought intractable by the loaders, beaters and pickers-up, 'guns' themselves did not mention the likely views of loaders, beaters and pickers-up during their focus group discussion. This was also true of the shoot owners, and illustrates the lack of consideration and the level of misunderstanding between stakeholder groups. Such conflicts have occurred since gamebird shooting began (Section 1.3.5), and which still seem to continue due to a lack of communication between different stakeholder groups.

The focus group discussions also highlighted that shoot owners and 'guns' generally fall into two distinct categories: (1) those who have a long association with gamebird shooting, which results in greater willingness to accept future changes to the sport in a bid to see it continue; and (2) those who have become involved with gamebird shooting at a later stage in life, becoming shoot owners because it is a profitable investment, or shoot purchasers because it is a prestigious and fashionable sport with which to be involved. Stakeholders in this second category would appear to be more willing to move on from the sport if it changes to their dissatisfaction.

The opinions of shoot owners centred on how the various issues related to their own gamebird shoots. This was expected, as any changes to the regime will primarily affect their business, their investment, and their way of life. Although the various aspects discussed can influence the other three stakeholder groups on a fundamental level, shoot owners expressed little, if any, consideration for these individuals, highlighted by their lack of reflection on the scope for change within the other stakeholder groups. This indicates the position of power held by shoot owners. Gamekeepers are their employees, and although shoot owners may value their opinion and appreciate their work, shoot owners ultimately make the decisions that affect their shoot. Most shoot owners expressed willingness to change their gamebird shoot if it would protect its future, regardless of the opinions of 'guns'. Indeed, shoot owners felt this stakeholder group would have to accept change if it was thrust upon them. As mentioned, at no point did shoot owners mention the concerns of loaders, beaters and pickers-up, indicating the lack of contact between these two stakeholder groups. Thus, gamekeepers arrange and manage the team of loaders, beaters and pickers-up for shoot days, so it is not surprising shoot owners have little, or no, consideration of the opinions of this stakeholder group.

'Guns' remain the most influential stakeholder group in terms of determining the current extent, and continuation, of gamebird shooting, as it is the purchase of shoot days that primarily funds the sport. 'Guns' expressed a widespread view of gamebird shooting and its related issues, yet showed little concern for the views of gamekeepers and loaders, beaters and pickers-up. This divide between stakeholder groups is a trend that keeps re-emerging, and this will affect attempts to protect the future of gamebird shooting. Despite such misunderstandings, all stakeholder groups were in agreement that the future of gamebird shooting was under threat and, in light of what has happened to hunting with hounds, recognised a need to be proactive in protecting the future of their sport.

The following chapters cover some of the issues raised in the focus group discussions: the costs of running a commercial gamebird shoot and of implementing an AES and additional land management with the purpose of increasing wild gamebird populations (and with the potential to produce significant benefits for wider wildlife) will be examined in Chapter 4; the scope for decreasing the number of gamebirds reared and releases on a commercial shoot as a result of increasing wild gamebird productivity will be examined in Chapter 5; the wider conservation benefits generated by gamebird management will be examined in Chapters 6 and 7;

the possible economic consequences of a ban on the releasing of reared gamebirds in the future will be examined in Chapter 8.

Chapter 4
Land Management on Shooting Estates in Lowland Britain

4.1 Introduction

Several interrelated factors have prompted the intensification of agricultural practices in Britain over the last 60 years (Chapter 1). The result was a surplus of food costing the government large sums of money to purchase and store, as agreed through the Common Agricultural Policy (CAP), and an associated decline of wildlife biodiversity in increasingly agrarian habitats (Krebs *et al*, 1999; Donald *et al*, 2002). Although CAP was originally designed, in part, to improve the financial circumstances of agricultural workers, the annual income of farmers has declined by between 2.5% and 2.8% since 1975 (Donald *et al*, 2002). Reform of the CAP followed as a result of pressure to combat the growing surplus of food and to resolve the increasing conservation crisis. For the most part, this failed, as remaining CAP payments continued to encourage intensive farming, which in turn dissuaded most farmers from adopting higher-tier agri-environment schemes (AESs) (Dobbs and Pretty, 2001).

Landowners are often regarded as custodians of the British countryside (Morris *et al*, 2000), responsible for maintaining biodiversity and enhancing the quality of rural areas for public access and enjoyment, all while cultivating the land and making it productive (Gilg and Kelly, 1997; Macdonald and Johnson, 2000). Reform of the CAP to make farming less intensive and initiate conservation benefits and to develop AESs, coupled with the prerequisite that farmers meet targets for cross-compliance conditions, all combine to emphasise the view that farmers are thought largely responsible for the conservation and preservation of agrarian wildlife and landscape features (Ovenden *et al*, 1998; Pacini *et al*, 2004). Indeed, given that *c.* 75% of Britain remains devoted to countryside, and that the majority of this is arable land, there is significant potential for the involvement of landowners in wildlife conservation on a large scale (Evans, 1992; Sheail, 1995; Gregory and Baillie, 1998; Macdonald and Johnson, 2000).

Conservation within agricultural habitats of Britain differs from that of the developing world in that it requires a degree of intervention and a certain level of management (Green, 1981; Kleijn and Báldi, 2005). Indeed, "most of the beauty and biodiversity of landscapes in the UK and elsewhere in continental Europe depends on the continuation of active farming. It is restoration or maintenance of a certain kind of farming that is desired in Europe, not the kind of extensification that would amount to abandonment of farming" (Dobbs and Pretty, 2001). This contrasts with the conservation of primary habitats in many areas of the world that rely predominantly on the exclusion of man and his activities (Sutherland, 2004).

The management regimes of the agricultural areas that constitute lowland Britain vary enormously, while the techniques employed by landowners are influenced by the needs of the land, including: (1) topography or soil type; (2) government regulations (e.g. cross compliance); and (3) personal considerations, including conservation interests and involvement in country sports. In general, the presence of gamebird shooting significantly affects many aspects of the land management regime for an area, regardless of whether the shoot is commercial or private, wild or reared. It is often stated that management for gamebird shooting is highly beneficial for wider wildlife (Hill and Robertson, 1988; McKelvie, 1991; Cobham, 1993; Stoate and Szczur, 2001; Oldfield *et al*, 2003). Indeed, stakeholders at the four focus group meetings (Chapter 3) believed in the conservation benefits of gamebird management and viewed this as a major point in future arguments to protect their sport.

Land management by shoot owners comprises two main aspects: (1) AESs; and (2) gamebird management in terms of gamekeeping, including predator control, supplementary feeding and the establishment of cover crops. In this chapter these two types of land management practices will be explored in the context of lowland gamebird shooting in Kent, to consider the various benefits and problems associated with each. This will be followed by an examination of the extent to which these regimes have been implemented at Site 1, with comparison to the controls, and the implications that each specific land management regime has for the production of wild game populations, for benefiting other wildlife species, and any other consequences that may arise.

4.1.1 Agri-Environment Schemes: A Solution to the Biodiversity Dilemma?

As outlined previously (Section 1.2.3), AESs were seized on by the EU member states as a solution to the increasing conservation problems facing agrarian wildlife in western Europe (Ovenden *et al*, 1998; Swash *et al*, 2000; Vickery *et al*, 2004). Several studies have shown that AESs have the potential to make significant conservation benefits for wildlife, particularly for certain bird species that have experienced declines in abundance and range. The majority of studies on AESs have involved those birds that are UK Biodiversity Action Plan (BAP) species, in the hope that AESs can deliver the prescriptions needed to protect these threatened birds. For example, one study focussed on the effects of a Countryside Stewardship Scheme (CSS) on cirl buntings (*Emberiza cirlus*), a BAP species that has suffered declines both in abundance and range (Peach *et al*, 2001). Land entered into the CSS was shown to support increasing numbers of cirl buntings between 1992 and 1998, whilst adjacent farmland that was not included in the scheme, only retained constant numbers of the birds. This demonstration of a positive effect resulting from specific land management is quoted as being the first definite example of the conservation benefits of AESs on British fauna (Peach *et al*, 2001).

Another study investigated the benefits of AESs on farmland birds, with particularly reference to the stone-curlew (*Burhinus oedicnemus*), another UK BAP species (Swash *et al*, 2000). Following declines over the last few decades, stone-curlew numbers had fallen to approximately 160 pairs in the 1980s. AESs were introduced to the two areas of farmland that supported the main populations of stone-curlews. As a result, the breeding population of stone-curlews increased during the 1990s to a total of 215 pairs in 1998. Despite a rise in the numbers of breeding pairs, the increase was not uniform in its distribution. Further AES options were introduced in 1998 in an attempt to address the lack of success at certain sites, highlighting the commitment of the government (MAFF at the time) to promoting conservation in farmland habitats, especially in relation to BAP species.

A further study examined benefits for corncrake (*Crex crex*) populations following the application of AESs (Aebischer *et al*, 2000). The corncrake, which once occupied agricultural habitat in every county of Britain, suffered population declines and range contractions during the 20th century (Williams *et al*, 1997). By 1993, numbers had fallen to 480 singing males, the majority of which were found in the north and west of Britain. The main threat to corncrakes arose from the mechanisation of mowing techniques and the early cutting of grass, which in combination made nests and chicks more vulnerable than under traditional regimes (Green *et al*, 1997; Tyler *et al*, 1998). This led to the formation of Corncrake Friendly Mowing (CFM) methods, such as mowing from the middle of the field out to the edge, opposite to the usual method, and leaving uncut areas for chicks to use as escape routes. The RSPB also introduced a payment scheme, directed at those farmers with corncrakes on their land, to compensate for delaying grass cutting until August. The British government incorporated the beneficial grass cutting practices into the schemes for the Machair ESA and Argyll Islands ESA, as both supported key corncrake populations. Since 1993, corncrake populations have increased by 23%, and reached a total of 589 males in 1998, indicating that the new management regimes were successful in halting the decline of corncrakes. Other species have also benefited from AESs including: butterflies, which respond particularly well to pollen and nectar mixes (Pywell *et al*, 2004); harvest mice (*Micromys minutes*), which find grassy arable field margins and beetle banks suitable habitat for nesting (Bence *et al*, 2003); bees and grasshoppers, which exhibit greater densities along field boundaries with grassy field margins (Marshall *et al*, 2006).

Nevertheless, the extent of conservation benefits derived from AESs is not clear (Herzog, 2005). Evaluation to assess the success of AESs, with regards to their multiple objectives, is compulsory for EU Member States (Kleijn and Sutherland, 2003; Primdahl *et al*, 2003). However, effectively evaluating the success of AESs is fundamentally difficult to achieve, due to the multi-disciplinary aims of the schemes, which are not simply concerned with wildlife conservation. Assessment is also hindered by the effects of factors such as natural population cycles, which cannot be controlled within wildlife populations (Carey *et al*, 2003; Herzog, 2005; Feehan *et al*, 2005). Carey (2001) noted that adequate assessment of AESs would take considerable amounts of money and governments are reluctant to spend more funds on top of the substantial sums already being paid out for AES programmes.

Key assumptions have been made regarding the successes achievable through AESs. Thus, changes to land management regimes through adoption of AESs *theoretically* provide conservation benefits, yet in many cases *actual* benefits have not been confirmed to date for the majority of wildlife, except for a few specific target species (Carey *et al*, 2002). The cirl bunting, stone-curlew and corncrake cases showed that the use of more intensive conservation practices was required to successfully increase breeding rates and nest and chick survival. However, these programmes also incurred greater costs, and make such examples inappropriate for comparison to normal AESs (Green and Hirons, 1991). Therefore, it is unreasonable to extrapolate from such studies to those lacking such intensive support and additional management activities (Kleijn and Sutherland, 2003). Hence, there were few studies that related the effects of AESs to changes in the abundance of wildlife species. Some 62 studies were identified that sought to investigate the effectiveness of AESs in Europe. However, on further examination, these studies did not adequately measure the success of AESs due to biased research designs (Kleijn and Sutherland, 2003). Therefore, at this stage, the lack of sufficient thorough, and scientifically-sound studies meant it was impossible to assess the effectiveness of AESs, a view also expressed by Peach *et al* (2001). However, a more recent re-examination of previously monitored CSSs and ESA schemes to assess their success in delivering desired conservation benefits, found that the effectiveness of both schemes in terms of conservation was less than originally reported (Carey *et al*, 2005).

Equally, it is unclear what constitutes success with regard to AESs. If a landowner undertakes all the work prescribed within his agreement, has he succeeded? Alternatively, should the new management regime be expected to have produced the conservation benefits for which the policy was designed? At one level, success could only arguably have been achieved if the management is carried out as prescribed (Carey *et al*, 2003). Nevertheless, it is doubtful whether EU government agencies, the tax paying public or conservationists would agree with this view. The success of AESs was originally assessed by measuring the uptake rate of agreements, but this fails to determine whether the regimes met their objectives (Hanley *et al*, 1999; Carey *et al*, 2002). Hence, the uptake of AESs does not in and of itself ensure preservation or enhancement of biodiversity (Kleijn *et al*, 2001).

A comparison of vegetation diversity on farmland involved in AESs with that of the English countryside as a whole revealed that land under AESs was of higher quality (Carey *et al*, 2002). However, the study failed to establish whether the AES was maintaining, or improving, the quality of the land, or whether the difference simply arose as a result of AESs being established on land that already supported greater than average biological diversity. The selection process for AESs may be inherently biased in preferentially choosing applications that provide the greatest level of benefits (Lobley and Potter, 1998; Ovenden, 1998; Morris *et al*, 2000; Peach *et al*, 2001). In turn, this means that farmland included in AESs is more likely to possess greater levels of target features than the British countryside in general. Indeed, the uptake of AES was greatest in areas with more extensive agricultural practices, and that had greater initial biodiversity as a result, relative to areas under intensive agricultural regimes (Kleijn and Sutherland, 2003). Another survey found that landowners who previously farmed in a conservation-minded manner were more inclined to partake in AESs (Wilson, 1996), In turn, this indicated that AESs are more likely to appeal to those already doing much to promote biodiversity conservation, a factor that is likely to be exacerbated by the selection process for successful applications. As a result, little new quality habitat is believed to have been created through AESs and the heterogeneous coverage of land involved means some regions of Britain are devoid of any AESs (Evans and Morris, 1997).

Irrespective of whether AESs deliver the desired conservation benefits, uptake by landowners of the CSS in particular has been below predicted levels (Morris *et al*, 2000). The former English Nature (EN), now Natural England, concurred with this view, finding that uptake was inadequate and land included in the schemes was uneven in its coverage, both in terms of location and habitat type (English Nature, 2002). Lack of uptake of AESs among landowners if often due to ignorance or mistrust of schemes. Furthermore, those who adopt AESs do not receive full compensation for their involvement or effort (Hanley *et al*, 1999; Thompson *et al*, 1999; Morris *et al*, 2000; English Nature, 2002). A considerable amount of land is required to reverse the decline of farmland bird populations (Vickery *et al*, 2004). Therefore, the low adoption rates suggest that quality habitat produced by AESs will not cover a sufficient area to provide the desired benefits.

The targeted selection of applicants for AESs has been criticised as paying many farmers to undertake work in which they were already involved (Morris and Potter, 1995), by buying conservation benefits that already exist and protecting habitats that are not immediately vulnerable. However, some landowners have farmed in a responsible manner outside of conservation schemes, and often incur significant expense in the process, yet may not be accepted onto AESs. In contrast, others may be undertaking detrimental practices, yet are being paid to alter their farming methods (Dobbs and Pretty, 2001). Therefore, EN recognised that AESs had failed to reward for previous good management, despite such work retaining habitat in a condition that means it is valuable as a "reservoir from which species colonise new habitat" (English Nature, 2002).

It is increasingly recognised that the success of AESs needs to be proven without doubt if such schemes are to be shown to be worth the money currently being spent on them, estimated at 24.3 billion Euros between 1994 and 2003 (Carey *et al*, 2002; Kleijn and Sutherland, 2003; Herzog, 2005). Although AESs have not produced all the desired benefits, the investment of money, time and effort into developing the schemes suggests EU governments are attempting to conserve wildlife species and their habitats. Therefore, there are grounds for confidence in asserting that a more positive approach has emerged in the 1990s, as to how environmental issues might be tackled (Sheail, 1995). Revision of current schemes and introduction of new programmes, such as Entry Level Stewardship and cross compliance, indicate that future farming regimes will be more conservation orientated, have greater adoption rates and will incorporate a greater area of farmland, perhaps removing one major problem common to wildlife conservation, that of fragmentation (Sutcliffe *et al*, 2003).

4.1.2 Alternative Land Management: Gamebird Management

Those involved in gamebird shooting have long expounded its benefits for wildlife management, a point raised several times during the focus group meetings (Chapter 3). Historically, gamebird management was undertaken by gamekeepers. Although the number of shooting estates, and consequently of gamekeepers, in Britain has decreased since World War II, a considerable number of gamekeepers are still employed (McKelvie, 1991). Many compare gamekeepers to farmers, as custodians of the British countryside. Indeed, at one time, gamekeepers possessed extensive knowledge about nature and country matters (Martin, 1990). A number of common gamebird management practices are considered beneficial to wider wildlife and the presence of a gamebird shoot is strongly responsible for influencing the habitat structure and species composition of a site.

The increased interest in driven shooting and the increasingly large bags shot in the 1800's meant that habitat for gamebirds became an increasingly important feature on farmland (Munsche, 1981; Hill and Robertson, 1988). Many woodland areas were protected for gamebird shooting, and traditional management practices, such as coppicing and creation and maintenance of rides, were continued to maintain the quality of these habitats (Martin, 1987). Woodland managed for pheasants has been shown to have higher densities of songbirds, greater abundance and diversity of butterflies, and more deer than unmanaged woodland (Robertson *et al*, 1988; Robertson, 1992; Draycott and Hoodless, 2004). Hedgerows, commonly removed to enlarge fields, were also protected, and hedge trimming was often restricted to provide higher quality habitat (Munsche, 1981; Martin, 1987). Studies have shown that landowners involved in country sports have higher quality and greater quantities of both woodland and hedgerow on their property compared to those landowners not involved (Macdonald and Johnson, 2000; Howard and Carroll, 2001; Oldfield *et al*, 2003).

Cover crops are commonly used to provide shelter and food during winter months, particularly in landscapes devoid of alternative habitat such as scrub, copses and hedgerows following their large-scale removal (Munsche, 1981). The practice of supplementary feeding has increased as farming techniques have become more efficient, and a lack of over-winter stubble has reduced the availability of food, such as spilt grain. A wide variety of wildlife utilise cover crops and take advantage of the supplementary feed regime provided to gamebirds (Martin, 1987; McKelvie, 1991). Consequently, some conservationists have recognised its benefits for songbirds during winter months (Wilson *et al*, 1997; Stoate, 2002; Critchley *et al*, 2004). Passerines preferentially use cover crops as winter forage sites (Boatman *et al*, 2000), as do butterflies, bumblebees and songbirds during summer months (Parish and Sotherton, 2004). A number of cover crop plots, each typically 0.5 to 1 ha in size and averaging 7.2 ha in total area for a farm (Howard and Carroll, 2001), produce a matrix of different habitat types (Hill and Robertson, 1988; Bence, 2000; Howard and Carroll, 2001). This point was confirmed with the finding that land managed for gamebird shooting has greater heterogeneity in terms of land types (Stark *et al*, 1999).

Predator control has also been a traditional aspect of gamebird management, and is especially important when shoots rely on wild gamebirds (Tapper *et al*, 1996). Reared shoots also use predator control, primarily of foxes, to protect reared birds prior to, and after, release (Hill and Robertson, 1988). Today, corvids, foxes, rats and mustelids are the main targets of control. Birds of conservation concern, such as golden plover (*Pluvialis apricaria),* stone-curlew (*Burhinus oedicnemus*) and lapwing (*Vanellus vanellus*) are found at higher densities, and experience increased breeding success, on moorland that is keepered, compared to areas that are not managed. This difference is due in part, to the reduced predation rates that result from predator control (Anon, 2000; Fletcher, 2003).

On this basis, the increased biodiversity and habitat quality on shooting estates arises largely by fortune than by design, but is an indisputable fact that is widely recognised (Martin, 1987). However, some shoot owners invest even more heavily in conservation work than is needed for gamebird management, due to their interest in conservation (Martin, 1987). Studies have shown that gamebird management can offset many of the negative effects of intensive farming systems (Howard and Carroll, 2001).

There are also negative aspects to gamebird management that must be recognised. Illegal persecution of predators continues to affect the recovery of many raptor species following significant reductions in density and range during the 19th and early 20th centuries as a result of intense control by shoot managers (Etheridge *et al*, 1997; Whitfield *et al*, 2003). Legal protection continues for badgers despite their increasing numbers (Sadlier and Montgomery, 2004). As a result, they are also illegally controlled in some areas as a consequence of gamebird management.

Management practices on reared shoots also produce a number of conservation problems. The breeding of large numbers of pheasant and partridge in captivity results in increased risks of spreading disease to wild bird populations. An outbreak of Newcastle Disease (ND), a highly contagious disease of birds, was confirmed in a population of pheasants on a game farm in 2005 (DEFRA, 2005c). Although this case was controlled successfully, ND continues to pose a world-wide problem. Unnaturally high densities of reared birds in release pens has been shown to seriously affect vegetation diversity, leading to reduced vegetation cover, increased areas of bare ground and a greater proportion of undesirable plant species as a result of disturbance and increased nutrients from the birds' faeces (Sage *et al*, 2005). Creating feeding areas for released birds by spreading straw along woodland rides can smother woodland plant species, increase the nutrient content of the soil and introduce weed species (Robertson, 1992).

As with AESs, gamebird management has the potential to be undertaken to a high standard, and to create significant benefits for wider wildlife alongside gamebirds. Nevertheless, many gamebird management regimes provide only limited conservation benefits, particularly if they are associated with purely reared gamebird shoots where there is little emphasis on providing high quality habitat or encouraging wild gamebird productivity. Indeed, some practices can be detrimental in their effect on habitat quality and biodiversity levels. An important contrast between AESs and gamebird management is that landowners fund the management regime themselves rather than using public funds. Therefore, failure to create any benefits does not waste limited public moneys specifically allocated for conservation.

This study aimed to explore and categorise the different land management and gamekeeping found on the different study areas. This would permit comparison between study areas and be used during the biodiversity aspect of the study as a way of determining whether the type of land management or gamekeeping had an affect on the wild productivity of pheasants, on insect numbers or on songbird numbers.

4.2 Methods and Materials

4.2.1 Assessment of the land management

The different levels of land management were examined to determine their relationship to gamebird productivity (Chapter 5), insect numbers (Chapter 6) or breeding songbird densities (Chapter 7). The government contracts produced for the AESs adopted at Site 1 and Control sites 2 and 4 were examined and were used in conjunction with the records kept by landowners relating to work undertaken for AESs to calculate the amount (length or area) of different habitat features. For features that were not part of an official scheme or where landowners had not kept records, aerial photographs of each site were examined within a geographical information system (GIS) programme (Global Mapper v5). The measuring tools and area calculator within the programme were used to measure the amount of agricultural land and alternative habitat features present on each site, giving details not provided by other documents. These tools were used to measure individual field area, the length of habitat features, comprising hedgerow, woodland edge, field boundary, the total area of CSS habitat, set-aside or equivalent features.

For Site 1, comprehensive records had been kept by the landowner of the payments for, and cost of, the AES. From these data, the deficit or profit per year was calculated. In addition, the value per acre of each crop for several years at Site 1 was provided by the landowner. Such data did not exist, or were not provided by the landowners, for the other study areas.

4.2.2 Assessment of game management effort

The different levels of gamekeeper management were examined to determine whether there was a relationship with gamebird productivity (Chapter 5), insect numbers (Chapter 6) or breeding songbird densities (Chapter 7). The level of game management at Site 1 and Controls 2, 3 and 4 was determined in two ways: (1) by estimating the number of traps, snares and feeders per km^2 within the arable area, along boundaries but not in woodland, at each study site. This was done by marking the position of each trap, snare and feeder on a map of each estate. It was then possible to calculate the number per km^2 based on how many traps, snares and feeders fell into each study area. (2) By examining the work schedule to which each gamekeeper adhered, an annual timetable of activities for each gamekeeper was created. This showed during which weeks of the year different gamekeeping activities were undertaken. These were then plotted on a calendar to indicate the rate of effort expended by each gamekeeper; by plotting all gamekeeper schedules together allowed for comparison.

Although records were kept on the number of predators culled by the gamekeepers, this information is of little use as the data provide no information on the number of predators remaining at each site or of the impact that these predators had on breeding success of gamebird populations and, therefore, of the success of each gamekeeping regime. The volume of grain used each season for supplementary feeding was compiled, but could not be used to indicate the rate of consumption of supplementary feed by gamebirds, which are not the only species that utilised feeders. Corvids, songbirds, rats and deer are among a number of species that also eat the grain provided specifically for gamebirds. In addition to the predator and supplementary feeding information, the number of gamebirds released at each site was provided by the gamekeepers.

4.3 Results

4.3.1 Land management at Site 1

The arable land at Site 1 was managed under a CSS that commenced in October 1999 with a 10-year contract. The motivation for adopting the scheme was to produce quality habitat for the gamebird shoot, both for wild and reared gamebirds (Countess Sondes, landowner, personal communication). The scheme principally targeted arable habitats and was mainly concerned with establishing 2 and 6 m-wide uncropped arable field margins and a beetle bank, as well as the creation of new hedgerows and gapping-up. The agreed CSS prescriptions are outlined in Table 4.1.

Table 4.1: Amount of stewardship applied to the four Treatment sites at Site 1

Study Area	Length of 2m uncropped arable margin (m)	Length of 6m uncropped arable margin (m)	Beetle bank length (m)	Area of arable land (ha)
1.1	1593	1414	90	109.9
1.2	1609	990	0	70.55
1.3	1858	3477	0	47.88
1.4	3776	2615	0	53.19

All field margins were created in autumn, winter and spring months of 2000/2001, the first year of this project, and those that did not establish successfully were re-sown the following year. The 2m and 6m uncropped arable margins were sown with grass mixes designed for chalk and limestone soil to produce a tussocky grass sward of native grass species. The aim was to produce margins that were sufficiently thick to suppress the growth of volunteer crops and unwanted weed species, whilst also providing suitable habitat for wildlife, especially small mammals and invertebrates.

The beetle bank was also created in these months of 2000/2001. The beetle bank, between 2 and 3m in width, was sown with a similar grass seed mix to the field margins. The aim was to produce suitable habitat for wildlife, especially predatory beetles, which could have a beneficial effect on controlling crop-damaging insects, other desirable invertebrates and small mammals.

Hedge planting was undertaken between 2000 and 2004, using native species common to the site. Management of existing hedges followed the prescriptions outlined in the agreement, which primarily limited the amount and timing of hedge trimming. The aim of hedge planting was to provide increased amounts of alternative habitat for wildlife (including gamebirds), and, in the cases of gapping up existing hedgerows, to improve the quality of these habitat features.

Table 4.2: Countryside Stewardship income and expenditure (£GB) for Site 1.

Scheme Year (Nov. – Oct.)	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005
Income						
Management Plan		420.00				
Grass Margins			3515.92	3515.92	3515.92	3515.92
Hedging		649.60	936.80	948	1053	2442
Tree Planting		35.65	23.00			
Arable Reversion		1538.40	1538.40	1538.40	1538.40	1538.40
Total Payment		2643.65	6014.12	6002.32	6107.32	7496.32
Expenditure						
Management Plan	500					
Hedge & Tree planting	909.30	837.85	793.13	1404.00	3256.00	525.00
Grass Establishment	769.60					
Margin Establishment		1185.60				
Grass Mowing	n/a	111.15	72.15	111.15	72.15	72.15
Labour	250	200	125	250	125	125
Profit Foregone						
Arable Reversion	1684.00	1684.00	1684.00	1684.00	1684.00	1684.00
Arable Grass Margins		3445.65	3445.65	3445.65	3445.65	3445.65
Total Expense	4162.90	7464.25	6119.93	6894.80	8582.80	5851.80
BALANCE	-4162.90	-4820.60	-105.81	-892.48	-2475.48	1644.52

N.B. Payments from DEFRA were received January of the following year, hence no payment for 1999-2000

The accounts for income and expenditure of the CSS at Site 1 were calculated for 1999 to 2005 (Table 4.2). From 1999-2000 to 2001-2002, the figures shown are for actual costs. From 2002-2003 and onwards, the figures shown are for estimated expenditures. In total, it was estimated that the CSS at Site 1 will cost the landowner *c.* £7044.00 over the 10-year agreement period. Annual deficits were high in the first two years, due to the amount of work and expenditure necessary to establish the habitat features. Furthermore, the re-sowing of grass margins that failed to establish in 2000-2001 also elevated the costs.

Table 4.3: Gross margin figures for the value (GB£) of crops per acre at Site 1

	Milling wheat	Feed wheat	Oilseed rape	Spring peas
1999	315	296	138	397
2000	257	243	238	158
2001	318	281	242	224
2002	325	250	271	203

The CSS does not appear to have affected crop production at Site 1. Table 4.3 shows the annual crop values per acre from 1999, the year before CSS management commenced, to 2002. Crop prices varied each year, based on changes in the market that arose from factors such as weather and disease. These factors can affect crop yield and quality, and influence the price that landowners can expect to receive for their crops in any one year. While the crop prices varied between 1999 and 2002, these variations do not appear to indicate an obvious negative affect following adoption of the CSS. Furthermore, the comparison of the harvest yields from Site 1 with 21 other farms in southeast England managed by the same land agent, also shows the success of the farming on Site 1 for the four years after CCS was established. Site 1 improved comparatively in terms of yield, and moved from 8th highest in a group of 22 farms in 1999 to 3rd highest in 2002. Furthermore, Site 1 enjoyed consistently higher crop yields than the national average, by comparison with yields expected by the major British grain merchants, Dalgety and enjoyed higher annual yields compared to farms in southeast England as a whole, based on data supplied by National Farmers Union (NFU).

4.3.2 Land management at the controls

The amounts of alternative habitat features at the control sites are shown in Table 4.4. Control site 2 was not managed under an AES, although many habitat features at the site are similar to those that remain options within AESs. The motivation of the landowner for establishing these alternative habitat areas was primarily for the gamebird shoot, although conservation of wider wildlife was deemed important (Sir

Swire, landowner, personal communication). Some of the grass margins were established under the set-aside scheme in 1995/1996, and were originally sown with a grass mix and cut annually in accordance with non-rotational set-aside rules. A derogation was granted in 2004, and permitted these margins to be left uncut to maximise the wildlife benefits, particularly for butterflies and bumblebees. The remaining grass strips were voluntarily included in the land management, established for the gamebird shoot and sympathetically managed in an attempt to provide quality habitat. The majority of hedgerows and woodland edges were buffered by grass strips and provided gamekeepers with access to most areas throughout the year.

Table 4.4: Amount of uncropped field margin and beetle bank at the control sites

	Length of 6m margin (m)	Length of 10m margin (m)	Length of 12m margin	Length of 15m margin	Length of 20m margin	Beetle bank length	Area of arable (ha)
Control 2	0	239	271	2456	313	0	55.04
Control 3	627.5	0	0	0	0	454.55	86.05
Control 4	0	0	0	0	1090	2.05	106.23

An AES was adopted at Control site 3 towards the end of this project, and prescription features were first established in winter 2003. Prior to this, no alternative habitat had been created at this site through set-aside nor voluntarily included in the land management. The management at Control site 3 was considered representative of farmland in south-eastern England on which management was mainly directed towards arable farming, but where there was no management for gamebird shooting.

Production of quality habitat was necessary at Control site 4, as the shoot relied on wild gamebird productivity. The landowner also stated that his interest in conservation was also incredibly important (Mr Lee-Pemberton, landowner, personal communication). The land at Control site 4 was managed under one of four CSSs adopted on the estate, which began in 1997. Other habitat features were created through set-aside schemes or were voluntarily included in the land management. The beetle banks were part of the CSS and the uncropped field margins were a mixture of set-aside and voluntary addition. The uncropped field margins were approximately 20m wide and divided into two strips, which were sown with a contaminant, usually linseed, but also phacelia, clover and Lucerne, in alternate years. The vegetation of each strip was also left for two years, producing a strip of mature vegetation that provided cover and seed, whilst the other half became established. After two years, the strip was mown, ploughed and re-sown.

No information was available on the costs of the land management at the control sites. For Control site 2, expense would have been incurred through taking land out of production to voluntarily produce alternative habitat. The landowner of Control site 3 would only have incurred alternative land management costs in the 2003/2004 season, when the AES was adopted. For Control site 4, there would have been costs due to the 4 CSSs, as well as opportunity costs through the loss of arable land voluntarily taken out of agricultural use. If the costs of the CSSs at Control site 4 were similar in scale to those at Site 1, the total cost would have been approximately £3000 a year.

4.3.3 The gamebird shoot at Site 1

The shoot at Site 1 has always been predominantly concerned with pheasants, although a number of partridge and a few woodcock have been shot to add variety when available. For many years, the estate has relied primarily on reared pheasants and a few red-legged partridge. Around 22,000 birds were released annually up until the end of the 1990's. In 2000, the numbers of released birds was greatly reduced (Table 4.5) and the agriculture, land management and gamekeeping were altered to promote an increase in wild gamebird numbers, particularly of pheasant.

Table 4.5: Number of birds released each season on Site 1

Shoot Season	Pheasant	Partridge
Pre 2000	22,000 birds (mainly pheasant but some partridge)	
2000/2001	8500	2000
2001/2002	8500	2000
2002/2003	8500	3000
2003/2004	8500	3000
2004/2005	8500	3000

The new gamekeeping regime was implemented alongside the work necessary for the rearing programme, and the primary emphasis was placed on predator control. Under the old management regime, predator control was concerned with protecting the reared gamebirds from predation prior to, and during, the shooting season. This mainly involved fox control in the autumn and winter months. By contrast, the new regime involved: more intensive fox control, including during spring and summer months, through lamping and snaring; corvid control, primarily using Larsen traps; and, control of rats and mustelids using tunnel traps.

Supplementary feeding was also increased. Under the old management regime, supplementary feed was only supplied to the reared gamebirds during the autumn and winter months. This feed was provided via sacks placed within the release pens and scattered along woodland rides covered in straw. By contrast, the new management regime provided supplementary feed primarily for the reared birds via hoppers located around the site, from mid-August until late spring, in order to enhance the condition of hens entering the breeding season.

Most of the habitat creation and land management was undertaken as part of the CSS, although several new areas of cover crop were established. Cover crops were located within 3 of the 4 treatment sites, and only Treatment site 1.1 had no cover crops. Predominantly, these crops were grown for shelter and as habitat from which the birds could be driven on shoot days, although some varieties of cover crop could also provide a source of food.

Approximately 14 shoot-days were sold each shooting season. The majority of shoot-days were purchased by a single shooting syndicate, while the remaining 2 or 3 days were bought by Holland and Holland. The first shoot-day of the season was a partridge bag at the end of September, which extended the shorter pheasant shooting season and provided the 'guns' with a different type of shooting. One or two shoot-days at the end of season were given as "beaters' days", and these would often be cock-only (pheasant) bags.

For bought days, bag sizes would vary, and ranged from approximately 150 to 300 birds. The average bag size was approximately 250, and most years saw a return rate that exceeded 30% relative to the number of birds released. The annual rate of return, comprising the size of the bag as a percentage of the total number of birds released, was always above 30%. This was considered to be a reasonable rate of return, and the return rate peaked at 38% in 2004. It is impossible to know how many of the birds in the bag were reared, how many were wild and produced on the estate, and how many came onto the estate from neighbouring areas.

The income and expenditures from the shoot at Site 1 are shown in Table 4.6. The income is generated from the sale of days to shoot purchasers, the sale of game meat after the shoot and the interest accrued on the money directly generated from the shooting. Costs incurred cover many different aspects, such as the purchasing of gamebird poults, their feed and the veterinary bills, the maintenance of rearing pens, the purchasing and establishment of cover crop, and the wages for the fulltime gamekeepers and part-time staff. Costs are also generated from less obvious aspects such as insurance for the shoot and enrolment of the gamekeepers in training programmes to ensure they are continually improving their techniques and learning new skills. Although the shoot is commercial in the sense that days are sold, it does not produce a profit when the costs incurred are considered against the money generated from the sale of shoot-days.

Table 4.6: Annual income and expenditure (GB£) for the gamebird shoot at Site 1.

Shoot Season	2001	2002	2003	2004
Total Income	125,605	129,342	116.556	137,144
Expenditure				
Poults	16,637	29,683	33,604	41,074
Shoot penalties	n/a	n/a	n/a	15,275
Total Expense	131,018	131,740	120,441	154,184
Balance	-5,413	-2,398	-3,885	-17,039

The cost of poults increased annually, even though there was only one increase in the number of poults bought in, when the number of partridge poults purchased increased by 1000 birds between 2001 and 2002 (Table 4.5). The large increase in the cost of purchasing the poults between 2003 and 2004 was due to the ban on Emtril, when game farms raised their prices to cover the increased amount of work necessary to prevent disease outbreaks. The large financial losses incurred in 2004 arose because the total bag for the year was not reached. As a penalty, the landowner had to return the sporting rent to the shoot tenant for that year.

4.3.4 The gamebird shoots at the controls

4.3.4.1 The gamebird shoot at Control site 2

Control site 2 annually released 500 pheasant and 150 red-legged partridge, and relied on wild birds to enhance the bag size. The release of this small number of reared birds required the gamekeeper to spend time in maintaining the three small release pens located on the site, and to feed the birds once in the pens. The presence of a chalk trout stream on the same property also meant that the gamekeeper spent much time on tasks other than game management, while undertaking stream management during late spring and summer. However, the relatively small area managed by the gamekeeper of Control site 2 meant the gamekeeping was generally of a high level throughout the year, and concentrated predominantly on predator control and supplementary feeding.

Approximately 10 shoot days were held annually at Control site 2. These were produced for invited friends and family and no income was generated from these shoot days. The first day of the season was a driven partridge shoot, while the rest were driven pheasant and partridge days, except for the last day, which was the beaters' day and consisted of rough shooting of cock pheasants only. The average bag size for a season was 100 birds per day, and the maximum was approximately 125 head of game. The return on the reared birds is usually high at this site in comparison to the 30% that is deemed reasonable, at approximately 55% per annum, although returns of 85% have been known in exceptional years. In such cases, it is understood that the bag was subsidised by birds coming in from over the estate boundary, perhaps attracted by the availability of quality habitat. Because the shoot was at the invitation of the shoot owner, no income derived to the estate.

4.3.4.2 The gamebird shoot at Control site 3

There was no gamebird shoot on Control site 3, so none of the associated game management, such as supplementary feeding and predator control, or habitat creation for game, such as cover crops and brood rearing strips, took place. Consequently, the landowner did not incur any expenses due to game management as did the landowners of Site 1 and Control sites 2 and 4.

4.3.4.3 The gamebird shoot at Control site 4

Control site 4 had not released gamebirds for 4 years prior to the start of this study, and relied entirely on wild productivity to produce the bag. Four years prior to the cessation of releasing, gamekeeping sought to promote wild gamebird productivity by building up wild stock and establishing quality habitat. The gamekeeping at this site was extensive, involving cooperation between neighbouring estates for aspects such as fox control through lamping, fox driving and control using terriers. Corvid control was also extensive: when crows or magpies were observed, a Larsen trap was moved to the location where it would remain until the birds were caught, shot or left the area.

Between 13 and 14 shoot days were produced annually at Control site 4 for invited friends and family guests, with no income generated. The first three were partridge-only days held in September, comprising two driven and one rough shoot. The rest of the season consisted of mixed or pheasant-only bags, approximately half rough and half driven. Towards the end of the season, bags were cock pheasants only. The largest bag size was roughly 100 birds, with an average bag size 50 birds. In total, approximately 750 head of game were shot each season.

There is no information regarding the annual cost of producing the shoot at Control site 4. As with Control site 2, one fulltime gamekeeper was employed. No expenses were incurred for purchasing poults, as was the case for Site 1 and, to a far lesser extent, for Control site 2. The intensity of the gamekeeping meant that, at one time, there was considerable initial expenditure on equipment such as tunnel traps, Larsen traps, snares and other materials necessary to create the extensive wild gamebird management at this site.

4.3.5 Assessment of game management at Site 1 and the control sites

The effort devoted to game management was not uniform across Site 1 (Table 4.7 and Appendix 1). Treatment site 1.1 received no game management as no gamebird shooting occurred in this area. Of the other three treatment sites at Site 1, Treatment sites 1.2 and 1.3 received the most game management in terms of predator trapping and supplementary feeding, while Treatment site 1.4 received slightly less effort. Treatment site 1.4 received the highest levels of releases, which meant that much of the predator control and supplementary feeding was confined within the woods in the immediate vicinity of the release pens. Treatment site 1.4 is also crossed by many public footpaths. Therefore, vandalism of traps and the risk of dogs getting caught in snares meant it was not possible to achieve the desired level of predator control at this site.

Table 4.7: Density of traps and feeders per km^2 per year across the sites

Site	Larsen traps	Tunnel traps	Snares	Letterbox traps	Feeders
1.1	0	0	0	0	0
1.2	5.7	22.0	22.1	0	25.1
1.3	5.7	17.6	25.8	0	22.4
1.4	4.4	13.2	18.5	0	18.5
2	7.3	20.0	25.5	0	18.2
3	0	0	0	0	0
4	3.5	28.6	31.7	1.6	41.3

Treatment site 1.2 supported the highest density of corvids per km^2 (Table 4.8). However, this figure is thought to be high because roost sites were located within this treatment site. Although corvids were recorded in large numbers, they were observed dispersing beyond the boundaries of the treatment site during the day. Therefore, it was inappropriate to assume that any impact of these birds was only experienced by gamebirds and other wildlife species within Treatment site 1.2.

The effort devoted to game management at Control site 2 appeared comparable with that at Control sites 1.2 and 1.3, where similar numbers of traps and snares were deployed per km^2. There were slightly fewer feeders at Control site 2, but this area supported more extensive and well-established natural feeding sites than Treatment sites 1.2 and 1.3, and supported fewer released birds each year. Furthermore, Larsen trapping was undertaken with fewer traps and for fewer months of the year at Control site 2 than at Treatment sites 1.2 and 1.3. However, the more limited extent of public access at Control site 2 meant that traps could be moved to where they were needed and where they would be most effective. In addition, Control site 2 experienced limited lamping compared to Site 1, 2 months and 6.5 months respectively. Gamekeepers at Control site 2 favoured snares for fox control, and ran them throughout the year, compared to only 4 months at Site 1.

Control site 3 experienced no game management because no gamebird shoot took place at this site (Table 4.7). Control site 4 supported the greatest number of traps per km^2 (Table 4.7). The range of traps used and activities undertaken by the gamekeeper to control predators was generally greatest at Control site 4, indicating that this site had the greatest level of game management. Control site 4 also supported the greatest level of supplementary feeding (Table 4.7).

Table 4.8: Level of game management experienced at each site

Site	Level of game management
1.1	1
1.2	4
1.3	4
1.4	3
2	4
3	1
4	5

Based on the data in Tables 4.7 and Appendix 1, the various sites were categorised in terms of game management and gamekeeping effort (Table 4.8). Treatment site 1.1

and Control site 3 received no game management so were both categorised with a score of 1 (Table 4.8). Treatment site 1.4 received less gamekeeping effort than Treatment sites 1.2 and 1.3 and Control site 2, which in turn received less than Control site 4. Therefore, these sites were categorised as receiving levels of gamekeeping effort ranging from scores of 3 to 5 (Table 4.8). The results of the game management categorisation are used in later analyses (Chapters 5 and 7).

4.4 Discussion

Normal AES prescriptions seek to deliver the objectives of enhanced habitat quality and increased wildlife abundance and diversity. However, such benefits do not appear to have become a reality to date (Evans and Morris, 1997; Macdonald and Johnson, 2000; Vickery *et al*, 2004). Studies have indicated that it is necessary to increase the level of management when attempting to protect and recover specifically-targeted agrarian species such as corncrakes using AESs. Indeed, extra financial compensation is necessary for landowners for their increased level of work, and of lost income (Carey *et al*, 2002).

Surveys of attitudes towards AESs indicate that those landowners with interest in conservation or gamebird shooting are more predisposed to adopting AESs than those whose only interest is farming (Oldfield *et al*, 2003). For landowners who shoot, the benefits for gamebirds produced by aspects of AES management programmes may be all the motivation they need to adopt the scheme and to implement them to a high standard (Morris *et al*, 2000; Oldfield *et al*, 2003; Morris, 2004). Therefore, the reason for involvement in AESs may have important implications for the manner in which the prescriptions are implemented and the quality of the resulting work. As of yet, no study has been identified that compares the quality of habitat management by landowners with differing motivations for adopting AESs, whether financial gain, gamebird shooting or conservation.

4.4.1 Land management at Site 1 and the control sites

The outlines of the management at Site 1 and the control sites indicate that the regimes can vary greatly and depend on the requirements of the landowner. Of the three sites that supported shoots, the adoption of AESs or the creation of similar land management prescriptions indicate that gamebird shooting provided motivation that encouraged the uptake of such land management regimes. AESs, although open to all, are often only taken up by those with gamebird shoots due to the quality habitat created for wild gamebird populations (Morris, 2004). Indeed, those interested in country sports have been shown to be "positively predisposed" to adopting such schemes (Morris *et al*, 2000; Oldfield *et al*, 2003). Advisory departments of organisations such as the Game Conservancy Trust (GCT), actively promote involvement in AESs, and cite the direct benefits that arise both to wild game populations, as well as to wider biodiversity, as a positive consequence of such management regimes for landowners interested in shooting. It is not surprising, therefore, that AES's, and land management that produce similar habitat features, were adopted on those sites that had gamebird shooting.

The cost data for the CSS at Site 1 show that the landowner incurred annual losses from the scheme. Therefore, financial gain was not the motivating factor in continuing to adopt an AES. Despite the new land management regime at Site 1, the agriculture does not appear to have been negatively affected, as shown by the crop yields and comparison with other farm production rates.

4.4.2 Game management at Site 1 and the controls

Management specifically for gamebirds significantly influences the way arable land is governed and, as with the land management, the gamebird management is determined by the requirements of the shoot. Land which does not support gamebird shooting lacked gamebird management, as was the case for Control site 3. Techniques such as the planting of cover crops and the provision of supplementary feed are purely undertaken by those involved in gamebird shooting (Stamp, 1969; Stoate and Szczur, 2001), and have been shown to provide concurrent benefits for both gamebirds and other wildlife species (Hill *et al*, 1996). Such management is also lacking on those areas of estates on which there is no shooting, as was the case for Treatment site 1.1.

The level of gamebird management appears to increase as the requirement for wild gamebird productivity increases. On wild shoots, there is no shooting if wild productivity fails. On those shoots that have rearing, wild gamebirds can supplement the bag. Nevertheless, the size of the bag is also partially determined by the success of wild productivity.

The data for Site 1 show that it is possible to undertake gamebird management that has the potential to promote wild gamebird productivity alongside the work required for substantial levels of rearing. However, for those areas of Site 1 that supported the greatest amount of rearing, the level of gamekeeping effort was compromised to some extent.

4.4.3 Summary

It is apparent from this study that significant benefits can be created through gamebird management. If AESs are initiated alongside established gamebird shoots, it is possible that this combination will produce the quality habitat that AESs schemes have failed to produce on their own. When AESs are adopted by landowners in the absence of gamebird shooting, areas of failure for stand-alone AESs may include: (1) the reasons for adopting AESs may not motivate the level of commitment required to produce conservation benefits; (2) the AESs may require elements of gamebird management to be successful. The degree to which the land and gamebird management successfully led to improved wild gamebird productivity and to wider conservation benefits, will be examined in Chapters 5, 6 and 7.

Chapter 5
Changing wild pheasant productivity on a commercial reared shoot

5.1 Introduction

5.1.1 Factors limiting wild gamebird productivity

Several factors limit the productivity of wild gamebird populations, of which predation and chick survival are the two key factors (Hill and Robertson, 1988; Tapper, 1999). Consequently, gamebird shooting estates have long used predator control to protect gamebird populations and to enhance wild gamebird productivity (McKelvie, 1991). Several studies have shown strong links between predator control and increased gamebird productivity (Reynolds *et al*, 1988; Kauhala *et al*, 2000; Sage and Robertson, 2000; Fletcher, 2004). However, unlike conservation biologists who tend to be most interested in the effect of predation on the size of a population entering the breeding season, those interested in gamebird management are more concerned with the effect of predation on the size of the gamebird population after the breeding season (Côté and Sutherland, 1997). Thus, gamebird productivity can be limited both by rates of predation on female gamebirds during the breeding season, particularly from the nest whilst incubating their clutch, and by the predation of the eggs (Reynolds *et al*, 1988; The Game Conservancy Trust, 1997). A review of 27 studies of pheasant populations concluded that sites with predator control had the highest rate of chick productivity, indicating that uncontrolled predation can restrain productivity (Sage and Robertson, 2000).

The quality of available foraging habitat for gamebird chicks can also limit wild gamebird productivity (Rands, 1988), as chick survival in the first few days after hatching is greatly affected by the availability of insects that are the main food items for chicks (Fry, 1991; Moreby, 1992). Improving the amount of insect food, through methods such as creation of conservation headlands, has been shown to increase the survival of partridge and pheasant chicks (Rands, 1988). To a lesser extent, death from inclement weather and predation can also reduce the fledging rate (Hill and Robertson, 1988; Meyers *et al*, 1988).

5.1.2 Factors affecting wild pheasant productivity on reared shoots

Estates that have relied heavily for many years on reared gamebirds for their shooting can take several years to build up wild stocks of gamebirds (Hill and Robertson, 1986; Robertson and Dowell, 1990). Although a wild population may be present on reared gamebird estates, lack of habitat management and of adequate predator control, and the presence of large numbers of reared gamebirds, can all combine to depress the productivity of wild birds (Hill and Robertson, 1988; Tapper, 1999).

On reared shoots, some predator control is generally undertaken in the period before poults are placed in release pens, and prior to and during the shooting season, to ensure that a high proportion of reared birds survive until the shooting season (Hill and Robertson, 1988). Therefore, unlike wild shoots, predator control tends to be confined primarily to limiting fox numbers in the autumn and winter months (Tapper, 1999). Protection of gamebirds after the shooting season is generally not a priority for reared shoots. Therefore, the breeding stock and productivity levels of gamebird populations on reared shoots can be negatively affected by predation rates (Tapper, 1999).

Previous studies suggest that the introduction of predator control akin to that practiced on successful wild gamebird shoots, alongside management to produce quality habitat for nesting and brood rearing, are important to convert a once reared shoot into successfully producing a breeding population of wild pheasants (Hill and Robertson, 1988; Sage, 1999; Tapper, 1999). However, research has also indicated that the presence of reared pheasants can detrimentally affect the breeding performance of wild populations, for various reasons:

(1) The presence of reared hen pheasants can reduce the breeding performance of a wild population (Robertson and Dowell, 1990), for reasons that are not well understood. However, key factors may be competition for suitable nesting

sites by reared and wild hens (Robertson and Dowell, 1990) and the reduced breeding success of reared compared to wild hen pheasants (Sage and Robertson, 2000; Woodburn, 2000).

(2) A large number of released birds on the ground can attract predators, which in turn can greatly reduce productivity if predator control is limited when the shoot manager relies on reared birds to provide the bag (Robertson and Dowell, 1990; Tapper, 1999; Woodburn, 2000).

(3) The presence of reared pheasants can lead to increased shooting pressure on wild pheasants. In turn, this can result in inclusion of more wild and reared hens in the bag, thereby reducing the size of the breeding population of wild pheasants for the following season (Hill and Robertson, 1986; Robertson and Dowell, 1990).

(4) Reliance on reared birds can reduce the need to undertake wider habitat management, such as establishment of brood rearing strips, as these features are of little importance to reared shoots (Hoodless *et al*, 1999; Tapper, 1999).

(5) Supplementary feeding has been shown to increase productivity as a result of improving the condition of hens entering the breeding season (Draycott *et al*, 1996), but is rarely continued into the start of the breeding season on reared shoots (Hoodless *et al*, 1999).

Most studies on the productivity of pheasant populations have concentrated either on wild birds exclusively, or on reared birds exclusively, but rarely on mixed populations of wild and reared pheasants. Furthermore, most research on mixed populations has concentrated on the differences between the two types of bird in terms of breeding success (Hill and Robertson, 1988b; Sage *et al*, 2003) rather than on determining the overall productivity of mixed pheasant populations. Other studies have examined the ability of reared shoots to convert into wild shoots, such as at Loddington in Leicestershire. There, major alterations to the land management regime, the introduction of predator control and of supplementary feeding, combined to allow gamebird shooting just two years after the release of reared pheasants ended (Stoate and Leake, 2002). A similar change was implemented at Tendring Hall Estate in Suffolk. Half of this (110 ha) estate was converted from a reared to a wild shoot that produced *c.* 100 pheasant chicks per km^2 after five years through a programme consisting primarily of predator control and supplementary feeding, and limited habitat management in non-arable areas (Sage, 1999). Therefore, previous research has highlighted key factors that influence the effect of reared pheasants on the productivity of wild pheasants. However, no study has previously been conducted on the productivity of mixed populations of reared and wild pheasants.

5.1.3 Motivation for and aims of the study

Many involved in gamebird shooting believe that the current number of gamebirds reared and released annually in Britain is too high (McKelvie, 1991). The four focus group meetings considered that numbers of reared and released gamebirds, particularly of pheasants, was unacceptable, not only to some members of the shooting fraternity, but also to welfarists and, increasingly, to the general public (Chapter 3). Therefore, future self-regulation of the countryside sport should formulate guidelines that propose sensible but sustainable limits on the number of reared and released gamebirds, and on the bag sizes killed on shoot days. Focus groups saw such an approach as the best way to allow commercial gamebird shooting to continue, thereby permitting shoots to generate revenue that has far reaching benefits, whilst also maintaining the incentive for shoot owners to undertake land management that can greatly improve habitat quality, that in turn has benefits for wider biodiversity. At the same time, this approach can simultaneously address the issue of welfare, extreme bag sizes, greed within the industry and encourage the consumption rather than the discarding of shot gamebirds (Chapter 3).

If bag sizes decrease because of limits on the numbers of birds reared and released, the establishment of a viable population of wild gamebirds may allow a reared shoot to supplement their bag with wild birds (Hoodless *et al,* 1999). Because previous studies have not examined the issue of productivity on mixed shoots, this chapter addresses the extent to which reared shoots can establish viable wild populations of gamebirds, and has two main aims:

(1) To investigate whether a commercial gamebird shoot that has relied predominantly on the release of reared gamebirds can integrate a new gamebird management regime, encompassing both gamekeeping and farming, and produce a viable wild gamebird population in the presence of a significant number of

released gamebirds on an estate that also supports a commercial agricultural business.

(2) To compare the productivity of gamebird populations managed under different regimes, with reference to: (a) the level of gamekeeping effort; (b) the extent of the releasing programme.

5.2 Methods

Surveys were designed to compare the size, composition and productivity of wild gamebird populations on treatment sites where radical changes in management had been implemented, and at control sites which remained under varied, but constant, management regimes (Chapter 4). Gamebird counts were undertaken from 2001 to 2004, and followed the standard methodology devised by the GCT and outlined in *Monitoring Pheasant Populations* (The Game Conservancy Trust, unpublished). The shoots at Site 1 and the control sites all primarily focus on ring-necked pheasants, so this chapter likewise focuses on pheasants.

5.2.1 Spring Counts

The spring counts aimed to provide an estimate of the size and composition of gamebird populations entering the breeding season within each treatment and control site. The spring counts were undertaken towards the end of March or the beginning of April, when cock pheasants were establishing territories, and when hens were choosing males and forming harems.

The arable fields within the treatment and control sites were the focus for the spring gamebird counts. Counts started half an hour after dawn or two hours before dusk, when field tracks and boundaries were driven, and binoculars were used to note the position of any pheasants on a pre-prepared map. Areas not suitable for driving were walked, although this was avoided if possible as gamebirds quickly hide when a person is visible, whilst they appear indifferent to a vehicle. Counts typically took between 1.5 and 2 hours per km^2, but those sites that required leaving the vehicle tended to take longer.

Territorial males are easily identified from non-territorial males by their inflated wattles and wing-beating (Hill and Robertson, 1988). Territorial males were recorded on the map with the symbol T, non-territorial males were recorded with NT and hens were recorded as H. If a territorial male was observed with a harem, it was recorded as T + n, where n denoted the number of hens present. Where groups of pheasants were seen, the group composition was recorded. For example, three non-territorial males seen together were noted as 3NT. Any distinguishing features observed on a particular bird were also noted on the map, including characteristics such as melanistic (dark) or leucistic (pale) coloration.

Three counts were undertaken at each treatment and control site within a 4-week period, and a separate map was used for each count. The three sets of data were then combined on an OHP sheet using a different coloured pen for each count. It was then possible to identify birds or groups of birds seen on two or more occasions, and these counts were combined to form a single estimate. The densities of territorial males, of non-territorial males, and of hen pheasants were calculated for each treatment and control site. It was also possible to calculate the density of harems within each site, the size of each harem and the cock to hen ratio. The total amount of arable land over which the counts were conducted was measured and the data for each treatment and control site was then converted into densities per km^2, to allow a comparison of results across the treatment and control sites.

5.2.2 Summer/Autumn Brood Counts

The summer/autumn brood counts aimed to provide an estimate of gamebird productivity within each treatment and control site. The summer/autumn brood counts were conducted from approximately late July, once the crops had been harvested, to late August before the fields were ploughed, to improve the chances of observing the birds and their broods as they foraged on stubble. As with the spring counts, arable fields were driven and binoculars used to record any pheasants observed on a pre-prepared map. As the fields only contained stubble, it was possible to traverse them in the vehicle in a zigzag fashion, to cover a greater area and allow a more thorough inspection than was possible by driving only on tracks and boundaries. This was vital as hens and broods behave warily and are often difficult to observe as their coloration blends into the crop stubble. A hen observed with a brood was noted on the map as H + n, where n denoted the number of observed chicks, and an estimate of chick age was also included. The coloration of cock pheasants made them more noticeable than hen birds and chicks. At this time of year they were no longer displaying territorial traits, so all cock pheasants were noted as C on the maps.

Counts took approximately 1.5 to 2 hours per km², although sites with large numbers of broods tended to take longer due to the extra time needed to accurately count the chicks. Three counts were undertaken at each treatment and control site within approximately a 4 week period, and a separate map was used for each count. As with the spring counts, the data were then combined on an OHP sheet using a different coloured pen for each count. Hens with broods, individual birds and groups of birds that were seen on two or three occasions were identified, and these counts were combined to form one observation. Again, the total amount of arable land over which the counts were conducted was measured and the data were converted into densities per km², providing three categories of productivity for each site: (1) density of chicks per km²; (2) density of broods per km²; and, (3) average brood size per site.

It was not possible to undertake an autumn brood count in Treatment site 1.3 in 2002, when set-aside and hemp were applied to the two arable fields in this site. The set-aside produced a thick growth of weeds and crop mixture from seeds spilt the previous year, which was not cut at harvest time. Hemp was also sown on a small area and was cut later than the conventional crops, while the brood counts needed to be completed before the hemp was harvested. Hence, the thick vegetation of the set-aside and hemp made autumn counts impossible.

5.2.3 Assumptions and limitations

There are a number of assumptions and limitations associated with the spring and summer/autumn brood counts that must be recognised. The data generated through the counts are a count of the population density and are not total population counts. Instead they are estimates of a population, generating a data value that would permit comparison between site and/or comparison over time. It is assumed that the pheasants (adult and chicks) reacted in the same way to the observer during the counts and that birds were equally observable at each site. In this sense, it was assumed that an equal proportion of each population was observed at each site and in each year. These assumptions meant that the counts were a representation of the spring populations and the chick numbers, permitting the comparison of data between sites and over time.

5.2.4 Site Variables

Site variables that could potentially explain any differences in gamebird productivity were also measured. The length of habitat features, comprising hedgerow, woodland edge and boundary, were measured within each treatment and control site, using estate data and aerial photographs within a geographical information system (GIS) programme (Global Mapper v5). These information sources were also used to calculate the total area of CSS habitat, set-aside or equivalent features.

5.2.5 Data Analysis

The data analysis sought to examine trends over time between treatment and control sites. Analysis considered the spring population structure and autumn productivity, and sought to determine which factors best explained any changes and differences in productivity.

Firstly, analysis was done to compare data gathered from the treatment sites within Site 1; this was considered necessary as the data from Treatment site 1.1 appeared different to the other treatment sites at Site 1. A t-test was conducted comparing territorial cock and hen numbers for Treatment site 1.1 to the means of Treatment sites 1.2 – 1.4. The findings of this analysis meant data from Treatment site 1.1 was not combined with data from the other three treatment sites from Site 1.

The initial examination of data from all sites for the spring counts was concerned with the densities of adult pheasants, sub-divided into the categories of cocks and hens per km^2. The density of hens signifies the potential breeding stock (Tapper, 1988; Robertson *et al*, 1993b). The autumn brood count data were sub-divided into the categories of chicks and broods per km^2 and average brood size.

To examine trends over time between treatment and control sites, the data were analysed using repeated measures ANOVA using unlogged data, to compare the variance caused by differences in the data. This analysis had two components: firstly, between subjects analysis looked for differences between sites. This considered data from all sites separately, including the four treatment sites. Secondly, within subjects considered trends over time (i.e. was there change over time at a site that was different to the trend with time at the other sites). To compare data between individual sites, a one sample t-test was used; this compared the mean values calculated from data from one year from treatment sites at Site 1 (Treatment sites 1.2-1.4 for reasons explained above) to the fixed value (with no variance) recorded from one of the other sites. There was no issue with repeat testing errors due to undertaking just one t-test. Due to the small sample size, it was considered appropriate to achieve significance at $P<0.1$. Productivity at Treatment site 1.3 was interpolated for 2002, as it was not possible to conduct an autumn brood count that year. This interpolation was achieved by taking the mid-point between the 2001 and 2003 autumn brood counts for Treatment site 1.3. Whilst not an ideal way to arrive at an accurate estimate for the 2002 count, such interpolation was considered preferable to excluding all data from Treatment site 1.3 from the analysis.

Management differed across the four treatment sites and three control sites (see Chapter 4). To determine whether any differences in autumn chick productivity across management types could be explained by such factors as the level of gamekeeping effort and releasing rates of reared birds, the autumn count data for different sites were combined into different management categories, as shown in Table 5.1. Where data for two separate treatment and/or control sites fell into the same management categories, the means of their respective autumn counts were included in the analysis. For management category 2, the mean densities for Treatment sites 1.2 and 1.3 were used in all years except for 2002, when the data for Treatment site 1.2 only was used, so as to avoid using the interpolated estimate for Treatment site 1.3. Autumn count data were analysed using repeated measures ANOVA, in order to determine whether there were differences in the density of chicks and broods between management categories over time.

A regression analysis was undertaken to assess which explanatory variables including management, habitat characteristics, and pheasant population dynamics),appeared to best explain any differences in autumn productivity at each treatment and control site. The dependant variable in the analysis comprised the autumn density of chicks at each site. The data from all sites for all years were used within the regression analysis as the variables differed between sites and between years. There were 27 data points in total (28 minus one due to the missing data point for Treatment site 1.3 in 2002) providing a reasonable data set for the analysis. However, the statistical test was given more power than it had really got as a result of the increased number of data points due to pseudo-replication.

Pseudo-replication was recognised as an issue but was considered to impose limits that come with any observational study[7]. Pseudo-replication is of particular concern when testing for treatment effects (Hurlbert, 1984). However, this study was observational, and using the data in this way was not considered problematic. Hence, the analysis was conducted to explore variation in the data with a view to generating interesting hypotheses, rather than proving causal effects, and the strength of those effects, of variables on the counts. Should the analysis highlight variables that appear to be contributing substantially to the variation in the counts, further experimentation using controlled treatments would be necessary investigate whether this is a causal effect.

Table 5.1: Table to show the game management categories for each site

Management category	Sites	Basis for classification
1	Treatment 1.1 & Control 3	No management for wild game; no releasing
2	Treatments 1.2 & 1.3	High levels of wild game management; high levels of releasing
3	Controls 2 & 4	Substantial wild game management; minimal/no releasing
4	Treatment 1.4	Some wild game management; substantial releasing

The explanatory variables that were included in the regression comprised all those believed likely to affect productivity, and were as follows:

(1) spring density of territorial cocks/km² (Figure 5.1);
(2) spring density of non-territorial cocks/km² (Figure 5.1);
(3) spring density of hens/km² (Figure 5.1);
(4) spring ratio of hens to territorial cocks;
(5) spring ratio of hens to all cocks;
(6) amount of CSS or similar feature (Tables 4.1 & 4.4);
(7) gamekeeper effort (Table 4.9);
(8) supplementary feeding effort (number of feeders/km²) (Table 4.7);
(9) total amount of edge habitat (m/km²);
(10) amount of woodland edge (m/km²);
(11) amount of hedgerow (m/km²);
(12) the number of reared gamebirds release per year (Tables 4.5 & Appendix 2).

Two regression analyses were performed. The first compared productivity with all explanatory variables at all treatment and control sites. Each variable was considered separately one at a time within the regression analysis to avoid problems of multicollinearity. For both regression analyses, the variability as a result of site and year was accounted for before each variable was analysed to suggests how much variability in pheasant productivity it accounted for. The second regression analysis was conducted using only the data from those treatment and control sites on which there was a gamebird shoot, to determine the possible effect of releasing reared gamebirds on productivity. Therefore, Control site 3 was excluded from this analysis because there is no shoot on this site. The reasoning behind this analysis is to determine whether the observations in this study followed previous findings that suggested that release of reared gamebirds had a negative affect on wild productivity and that the greater the density of reared birds, the greater that impact (see Section 5.1.2; Robertson and Dowell, 1990; Tapper, 1999; Woodburn, 2000). Should this supposition be supported (increased levels of releasing increases the degree of negative impact on wild productivity) it may be possible to persuade those shoot

[7] There was no control over the variables at the sites, such as the gamekeeping management, spring pheasant population etc, making this study observational rather than experimental in design.

owners who are unwilling to stop releasing altogether to reduce the degree to which they release reared gamebirds. Therefore, it was unsuitable to include data relating to wild productivity on a site that does not have any gamebird management (i.e. Control site 3).

5.3 Results

5.3.1 Spring pheasant counts

Comparison of the data gathered in 2004 at Treatment site 1.1 at Site 1 with those from 1.2, 1.3 and 1.4 highlighted that there was a significant difference in the density of territorial cocks at Treatment sites 1.1 compared to 1.2 to 1.4 ($t = 5.299$; $df = 2$; $P<0.05$). Due to this difference, data for Treatment site 1.1 was not combined with that of Treatment sites 1.2 to 1.4 for analysis; as such Treatment site 1.1 was classified in a separate category of management (see Table 5.1).

Figures 5.1 show the spring counts for the different sites. There were more territorial cocks at Site 1 (Treatment sites 1.2 to 1.4) compared to the other sites ($F= 4.659$; $df = 2,4$; $P<0.1$). Considering the data from all sites, there was no difference in the overall trend over time ($F=0.241$; $df = 3,12$; $P = 0.866$) and no difference in the trend over time between one site and another ($F=0.228$; $df = 6,12$; $P = 0.960$) (Figure 5.2).

Comparison of the data gathered in 2004 at Treatment site 1.1 at Site 1 with that from 1.2, 1.3 and 1.4 highlighted that there was a difference in the density of hens at treatment sites 1.1 compared to 1.2 to 1.4 ($t = 4.122$; $df = 2$; $P<0.1$) (Figure 5.1). As with the data for territorial cocks, this difference meant the data for Treatment site 1.1 was not combined with that of Treatment sites 1.2 to 1.4 for analysis; this reinforced the necessity to classify Treatment site 1.1 in a separate category of management (Table 5.1).

Figure 5.1: Densities/km² of each sex class of pheasants during spring counts across all treatment and control sites from 2001 to 2004. Data from Site 1 (Treatment 1.2 – 1.4) represent the mean ± SE of the three treatment sites. No data were available for Control sites 2 and 4 during 2001.

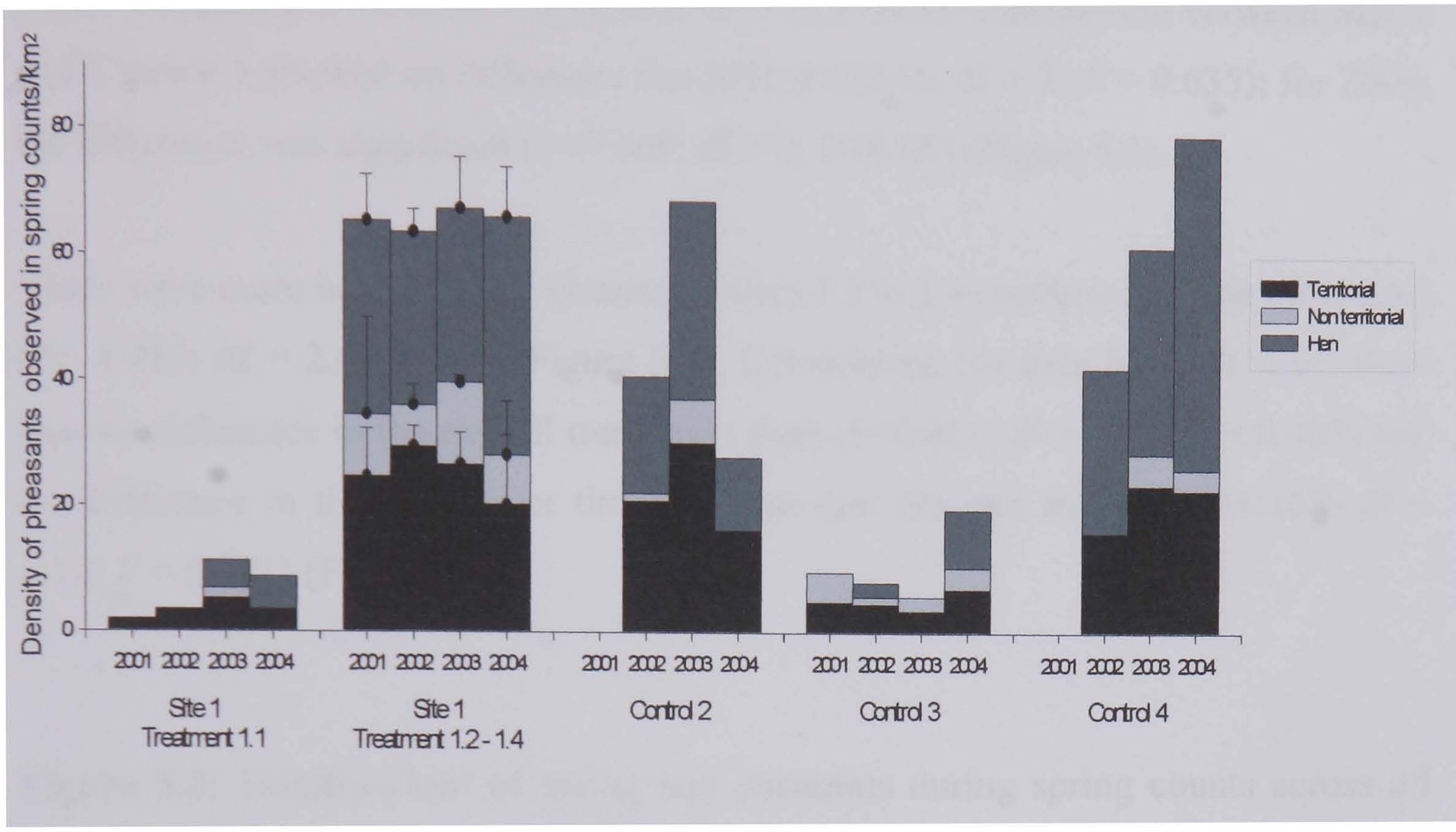
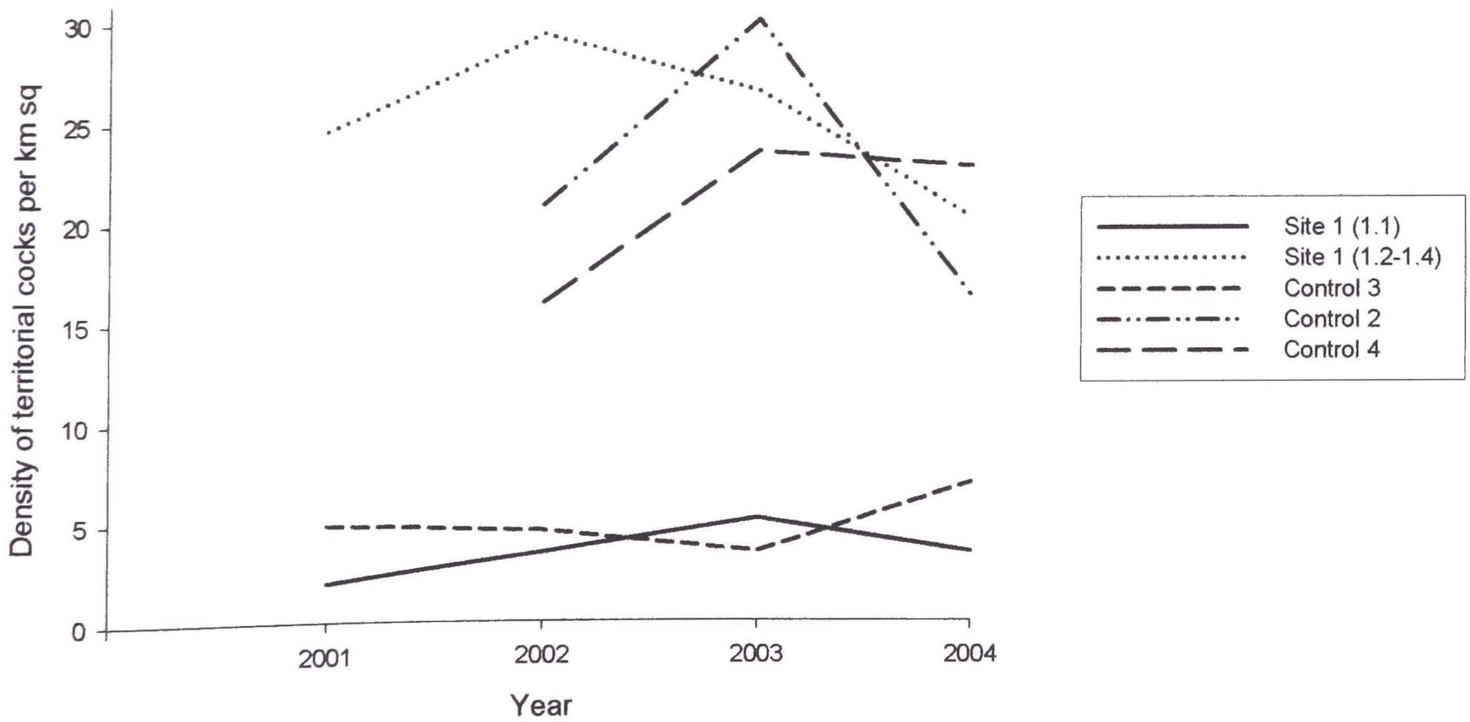


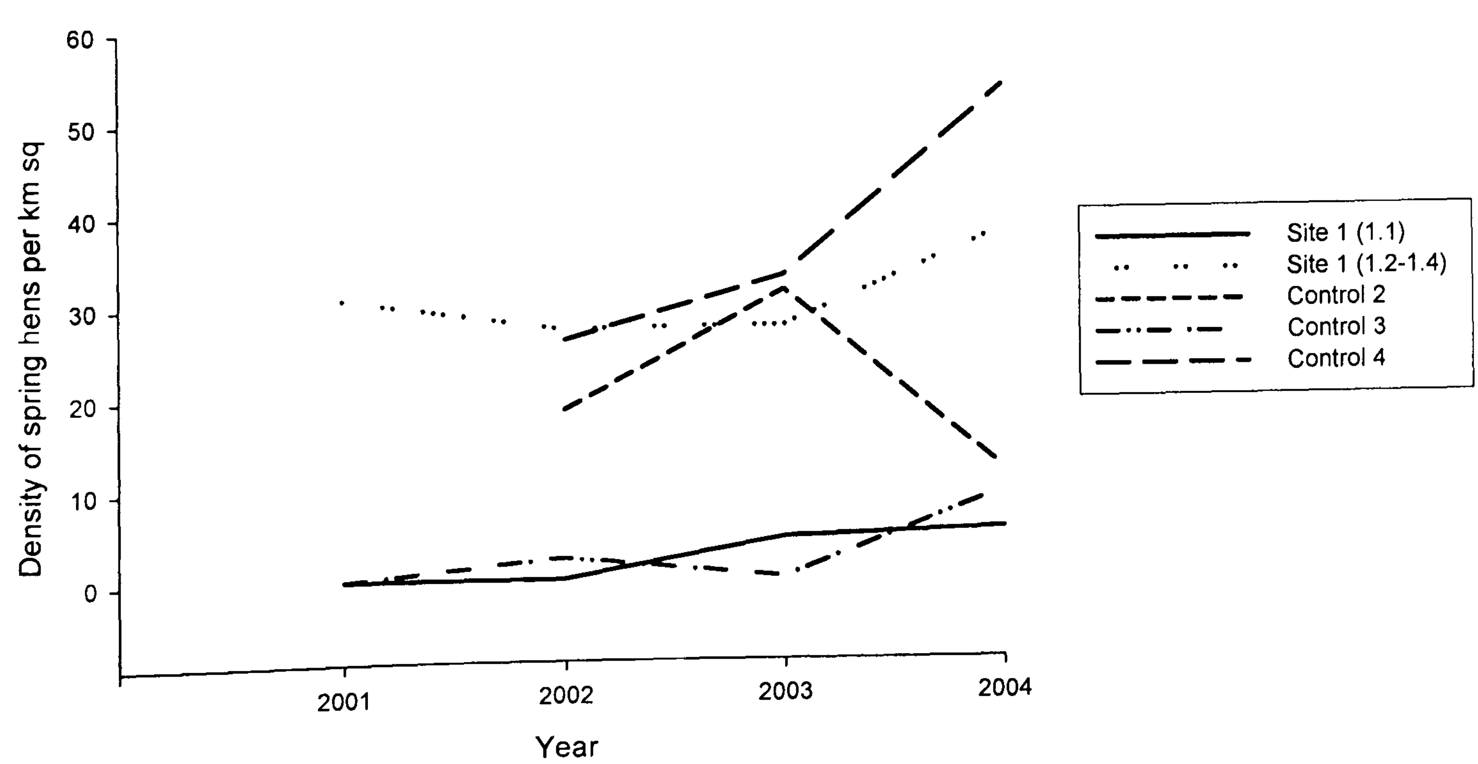
Figure 5.2: Densities/km² of territorial cock pheasants during spring counts across all treatment and control sites from 2001 to 2004. No data were available for Control sites 2 and 4 during 2001.



T-tests were undertaken to compare the chick numbers for Site 1 (1.2 – 1.4) to Control 2 for 2002 (baseline data as there were no counts for 2001 for this site) and 2004. In 2002, there was no difference in the hen numbers between Site 1 and Control 2 (t= 1.497; df = 2; P = 0.273). For 2004, there were more hen pheasants at Site 1 compared to Control 2 (t=4.956; df = 2; P<0.5). Comparison between Site 1 and Control 4 showed no difference for 2001 (t=0.555; df = 2; P = 0.635); for 2004, the difference was significant (t=-7.969; df = 2; P<0.05) (Figure 5.1).

There were more hens at Site 1 (treatment sites 1.2 to 1.4) compared to the other sites (F= 4.433; df = 2,4; P<0.1) (Figure 5.1). Considering the data from all sites, there was no difference in the overall trend over time (F=0.851; df = 3,12; P = 0.492) and no difference in the trend over time between one site and another (F=0.168; df = 6,12; P = 0.981) (Figure 5.3).

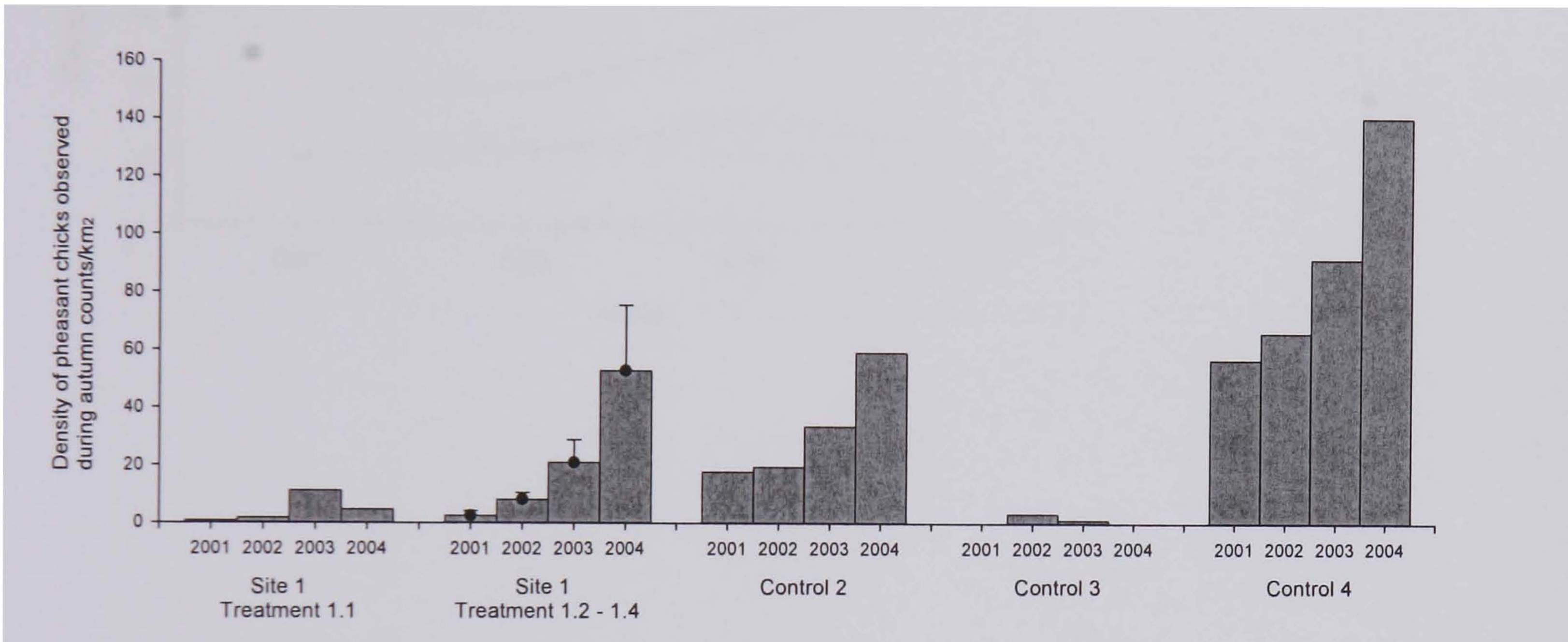
Figure 5.3: Densities/km² of spring hen pheasants during spring counts across all treatment and control sites from 2001 to 2004. No data were available for Control sites 2 and 4 during 2001.



5.3.2 Autumn pheasant counts

Pheasant broods were widely and increasingly distributed across Site 1 between 2001 and 2004 (Appendices 3 to 6). The number of chicks observed at Site 1 (Treatment sites 1.2-1.4) rose over the four years (Figure 5.4). Comparison in the number of chicks between Site 1 (Treatment sites 1.2-1.4) and the control sites indicated no significant difference in the data (F=3.690; df = 2,4; *P*=0.124).

Figure 5.4: Densities of pheasant chicks per km² during autumn counts at each treatment and control site from 2001 to 2004. Site 1 (Treatment 1.2-1.4) data represent the mean ± SE of the three treatment sites.



A significant difference was found when considering chick numbers over time (F=12.698; df = 3,12; *P*<0.01) (Figure 5.5). ; The comparison of chick numbers between sites over time suggests a significant difference in the trend over time between Site 1 (Treatment sites 1.2 – 1.4) and at least one other site (F=2.973; df = 6,12; *P*<0.01) (Figure 5.5).

T-tests were undertaken to compare the chick numbers for Site 1 (1.2 – 1.4) to Control 3 for 2001 (baseline data) and 2004. In 2001, there was no difference in the chick numbers between Site 1 and Control 3 (t=1.546; df = 2; *P* = 0.262). For 2004, there was a trend towards significance (t=2.989; df = 2; *P*<0.1). Comparison between Site 1 and Control 4 showed a very highly significant difference for 2001 (t=-33.243; df = 2; P<0.001); for 2004, the difference was significant (t=-4.493; df = 2; P<0.05).

Figure 5.5: Densities/km² of pheasant chicks during autumn counts across all treatment and control sites from 2001 to 2004.

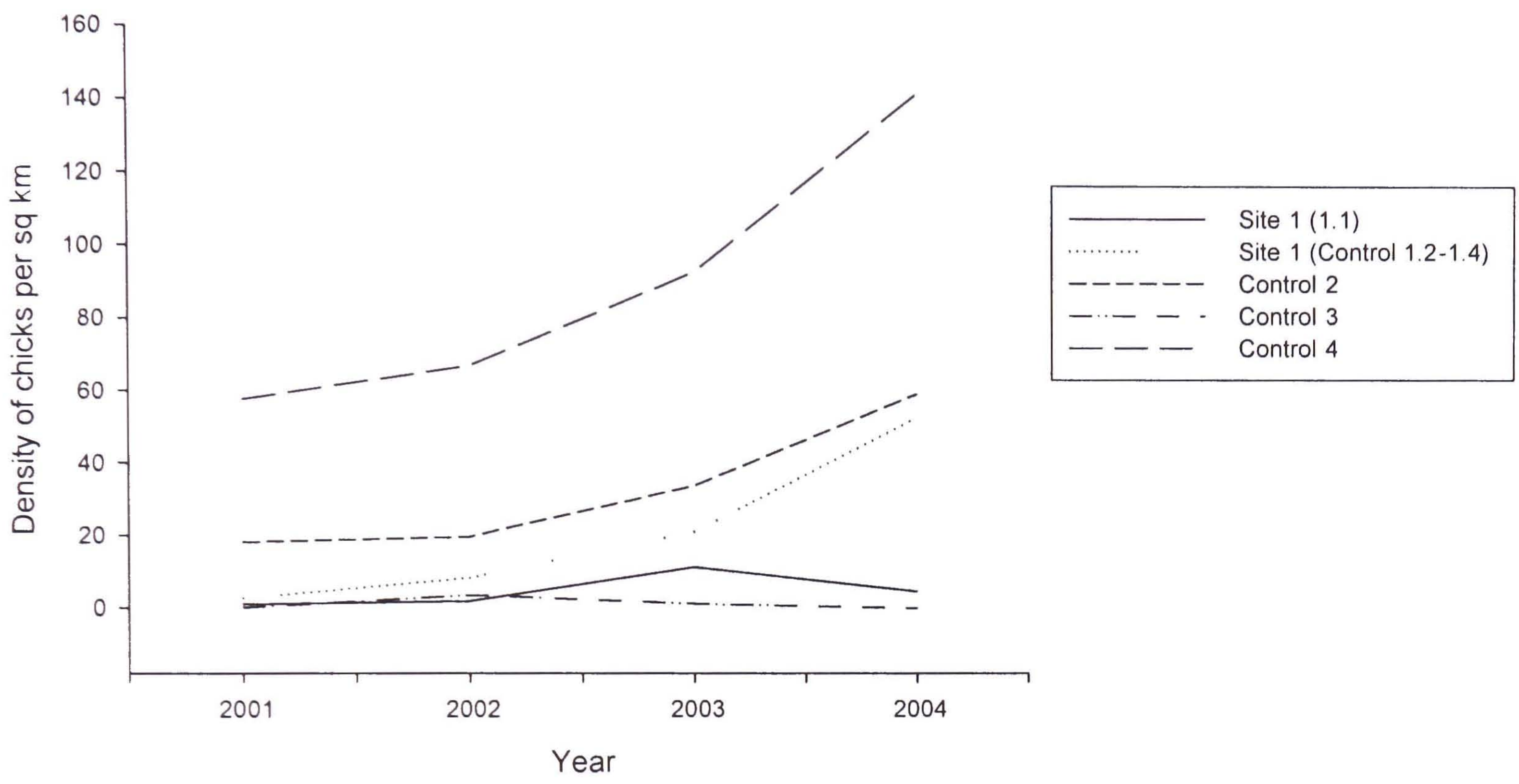
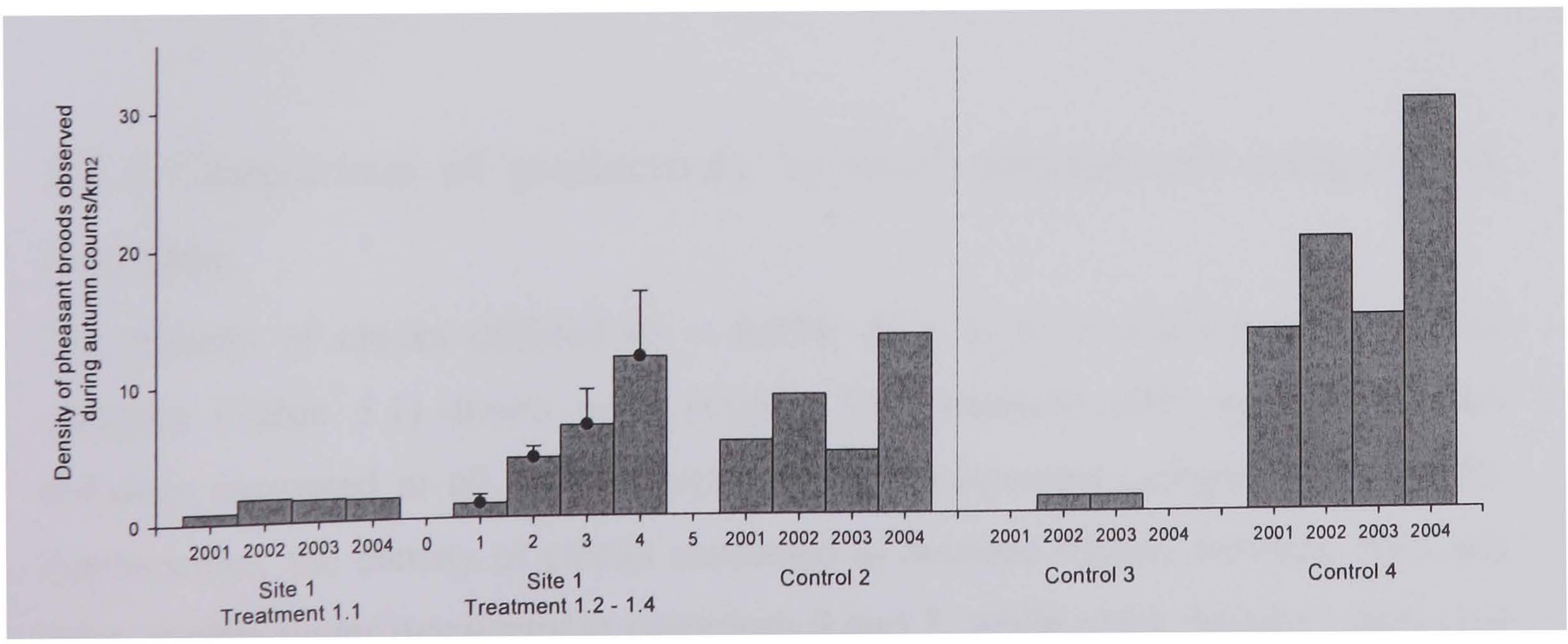
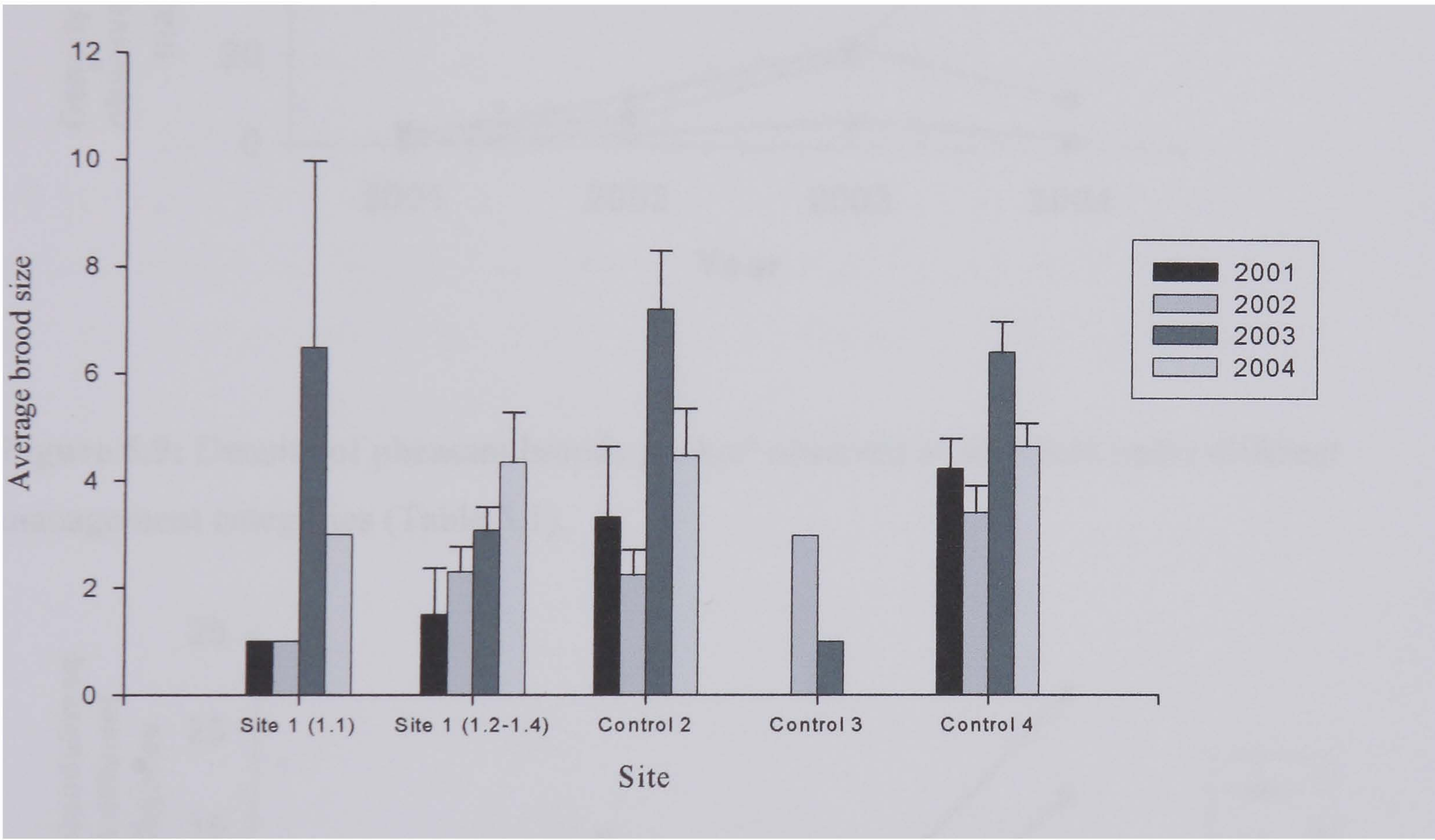


Figure 5.6: Densities of pheasant broods per km² counted during autumn counts at each treatment and control site from 2001 to 2004. Site 1 (Treatment 1.2-1.4) data represent the mean ± SE of the three treatment sites.



The trend in pheasant brood density shows the number of broods observed at Site 1 (Treatment sites 1.2 – 1.4) increased between 2001 and 2004 (Figure 5.6). Comparison in the number of broods between Site 1 (Treatment sites 1.2-1.4) and the control sites indicated no significant difference in the data ($F=3.822$; df = 2,4; $P=0.118$). A significant difference was found when considering the number of broods over time ($F=6.800$; df = 3,12; $P<0.05$), suggesting an increase in the brood density.

Figure 5.7: Mean ± SE of brood size counted during autumn counts at each treatment and control site from 2001 to 2004.



5.3.3 Comparison of productivity between management categories & over time

The density of chicks differed ($F = 8.974$; df = 3, 9; $P<0.05$) by management category (Table 5.1) across years (Figure 5.8). Between 2001 and 2003, chick densities increased at all sites, irrespective of management category (Figure 5.8). Furthermore, the density of chicks continued to increase sharply between 2003 and 2004 at sites under management categories 2 and 3, while chick densities decreased at sites under management categories 1 and 4.

Figure 5.8: Density of pheasant chicks per km² observed at sites held under different management categories (Table 5.1).
Management categories: 1 – no wild game management; 2 – high levels of wild game management, releasing; 3 – substantial wild game management, minimal/no releasing; 4 – some wild game management, substantial releasing.

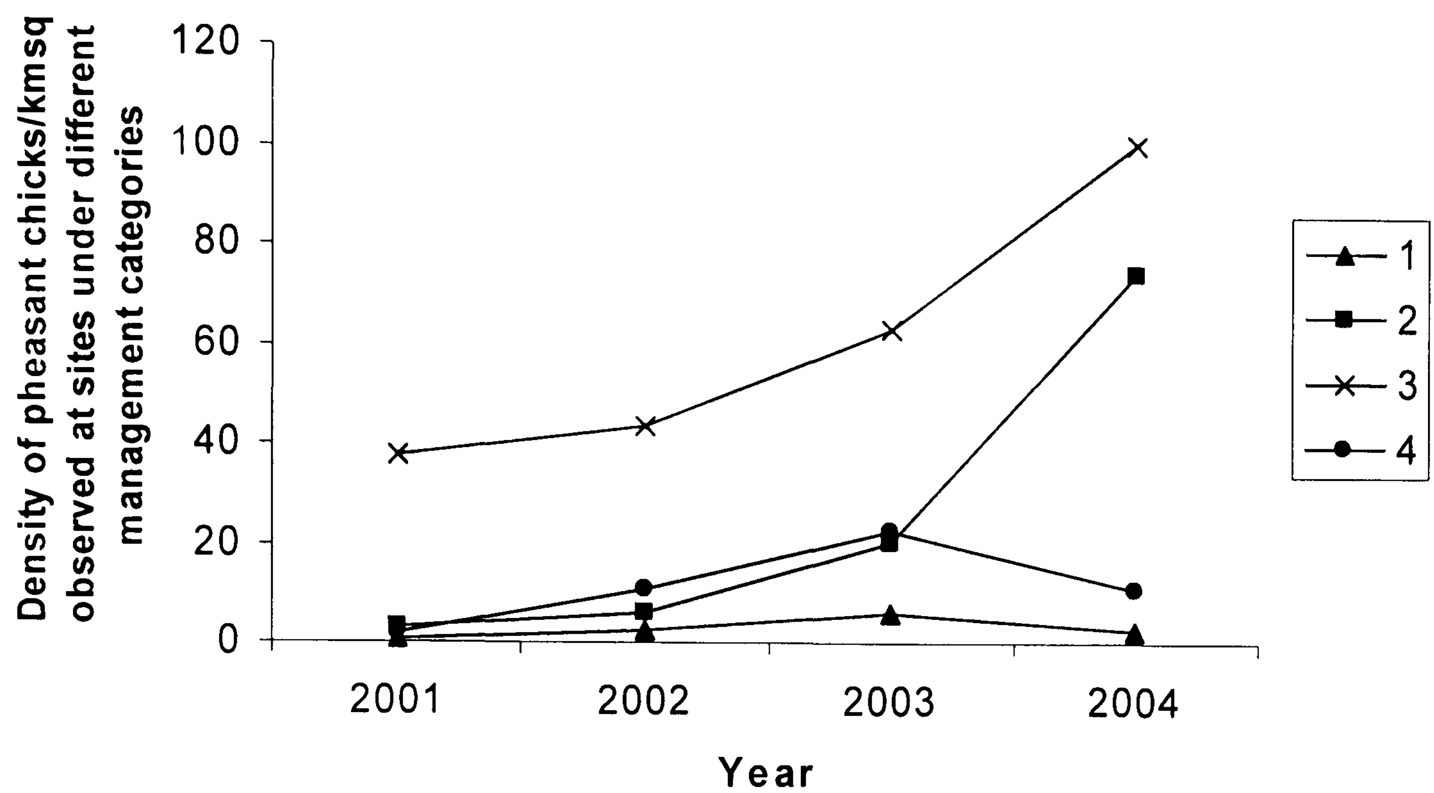
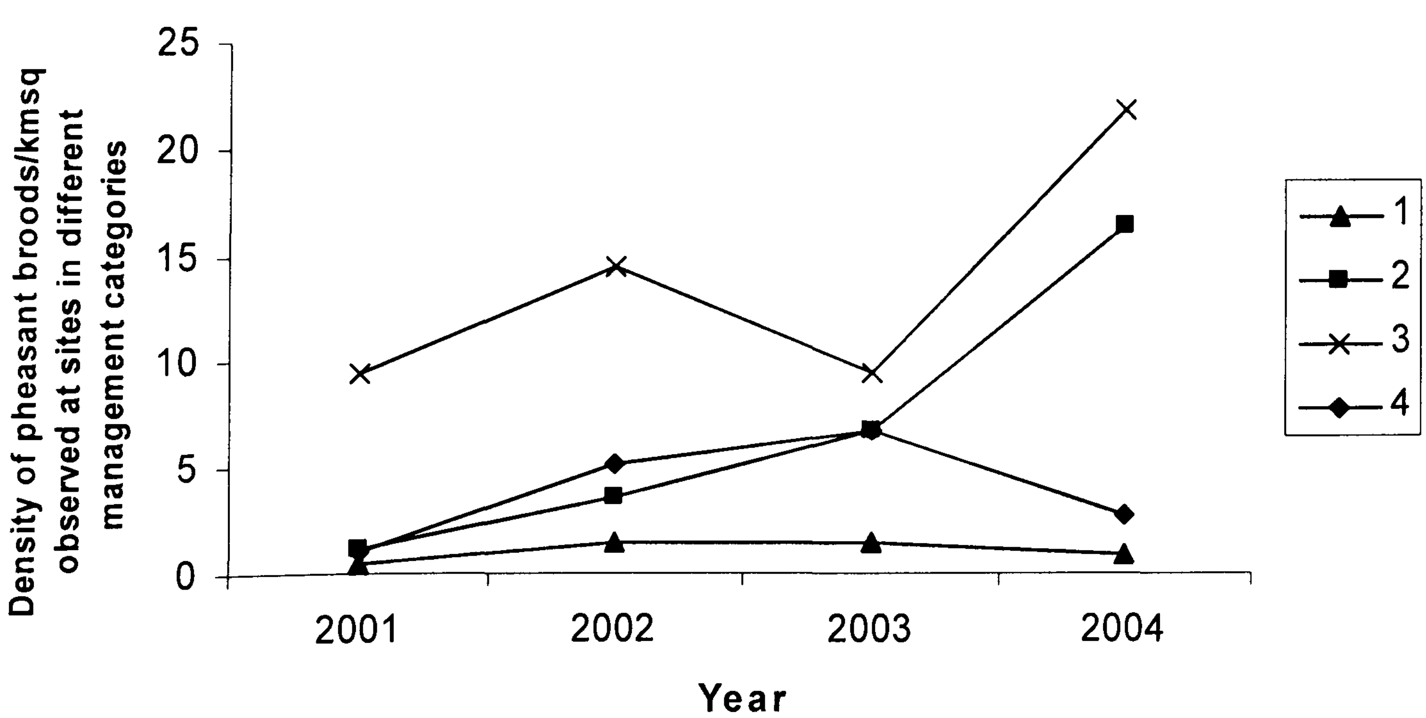


Figure 5.9: Density of pheasant broods per km² observed at sites held under different management categories (Table 5.1).



The trend in the density of broods differed (F = 8.893; df = 3, 9; $P<0.01$) by management category (Figure 5.1) over time (Figure 5.9). The density of broods at management category 1 returned to the starting density in 2004 after a slight increase in 2002 (Figure 5.9). Management category 2 experienced an annual increase in the density of broods (Figure 5.9). The density of broods at management category 3 fluctuated over the four years (Figure 5.9), although the density of broods was always greatest for this site type. The density of broods increased for two years at management category 4 before decreasing in the final year (Figure 5.9).

5.3.4 Analysis of site variables on pheasant chick productivity

The density of territorial and non-territorial cocks, amount of CSS, total amount of edge, amount of hedge and amount of woodland edge had no significant effect (all $P > 0.05$) on chick density in autumn counts (Table 5.2). In contrast, the density of hens and the ratio of all cocks to hens in spring counts and gamekeeping effort and supplementary feeding had significant effects (all $P < 0.05$) in explaining differences in the density of chicks observed during the autumn counts at all treatment and control sites (Table 5.2). When considering the density of pheasant chicks at those sites on which there was shooting (Site 1 and Controls 2 and 4), the level of releasing did not appear to significantly affect the density of chicks ($P > 0.05$) when considered independently of other variables (Table 5.2).

Table 5.2: Regression analysis for the variables that best explain the density of chicks in autumn brood counts across all treatment and control sites

Variable	B	s.e.	df	Significance
Territorial Cocks	1.205	0.665	3	0.083
Non-territorial cocks	-0.115	1.404	3	0.935
Hens	1.548	0.340	3	<0.001
Ratio cocks:hens	41.568	12.350	3	<0.01
Gamekeeping	17.676	0.136	3	<0.001
Supplementary feeding	20.298	3.961	3	<0.001
CSS	3.343	2.444	3	0.184
Total edge	0.489	2.784	3	0.862
Wood edge	-1.844	3.283	3	0.579
Hedge length	2.830	3.962	3	0.482
Release	-5.423	4.739	3	0.263

The results suggest that the density of hens in spring counts, the gamekeeping effort and supplementary feeding best explain the variations in chick densities, as indicated by high *P* values ($P<0.001$) (Table 5.2).

5.4 Discussion

During focus group meetings, all stakeholder groups raised the issue of current levels of rearing and releasing on lowland gamebird shoots (Chapter 3). Focus groups noted concerns about detrimental effects to conservation, poor husbandry, and the spread of disease. As importantly, focus groups raised the emotive issue of public perceptions on rearing large numbers of animals specifically to be shot. Focus groups saw the best solution as reducing the number of gamebirds reared for release. If release levels indeed become subject to future regulation, wild produced gamebirds could be used to supplement the bag, and the marketing of mixed shoots might in turn increase the sums 'guns' would be willing to pay (Chapter 8). Indeed, if Britain follows the Netherlands in imposing a future total ban on releasing (Tapper, 1999), wild produced gamebirds will be essential to the continuation of shooting.

Consequently, this chapter sought to determine whether it was possible to enhance the viability of the wild pheasant population, on a commercially-managed arable farm, in the presence of a commercial shoot on which a substantial, but decreasing, number of reared gamebirds were released (Chapter 4). If a significant number of wild birds can be produced through habitat management and gamekeeping, it is conceivable that the number reared for shooting can be further reduced, thus addressing some of the concerns attributed to the current levels of release.

5.4.1 Spring pheasant counts

Comparison of the spring counts data (territorial cocks and hens) for Treatment site 1.1 and Treatment sites 1.2 to 1.4 for 2004 showed a significance difference for both pheasant groups. This indicates that management at Treatment site 1.1 was different to that at the rest of Site 1 (1.2 to 1.4) generating a difference in the number of territorial cocks and hens. Therefore, Treatment site 1.1 was classified as a separate management category, given there was no game management or game shooting occurring on this part of the estate, and the difference found in the data from Treatment site 1.1 when compared to Treatment sites 1.2 to 1.4 corroborates this decision.

There were more territorial cocks at Site 1 (1.2 – 1.4) compared to other sites (Figure 5.1). On gamebird shoots, the density of territorial cocks is often assumed to be an indicator of habitat quality (Hill and Robertson, 1988) suggesting that Site 1 was of higher quality than the other sites. In addition, the density of territorial cocks at Site 1 did not vary to a great degree over the four years suggesting that habitat quality did not change either. Such a conclusion was reached when the density of territorial cocks did not change on a farm in Dorset (Woodburn, 2000). However, the quality of habitat for territorial cocks only depends on their requirements prior to and during the breeding season, and may not reflect the quality habitat required for successful nesting and production of young. Hence, hens do not select a mate based on the nesting habitat within his territory. Instead, the quality of the cock is the primary factor dictating mate choice (Hill & Robertson, 1988; Hoodless *et al*, 1999). However, territory quality, including aspects of the availability of natural food and the provision of shelter, may have an important effect on harem size (Robertson *et al* 1993b). Therefore, the density of territorial males is an accurate method of comparing habitat quality between sites or over time but provides no information on the overall population size (Draycott, 2003) or necessarily how successful productivity will be.

Densities of territorial cocks at Site 1 are similar to territorial cock densities recorded during a long-term study on wild pheasant population dynamics on arable land in East Anglia (Draycott, 2003) and with territorial cock densities at Seefeld Estate in Austria, an arable area with some of the highest densities of wild pheasants in Europe (Draycott *et al*, 2002). Both studies examined managed wild pheasant populations where productivity permits significant levels of shooting each year, which suggests that habitat quality for Site 1 is comparable to that of sites where wild productivity is substantial.

The density of non-territorial cocks each year at Site 1 (Figure 5.1) shows that there were sufficient cocks to occupy all available territories (Robertson *et al,* 1993b).

However, high densities of non-territorial cocks can lead to reduced productivity as non-territorial males attempt to mate with unguarded hens who, in turn, may expend energy and attention whilst incubating eggs, trying to escape and risk suffering injury, which can increase the rate of nest abandonment and lower productivity levels should another clutch not be laid (Hill and Robertson, 1988). The density of non-territorial cocks on Seefeld Estate was similar to those observed at the Control sites, possibly indicating that densities of non-territorial cocks at Site 1 may be higher than that which is ideal for realising maximum productivity, if hens are excessively harassed.

The density of non-territorial cocks at Site 1 was similar to the mean density observed in the East Anglia study (Draycott, 2003). However, hen densities were twice as great at the East Anglia sites, suggesting that, if occurring, harassment levels per hen were lower due to more favourable hen to cock ratios. Therefore, it may be beneficial to decrease the density of non-territorial cocks at Site 1. In general, so long as there are enough cocks to 'service' the hens, the polygynous breeding system of pheasants means that there can never really be too few males (Hill and Robertson, 1988). Shooting cocks only, particularly towards the end of the season and leaving a couple of days before 1st February for gamekeepers to shoot any cocks they observe, may be highly beneficial.

The density of hens can have important implications for productivity, as this determines the potential nesting rate of a population (Hill and Robertson, 1988b). Comparison of Site 1 (1.2 – 1.4) and all other sites showed there to generally be more hens at Site 1, indicating a good density of hens available to produce broods. Direct comparison of hen densities at Site 1 (1.2 – 1.4) and Control 2 showed no significant difference for 2002 but significantly more at Site 1 for 2004. This may have been a result of the new shoot policy at Site 1, indicating that the cock-only bags on shoot days towards the end of the season had a positive result in increasing the hen density entering the breeding season.

As there was no difference in hen densities at Site 1 and Control 4 when comparing 2002 data but a significant difference for 2004 (Figure 5.1). This indicates that the population at Site 1 may support sufficient hens at the start of the breeding season to produce comparable productivity levels but that the practice of cock-only bags at Control 4 was also having a positive influence on the density of hens at this site, and to a greater degree than at Site 1, hence the difference.

In contrast, Control site 3 had low hen densities, possibly because of a lack of habitat management, predator control and supplementary feeding. The low densities of cocks may also have failed to attract hens, and the lack of suitable nesting habitat probably compounded the situation as any hens present in the spring would have dispersed in late spring in order to find a nest site.

There was no difference in the trends over time between sites for densities in territorial cocks (Figure 5.2) and hens (Figure 5.3) indicating that spring densities did not alter significantly between years.

The data for the spring counts at Site 1 (1.2 – 1.4) shows that the overall densities of adult birds did not change over four years (Figure 5.1). This indicates that gamebird bird survival, wild productivity, and shooting intensity were relatively constant in relation to the number of birds on the ground (Robertson and Rosenberg, 1988) and suggests a stable pheasant population. So long as the number of birds driven over the 'guns' allow for bag sizes to be met[8], these counts for Site 1 suggest that the new shoot management regime at Site 1 is meeting shoot day targets. Because spring population sizes at Control sites 2 and 4 are similar to those at Site 1, this suggests that Site 1 is not releasing too many birds in relation to the size of bags, as not many birds remained after the shooting season.

5.4.2 Summer/Autumn pheasant counts

Summer/autumn brood counts showed that Site 1 (1.2 – 1.4) experienced an increase in productivity in terms of brood density (Figure 5.4) and average brood size (Figure 5.6), possibly in response to improved habitat quality resulting from the new land management regime.

[8] It is more appropriate to look at the number of birds driven over the 'guns' & the number of shots taken rather than the final bag size. Not reaching bag limits can imply a lack of sufficient birds, but a team of Guns who are poor shots may not reach the target bag size as birds are too challenging a shot.

The increase in productivity at Site 1 arose from increases in average brood size, and in the density of broods. Small brood sizes are indicative of a lack of chick food resulting in low chick survival rates (Tapper, 1988). Conversely, the increase in brood size at Site 1 suggests that chick survival may have increased, because of improved provision of chick food insects through the establishment of habitat features such as grass strips and beetle banks. The highest average brood size of 4.4 chicks/brood at Site 1 was almost equal that proposed as the average brood size 5.0 chicks/brood on optimum land that is keepered and well managed, and well in excess of the estimate of 2.5 chicks/brood for optimum land lacking good management (Tapper, 1999).

The locations of pheasant broods at Site 1 show that the broods were generally observed within close proximity of cover, usually a hedge or woodland edge (Appendices 3 to 6). Such edge habitats are preferentially utilised by broods, and provide a good source of food and protection from predation and inclement weather (Bence, 2000). Indeed, hedgerow removal can leave gamebirds vulnerable to predation (Tapper, 1999).

The cropping regime and availability of scrubby areas may also have affected brood distribution. The layout of non-crop habitat at Site 1 was not uniform, as is the case for most agricultural areas. Cropping was done primarily by rotation rather than through design of grouping fields of the same crop together, although block-cropping did occur in some seasons. It is impossible to say whether habitat uniformity or crop type influenced the location of broods at Site 1. Radio-tracking hens with broods is the most appropriate method to establish habitat preferences. Such studies have been previously conducted and have shown that food appeared to be the most important factor in determining the locations visited by broods, with chicks preferring to feed in insect-rich habitat, such as grassy and weedy strips and areas of weedy crops (Hill, 1985; Hill and Robertson, 1988). Such areas are primarily found on the edge of arable fields, either as a consequence of normal farming practices or created by specific land management such as AESs and gamebird management. A more recent study found that set-aside was the preferred habitat for broods, providing it was near or within the home range of the hen. Edge habitat, woodland and winter wheat were also found to be preferentially used by broods (Bence, 2000).

Comparison of the density of chicks at Site 1 (1.2 – 1.4) with chick density at Control 3 in 2001 showed there was no significant difference between the counts; however, comparison of the 2004 data suggested a trend towards (with significance at 0.1), with Site 1 having a higher density of chicks. This indicates that the new management regime was having a positive effect on pheasant productivity, an effect responsible for creating higher densities of chicks compared to a site not receiving game management thought to be beneficial (such as predator control, supplementary feeding and additional quality habitat provision).

Control 4 had greater densities of chicks than Site 1 (Figure 5.4), possibly due to the greater length of time wild game management had been undertaken at these two sites. The alternative habitat, such as grass strips and beetle banks, had been in place a number of years prior to the commencement of the study. Hence, they were more established and likely to have provided better quality habitat than the habitat at Site 1, which was newly created. The level to which productivity will continue to increase at Site 1 will depend on factors such as final quality of habitat once enhancement has ceased, the level of future gamekeeping effort, future shooting pressure, and the dynamics of the adult pheasant population. In addition, the gamekeeping directed to promote wild game productivity at Control 4 was in place for several years prior to its introduction at Site 1. Therefore, this control site may have had higher densities of wild pheasants than Site 1 and that the gamekeepers may have been more skilled in the techniques required for promoting wild game productivity, such as effective predator control, as a consequence of their longer experience. However, comparison indicated that the difference in chick densities was moving towards becoming less significant, as for 2001 $P<0.001$ but for 2004 $P<0.05$. This suggests that the management regime was having a beneficial effect on productivity at Site 1 and that chick counts from subsequent years may have shown Site 1 to have comparable densities to the wild game shoot at Control 4.

Comparison in the density of broods at all sites over time indicated a difference, suggesting that pheasant broods increased over time. This suggests that there was perhaps a regional increase in pheasant broods, perhaps as a result of suitable breeding conditions. However, brood densities at Site 1 may have increased as a result of the new management regime, and the data shows the site experienced annual increases (Figure 5.6), suggesting this was a response to the new management regime. Brood densities at Controls 2 and 4 may still have been increasing as a result of the game management regimes they introduced several years previously, although the two sites did not experience annual increases and displayed similar variations in brood density (Figure 5.6).

The density of pheasant chicks and broods at Control site 3 were very low throughout the study (Figures 5.4 and 5.6). The lack of gamebird productivity was most likely due to factors such as: (1) the lack of gamebird management in terms of predator control and supplementary feeding; and (2) the absence of alternative habitat types within the arable landscape due to no AESs, cover crops or brood rearing strips. Adoption of an AES in 2004 may have lead to increased productivity in subsequent years, should the grass strips provide suitable nesting and brood rearing areas. However, this will also depend on factors such as mortality rates in the absence of gamekeeper management, which is designed to enhanced survival through practices such as predator control and supplementary feeding.

5.4.3 Productivity between management categories and over time

The different levels of land management at each site (see Chapter 4) had the potential to affect gamebird productivity. The management varied between the four study areas at Site 1, even though they were located on one estate. Division of the study areas into management categories highlighted the differences between the sites and the variables that could affect productivity; Tapper (1988) endorsed monitoring of gamebird populations for just such a reason and, for Site 1, this method has identified areas of the estate where differences in the management regime could have substantial repercussions on gamebird productivity.

The density of pheasant chicks increased between 2001 and 2004 at Management category 3. In part, this presumably arose in response to increasing habitat quality and high levels of gamekeeper effort. Furthermore, the fieldwork period may have represented four good years for pheasant productivity. Management category 3 sites showed the greatest level of productivity, possibly because this category experienced the highest levels of gamekeeping and the least amount of releasing. These two factors are indicative of estates such as Tendring Hall with high productivity (Sage, 1999). Productivity also increased substantially over time within management category 2 sites because gamekeeping effort was high at these sites. The number of reared gamebirds released, particularly pheasants, was also high for management category 2 sites, which indicates that the level of releasing did not prevent wild pheasant productivity, although it is possible that negative impacts, such as increased predation pressure if predators were attracted by the increase in prey availability or harassment of hens by cocks, may have limited productivity levels.

The comparatively low levels of chick productivity at the management category 4 (Figure 5.5) site may have arisen because of the high level of releases and the lower levels of gamekeeping effort. It has previously been recognised that increasing demands from rearing regimes result in less time for traditional gamebird management such as predator control (Tapper, 1999). Gamekeeping effort at the management category 4 site may also have been restricted by the public access, which can limit the ability of the gamekeeper to undertake predator control. Public access can make it difficult to deploy traps and snares, which are often interfered with, or to practice lamping, which is dangerous when members of the general public may be present (John Fountain, head gamekeeper, personal communication). The low level of pheasant productivity at the management category 4 site may also have been a direct result of the release of reared gamebirds. The presence of reared hens can reduce the breeding success (Robertson and Dowell, 1990; Sage and Robertson, 2000) and the presence of a large number of reared birds on the ground may attract predators, increasing hen and nest predation (Robertson and Dowell, 1990; Woodburn, 2000).

Management category 1 sites had extremely low productivity throughout the study (Figure 5.5). No reared birds were released and these sites experienced no gamekeeping effort. Hence, the presence of reared birds was not responsible for the low levels of productivity. Indeed, the data suggest that pheasant populations require a degree of management in order to breed successfully, and may benefit from the establishment of alternative habitats, such as grass strips and cover crops, both of which were virtually absent from this type of site. Similar conclusions have been reached from several previous studies (Hill and Robertson, 1988; Stark et al, 1999; Bence, 2000; Howard and Carroll, 2001).

The densities of pheasant broods varied between management categories over time (Figure 5.6), most probably as a result of factors such as differences in the level of gamekeeping effort, and increases in habitat quality at certain sites over time. Brood density appeared to increase annually at management category 2 sites (Figure 5.6), most probably as a result of habitat creation and improved habitat quality, leading to increased nesting success year on year. Management category 3 sites had higher densities of broods each year in comparison with all other management categories (Figure 5.6), but there was no definite trend over time. The high level of gamekeeping and negligible levels of releasing reared birds may have resulted in the high overall densities of broods. However, the habitat quality may be more stable, therefore not producing the annual increases observed at management category 2 sites. Examination of the hen data for management category 3 sites revealed that hen densities mirrored the trend of brood densities. This suggests that changes in hen densities, whether through predation or dispersal, may have caused of fluctuations in the densities broods over time. It seems sensible that the loss of hens through predation will result in the production of fewer broods. However, dispersal of hens when population levels become too high can also affect hen densities. A radio-tracking study found that one third of radio-tracked hens naturally emigrated off an estate in the five months prior to nesting (Boatman and Brockless, 1998).

The densities of broods (Figure 5.6) for management categories 1 and 4 sites mirrored that of the chick data (Figures 5.5). The lack of gamekeeping within management category 1 sites, and the reduced gamekeeping and increased levels of release in the management category 4 site are possible reasons. The difference in brood densities between these management categories and those of management categories 2 and 3 indicate that the varying levels of management had a considerable impact on pheasant productivity.

5.4.4 Factors affecting chick productivity

The lack of effect of the amount of habitat features, whether CSS, total edge, woodland edge, or hedgerow length on chick productivity was unexpected (Table 5.2). Set-aside, edge habitats and woodland are preferred habitat for nest sites and brood rearing (Bence, 2000). The inclusion of grass strips in CSS, or as set-aside or created outside of a conservation scheme, is often motivated by the desire to produce high quality nesting and brood rearing habitat. It may be that quality as well as quantity is of importance for any alternative habitat feature.

Aspects of spring pheasant population structure appeared to affect chick productivity (Table 5.2). Studies use the density of territorial cocks to represent habitat quality in terms of spring requirements (e.g. Draycott, 2003). Hen densities may also be representative of habitat quality, with hen density increasing as habitat quality increases. In turn, this can mean the site is of high quality for nesting and rearing chicks. Therefore, as hen densities increase so does breeding success. A high hen density may represent greater habitat quality and more favourable breeding conditions, as well as directly increasing productivity as there are more females to lay eggs.

Caveats must accompany the use of adult spring densities to predict future breeding success. A high level of shooting pressure at a site that has high quality habitat can reduce cock and hen densities, whilst habitat quality remains unaffected. Alternatively, managing a population with the aim of increasing hen densities in order to maximise chick densities may negatively impact on productivity as a result of density dependent factors (Hill and Robertson, 1988; Sage and Robertson, 2000). The effect of the ratio of hens to cocks on productivity in this study supports a previous study that has shown hens can be harassed by too many cocks, which in turn lowers productivity (Hill and Robertson, 1988).

Gamekeeping effort and supplementary feeding are other factors that appear to affect productivity (Table 5.2). It is not possible to say which specific aspect of a gamekeeper's regime had the greatest influence on chick density. Several factors may be interrelated, although studies suggest that predator control, along with supplementary feeding, has had a substantial impact on the breeding success of pheasants (Tapper *et al*, 1996).

It was expected that there would be a negative effect of release on productivity, as has been found in previous studies (e.g. Robertson and Dowell, 1990; Woodburn, 2000) but the regression did not find this (P=0.263) for the level of release at the different sites in this study. This indicates that the level of release at the sites was not at a level that negatively impacted upon productivity. However, this does not mean that release in greater numbers would not have a negative impact and as such, the level release at a site needs to be carefully monitored to establish whether it is having a significantly negative effect.

Combined with the results from previous studies, the examination of the effect of individual variables on chick density can suggest areas of management that can be adopted or improved if the aim is to increase wild pheasant productivity, measured as the density of chicks produced. This was why it was important to examine the variables separately rather than combining the factors in a bid to determine the arrangement that best explained chick density. Such analysis has provided information, and supported previous findings, that can be used by shoot owners who may be considering altering some of the management variables on their land. It would not always possible for landowners to adopt the "best" practice for maximising chick productivity; for example, those who are required to produce larger bags over the shooting season may be able to reduce the number of birds they release (which may have benefits for wild productivity) but they will not be able to stop rearing completely. Likewise, they could introduce other factors into their land management that have been shown to produce benefits, creating a more appropriate ratio of cocks to hens reducing the number of cocks in spring prior to the breeding season (perhaps through cock-only shoot days towards the end of the season) and by increasing certain aspects of gamekeeping (predator control) and supplementary feeding beyond the shooting season.

In conclusion, it is vital that gamebird shooting changes if it is to have a future. A reduction in the number of gamebirds reared and released, and emphasis on management to produce viable wild populations are seen by stakeholders as the best options (Chapter 3). Therefore, it is encouraging that this study found it was possible to increase wild gamebird productivity in the presence of released birds through modified gamekeeping and land management regimes that integrated well with the management required for the rearing programme and farming and that a level of release was possible with no apparent negative effect on productivity. Over the four years since commencing the new management regime at Site 1, chick density was high although it did not increase. The extent to which future wild productivity will increase is not fully understood. Therefore, it is not possible at present to ascertain whether the number of wild birds produced at Site 1 will permit a decrease in the number of reared birds released. Comparison of sites managed under different regimes indicated that variation in population structure and different management techniques produce varying rates of gamebird productivity, although several of these factors maybe interrelated. Therefore, trying to single out the factor that is the most influential in determining chick productivity is redundant. Instead, if possible, it may be better to integrate some, or preferably all, these aspects of land management and gamekeeping into a regime that would most likely maximise wild gamebird productivity.

Previous studies of new management techniques adopted to enhance the wild productivity of gamebirds have also been found to benefit other wildlife species. Studies have highlighted the importance of supplementary feeding (Hoodless *et al*, 1999), population dynamics (Woodburn, 2000), predator control (Sage and Robertson, 2000) and provision of suitable nesting and brood rearing areas (Hill and Robertson, 1988; Robertson and Dowell, 1990). These premises are examined in the following chapters, which investigate the effects of the new management regime at Site 1 on insect (Chapter 6) and songbird species (Chapter 7).

Chapter 6
Benefits of Gamebird Shooting: Changes in Insect Populations

6.1 Introduction

6.1.1 Species abundance as a measure of habitat quality

The abundance of different species within a habitat is often used to indicate habitat quality (Van Horne, 1983; Wiens, 1992; Burel *et al*, 1998; Pywell *et al*, 2004). Therefore, it is assumed that a species will select and use areas that are best able to satisfy its life requirements and, as a result, greater use will occur in higher quality habitat (Schamberger and O'Neill, 1986). The use of indicator species can be a cost-effective method of estimating the quality of a habitat and whether that habitat is undergoing change (Thomson *et al*, 2005), assuming that a suitable indicator species can be identified for a particular ecosystem (Simberloff, 1998). In an ideal scenario, an indicator species will also be keystone species, in that the activities of the keystone species will be far reaching, enveloping the requirements of many other species within the ecosystem, and the loss of that keystone species will result in significant changes for the ecosystem and its remaining species (Albrecht, 2003). However, as for indicator species, the use of keystone species as a method of identifying quality habitat or targeting conservation requires said species to be identified. Indeed, it is not known whether all ecosystems have a keystone species (Simberloff, 1998). Studies have pointed towards using a group of species for indicator-based conservation, with the group more liable to act as an umbrella, the ecosystem requirements of which will be positively correlated with species diversity and habitat quality (Maes and Dyck, 2005).

The relative abundance of a species within a particular habitat, however, may not be the best measure for species with strong social interactions, where dominant individuals exclude subordinate animals from high quality habitat, thereby underestimating habitat quality (Van Horne, 1983). Such social systems appear to be most common among mammal populations, for example among deer mice

(*Peromyscus maniculatus*), lemmings (*Lemmus lemmus*), and red foxes (*Vulpes vulpes*). Measures of abundance also have limitations where factors other than habitat quality, for example predation pressure, best explain the abundance of a species within a particular habitat (Schamberger and O'Neil, 1986).

Butterfly abundance has been used to measure habitat quality (Pywell *et al*, 2004) as has bumblebee abundance (Bäckman and Tiainen, 2002). Measures of abundance are of particular value when the historic quality of a habitat is being considered, and when abundance data is all that is available if in-depth habitat surveys were not undertaken at the time (Bäckman and Tiainen, 2002).

Equally, measures of abundance can be very subjective indicators of habitat quality, particularly if the resources that one species needs within a habitat, perhaps for survival or successful breeding, are not required by another species. Therefore, assessing the ecological quality of a habitat is not straightforward and depends on the value system and objectives (Herzog *et al,* 2005). Unfortunately, there are few alternatives, as there are no agreed methods for determining habitat quality (Schamberger and O'Neil, 1986). The complex nature of ecosystems, and of the interaction between species and the different facets of that ecosystem, make understanding the factors that affect population abundance extremely difficult (Furness *et al*, 1993; Benton *et al*, 2002). Therefore, little research has been done to identify the specific practices of agricultural intensification that are responsible for declines in agrarian wildlife. Understanding the causes would make it easier to establish the types of land management that should improve habitat quality for those species that have experienced declines (Greenwood *et al*, 1993; Siriwardena *et al*, 1998).

6.1.2 Monitoring wildlife populations

It is important to monitor wildlife populations to determine their status and to assess whether the ecosystems they inhabit are being altered by factors such as management or environmental change (Cousins and Lindborg, 2004). Monitoring is particularly important following the instigation of new habitat management in order to assess the effects on the wildlife (Hellawell, 1994) and to determine whether they are producing the effects desired for conservation programmes (Firbank *et al*, 2003; Cousins and Lindborg, 2004). Time and financial constraints mean it is rarely possible to monitor all species within a particular habitat (Joutinen and Mönkkönen, 2004). Instead, indicator species are used to gauge the effects of habitat management on the ecosystem (Cole *et al*, 2002; Thomas *et al*, 2005; Similä *et al*, in press). Ideally, the species chosen is comparatively easy to measure and will respond to changes in habitat quality (Sutherland, 2001).

Bumblebee abundance and density have been used to indicate the quality of habitat within arable landscapes (Herzog *et al*, 2005) as have butterfly species (Pollard, 1994; Smart *et al*, 2000), and ground beetles are also monitored (Cole *et al*, 2002) as some are considered to have a beneficial impact as they are predators of agricultural pests (Thomas and Marshall, 1999; Maudsley *et al*, 2002). Insect monitoring is a popular method of determining the quality of agri-environment scheme (AES) prescriptions such as conservation, uncropped grass margins and beetle banks (Kleijn *et al*, 1998; Critchley *et al*, 2004; Marshall *et al*, 2006).

6.1.3 Motivation for and aims of the study

Land management for gamebird shooting is often said to have considerable benefits for other wildlife species. Indeed, the uptake of AESs is positively influenced by the involvement of landowners with gamebird shooting (Morris *et al*, 2000). At Site 1, the countryside stewardship scheme (CSS) was adopted, alongside additional gamekeeper and farming management, was the intention of encouraging wild gamebird productivity

Chapters 6 investigates the concept of habitat quality and species density to investigate whether a new habitat management regime designed to produce ecological benefits for gamebird species concurrently produced benefits for insect species by increasing the habitat quality. The survey was concerned with key insect species commonly found in arable landscapes and which could be easily monitored, annually recording the number at Site 1 following the commencement of new management designed to promote wild gamebird populations to determine whether the regime positively affected insect populations.

6.2 Methods

This chapter seeks to show whether the numbers of butterflies, bumblebees and other insects differed over time at Site 1, possibly indicating a change in habitat quality, and between sites managed under different regimes to determine whether different management programmes produced habitats of different quality.

6.2.1 Monitoring of Butterflies and Bumblebees

Butterfly monitoring was undertaken using the methodology outlined in The Butterfly Monitoring Scheme, established in 1976 by the Institute of Terrestrial Ecology (ITC) at Monks Wood Experimental Station and which currently monitors over 100 sites in Britain (Asher *et al*, 2001). The survey uses the transect count method, which is simplistic in that it provides an index of relative abundance rather than an estimation of actual population size, thereby allowing the measurement of changes over time at a specific site or to compare between sites (Pollard and Yates, 1993). Monitoring was undertaken along the three transects of 200m allocated within each treatment and control site (see Chapter 2). Each transect was divided into 10 x 20m sections, to allow the position of each butterfly to be determined along the transect.

Transects were walked at a steady pace, and all butterflies observed 2.5m either side of the transect, and 5m in front, were identified and recorded for the relevant 20m section on data sheet. Starting 1st May, each transect was visited once a week for 12 weeks between the hours of 1045h and 1545h, and the date, time of day, and temperature were recorded. The amount of sunshine was estimated for each 20m section to the nearest 10% to give an average amount of sunshine for the transect, while the average wind speed was recorded for the whole transect using the Beaufort scale (Table 6.1). The survey was postponed if conditions were inappropriate, for example if it was below 13°C, was raining or was too windy, and the survey was completed when conditions were next suitable.

Table 6.1: The Beaufort scale, used for estimating wind speed for butterfly and bumblebee counts.

Scale	Wind speed
0	Smoke rises vertically.
1	Slight smoke drift.
2	Wind felt on face, leaves rustle.
3	Leaves and twigs in constant motion.
4	Wind raises dust and loose paper, small branches move.
5	Large branches move and small trees sway.

The bumblebee survey was conducted using methods similar to those used for the Bumblebee Distribution Maps Scheme (BDMS), which was established in the 1970's following concerns over declines in numbers and in the distributions of British bumblebees (Prys-Jones and Corbet 2003; Croxton *et al*, 2002). The bumblebee monitoring was run concurrently with, and using the same methods as, the butterfly monitoring. The number of butterflies and bumblebees observed in each transect walk were totalled to provide two indices of abundance for each week.

6.2.2 Monitoring of other insect species

A D-Vac suction sampler (Figures 6.1 and 6.2) was used to monitor insects from vegetation in the headland along which transects were sited, either in the uncropped margin, or in the crop if there was no margin present, as in Control site 3. Using standard methods (Southwood and Henderson, 2000), samples were gathered by fitting the hose over the vegetation and pushing it firmly to the ground, ensuring it tightly fitted on all sides to prevent insects escaping. The hose was held in place for 10 seconds before moving along the transect and repeating: five sucks of 10 seconds made up one sample and three samples were taken from each transect. Samples were transferred from the sieve of the collection hose to large plastic bags, and were then frozen to kill the insects.

Figure 6.1: Diagram of a D-Vac suction sampler (Southwood and Henderson, 2000)

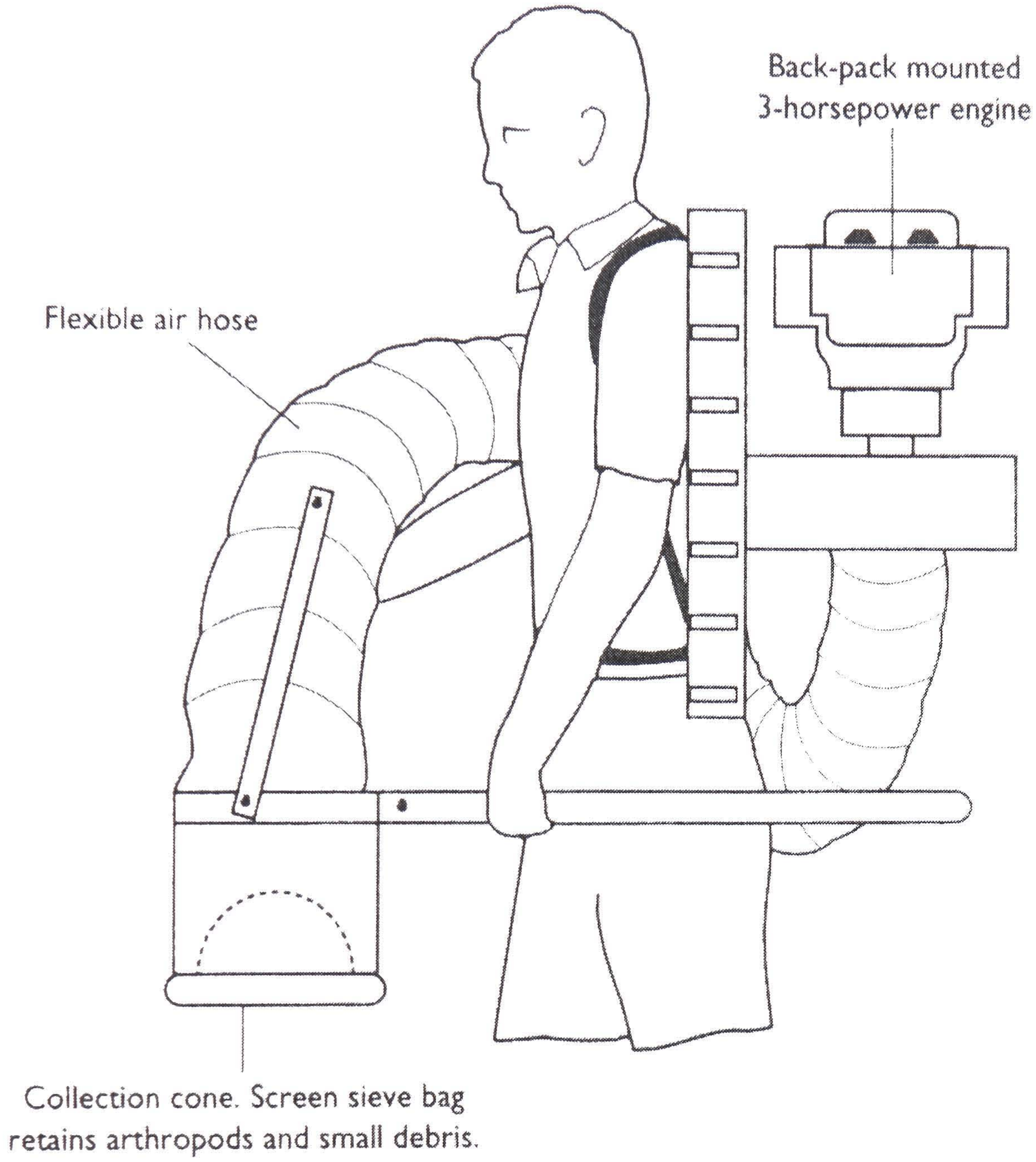


Figure 6.2: Insect sampling using a D-Vac suction sampler at Control site 4.

Vegetation and other debris were removed from the samples. Tweezers and a paintbrush were used to 'sweep' the debris and to retain any insects within the sample. The insects were then placed in a sample tube and covered in ethanol to preserve them. Samples were examined under a high powered microscope and insects were identified using keys and counted, providing an index of the number of insects and of the population composition for the three samples from each transect. The total insect counts were sub-divided to derive an index of key food items for gamebird chicks, based on many years of research by the GCT and which has now been used to create the Chick Food Index (CFI) (GCT, 2005). Data on insect samples are only available for 2001 and 2003, as the time needed to examine the samples limited the sampling that could be completed.

6.2.3 Vegetation and hedgerow survey

The availability of nectar can influence the abundance of butterflies and bumblebees, so a vegetation survey was conducted to measure the number of flowering plants and provide an index of the availability of insect forage along transects (Asher *et al*, 2001). Whilst conducting the butterfly and bumblebee surveys, the proportions of vegetation within the transect that was made up of flowering plants and herbs within each 20m section of the transect was evaluated, to provide an index of the availability of flowering plants and herbs. The proportion of bare ground was also estimated using the same methodology. The methods were consistently applied across sites, and so provided an index that permitted inter-site comparisons. However, the methodology did not provide an accurate measurement of the availability of these variables at each site.

The shelter provided by hedgerows can influence the abundance of butterflies (Maudsley *et al*, 2000), so the hedgerows adjacent to each transect were measured to determine the amount of shelter each provided. The width and height of the hedgerows adjacent to each 200m transect were measured at ten points along its length, set at every ~20m along the hedgerow. These two measurements were assigned to categories (Table 6.2). To provide an index of shelter, the two category figures were multiplied together. The width of the non-cropped field boundary was also measured at these ten points, measuring from the edge of the cultivated land to the start of the hedge vegetation. Again, this was not a true measurement of the amount of shelter provided by the hedgerows but provided an index which allowed inter site comparisons and that provided an indication of whether shelter within a site might be a factor that explained the distribution of butterfly, bee and index species.

Table 6.2: Measurement categories for the hedgerows adjacent to the transects used in the insect monitoring.

Category	Hedge height	Hedge width
1	No hedge	No hedge
2	Up to 1.5m	Up to 2.00m
3	1.51m to 3.0m	2.01m to 4.00m
4	3.01m to 4.57m trees	4.01m to 6.00m
5	Over 4.58m trees	Over 6.01m (wood)

6.2.4 Assumptions and limitations

As with the gamebird surveys, there were a number of assumptions and limitations associated with the butterfly, bumblebee and insect surveys. The data generated through the surveys and d-vac suction samples did not constitute total population counts. Instead, they represent indices of population size, generating data that permits comparison between sites and/or over time. An underlying assumption of the methods used was that the butterflies and bees were observed to the same degree at each site. In addition, it was assumed that there was no difference between sites in the likelihood of the insects to be gathered from the transect vegetation using the d-vac suction sampler (i.e. that insects present were as likely to be gathered regardless of the site).

6.2.5 Data Analysis

The data analysis aimed to determine whether the radical management regime implemented at Site 1 had produced benefits for biodiversity. Butterfly and bumblebee data were gathered using comparable methods along transects of the same length (200m) in both treatment and control sites. Insect data were gathered using the same D-Vac suction sampler applied to the vegetation for the same length of time at each transect in both treatment and control sites. The data from each transect within each treatment and control site were combined to provide an index of abundance per site per year of monitoring. The means from each transect were used during the data analysis.

Univariate and multivariate statistics were used to compare differences in the number of butterflies and bumblebees over time and between treatment and control sites. The data were analysed using repeated measures ANOVA, to compare the variance caused by differences in the data over time and between treatment and control sites. One-sample t-tests were conducted to compare data between individual sites to identify whether there was a significant difference in the data for a year. As previously described for comparing gamebird productivity (Chapter 5) this compared the mean values calculated from one year from treatment sites at Site 1 to the fixed value recorded from one of the control sites. Due to the issue of pseudo-replication, the mean values for the three transects within a study area were used in the t-tests. Insect monitoring provided only two years of data, so paired sample t tests were used to compare differences over time and between treatment and control sites.

Regression analyses were undertaken to assess which variables appeared to best explain any differences in the number of butterflies, bumblebees, and insects at treatment and control sites. The data from all sites for all years were used within the regression analysis as the variables differed between sites and between years. Thus, there were 63 data points in total for the butterfly and bumblebee data – 21 transects within the seven study areas, and data for three years. For the insect data gathered from D-Vac sampling there was a total of 42 data points – the mean of the three samples taken from each of the three transects within the seven study areas, with two years of sampling. As with the gamebird analysis, pseudo-replication was recognised as an issue but was considered to impose limits that come with any observational study. As this was an observational study, using the data in this way was not considered problematic. Hence, the analysis explored variation in the data with a view to generating interesting hypotheses, rather than proving causal effects, and the strength of those effects, of variables on the counts. As was the intent with the gamebird analysis, should the regression analysis highlight variables that appear to be contributing substantially to the variation in the counts, further experimentation using controlled treatments would be necessary investigate whether this is a causal effect.

The explanatory variables that were included in the regression primarily comprised those that differentiated the arable field margin habitats between sites, although other factors relevant to data collection were also included. For butterflies and bumblebees these variables were as follows:

1. mean time of day of the survey;
2. temperature (°C);
3. mean amount of sun during the survey period;
4. mean amount of wind during the survey period (Beaufort scale);
5. crop adjacent to the transect;
6. index of amount of flowers along the transect (proportion of vegetation within the transect area);
7. index of the amount of herb within the vegetation matrix (proportion of vegetation within the transect area);
8. index of amount of bare ground along the transect (percentage of transect area);
9. mean hedge width adjacent to transect (m);
10. mean hedge height adjacent to transect (m);
11. index of shelter provided by the hedge (m^2);
12. mean margin width (m);
13. margin age (number of years established).

For insects, the variables were as follows:

1. crop adjacent to the transect;
2. index of the amount of flowers along the transect (percentage of vegetation within the transect area);
3. index of the proportion of herb within the vegetation matrix (percentage of vegetation within the transect area);
4. index of amount of bare ground along the transect (percentage of transect area);
5. mean hedge width adjacent to transect (m);
6. mean hedge height adjacent to transect (m);
7. index of shelter provided by the hedge (m^2);
8. mean margin width (m);
9. margin age (number of years established).

A total of four separate regression analyses were run for each insect group: butterflies, bumblebees, insects and key insect food species. Within the regression analyses, each explanatory variable was considered independently of the others, to avoid concerns over multicollinearity. For each regression analysis, the variability as a result of transect, site and year was accounted for before each variable was analysed. This meant the test was investigating how much variability in insect abundance was accounted for by each variable; any significance was not a result of site, transect or year. As with the data relating to gamebird productivity (Chapter 5), the strength of individual factors was desired so as to provide information for those considering adopting a particular aspect of land management; AESs allow for different prescriptions to be adopted and landowners, particularly those interested in gamebird shooting, may have preferences for particular types of alternative land management because of the potential benefits these prescriptions can provide for gamebird (whether wild or reared), for the shooting itself (provision of habitat from which to hold birds and flush them over guns). Likewise, those landowners whose primary concern is the agricultural aspect of land management, but with an interest in conservation, will benefit from information detailing possible advantages related to providing quality habitat for alternative wildlife. For landowners who may not want to adopt the full range of suggested land management prescriptions that are recognised as having benefits for insect populations, details relating to the strengths of individual aspects of management will provide useful information that will allow an informed decision.

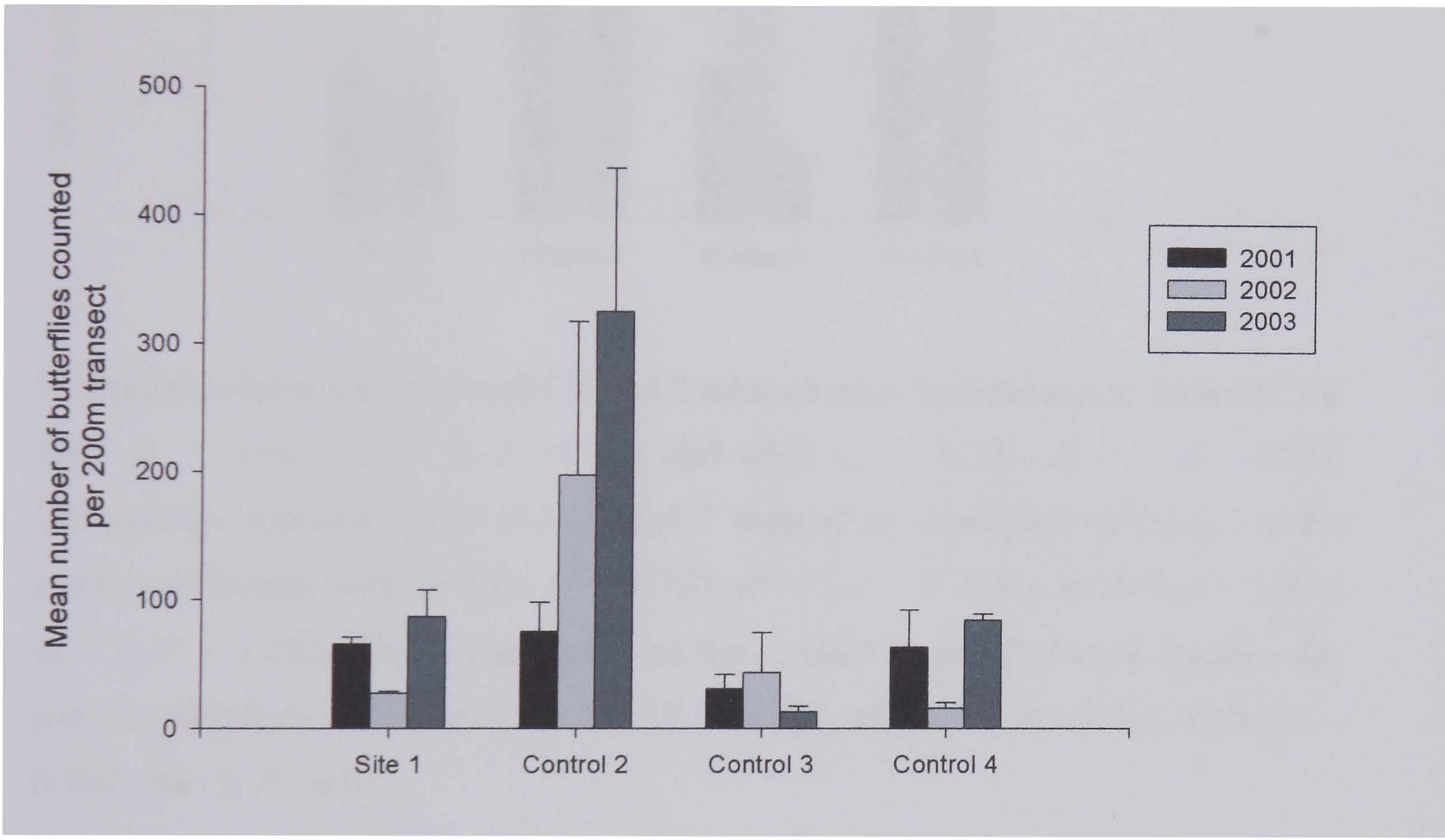
6.3 Results

6.3.1 Abundance of butterflies at treatment and control sites

The mean number of butterflies counted along transects showed some differences between treatment and control sites from 2001 to 2003 (Figure 6.3). In the treatments at Site 1, there was an overall difference ($F = 5.427$; $df = 2,22$; $P<0.05$) in the mean number of butterflies over time (Figure 6.3). However, there was no difference in the mean number of butterflies within treatment and control sites ($F = 3.439$; $df = 3,6$; $P = 0.092$) nor between years ($F = 4.973$; $df = 2,6$; $P = 0.082$;), as shown in Figure 6.3.

T-tests comparing butterfly counts at Site 1 to Control 2 found no significant difference for 2001(baseline data) (t= -2.093; df = 3; $P = 0.127$); however, Control 2 had significantly more butterflies for 2003 (t= -9.608; df = 3; $P < 0.01$). There were significantly more butterflies at Site one than Control 3 for 2001 (t= 5.005; df = 3; $P < 0.05$) and 2003 (t= 3.298; df = 3; $P < 0.05$). Comparison with Control 4 showed no significant difference in the number of butterflies for 2001 (t= -0.186; df = 3; $P = 0.864$) and 2003 (t= 0.336; df = 3; $P = 0.759$).

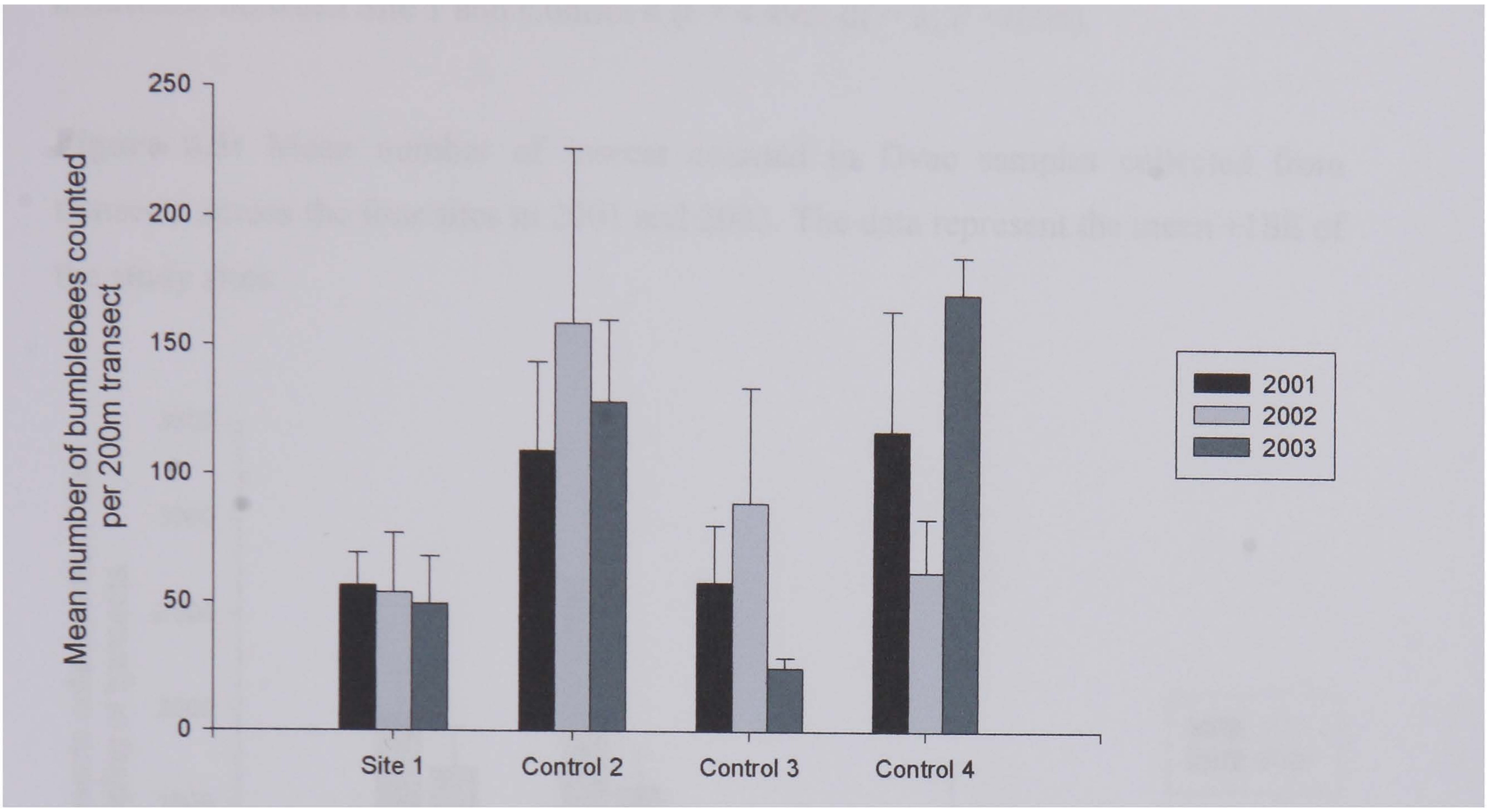
Figure 6.3: Mean number of butterflies per 200m transect counted across treatment and control sites from 2001 to 2003. The data represent the mean ± SE for each treatment and control sites.



6.3.2 Numbers of bumblebees at treatment and control sites

The mean number of bumblebees counted along transects showed no differences between treatment and control sites from 2001 to 2003 (Figure 6.4). At Site 1, there was no difference (F = 0.203; df = 2,22; $P = 0.818$) in the mean number of bumblebees over time (Figure 6.4). Likewise, there was no difference in the mean number of bumblebees between treatment and control sites (F = 3.999; df = 3,6; $P = 0.070$) or between years (F = 0.130; df = 2,6; $P = 0.881$) as shown in Figure 6.4.

Figure 6.4: Mean number of bumblebees per 200m transect counted across the treatment and control sites from 2001 to 2003. The data represent the mean ± 1SE for each treatment and control site.

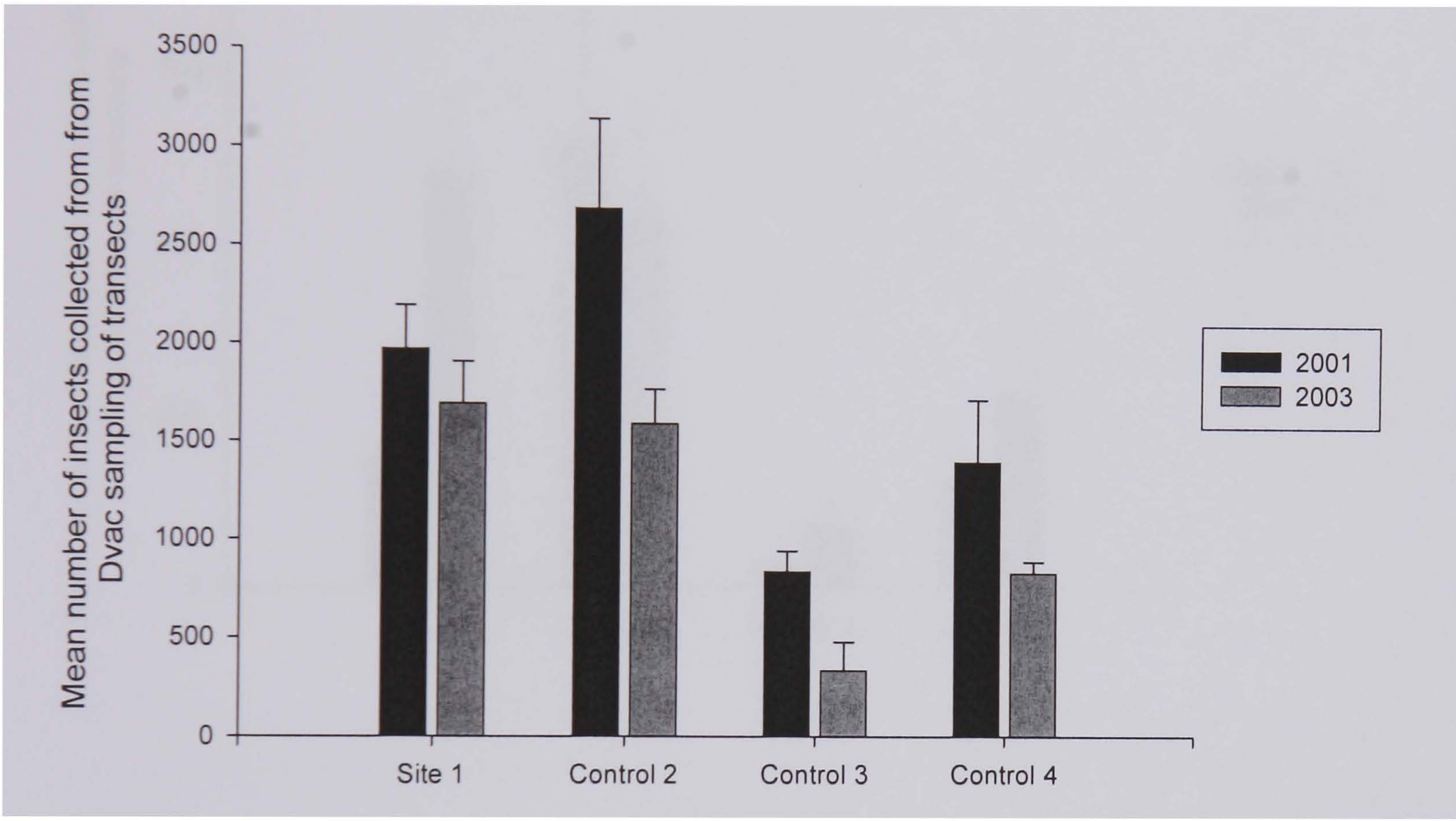


Comparison between Site 1 and Control 2 showed more bumblebees as Control 2 for 2001 (t = -4.161; df = 3; *P* <0.05) and 2003 (t = -4.248; df = 3; *P* <0.05). Comparison between Site 1 and Control 3 showed no significant difference in the number of bumblebees for 2001 (t = -0.137; df = 3; *P* = 0.900) and 2003 (t = 1.309; df = 3; *P* = 0.282). Comparison between Site 1 and Control 4 showed significantly more bumblebees at Control 4 for 2001 (t = -4.814; df = 3; *P* <0.05) and 2003 (t = -6.546; df = 3; *P* <0.01).

6.3.3 Abundance of other insects at treatment and control sites

There was no difference (t = 1.352; df = 11; *P* = 0.204) in the mean number of insects counted from the D-Vac sampling over time at the treatments at Site 1 (Figure 6.5). However, there was a difference (F = 14.807; df = 3,24; *P* <0.001) in the mean number of insects between treatment and control sites. There were significantly more insects at Control 2 compared to Site 1 for 2001 (t = -3.278; df = 3; *P* <0.05), but there was no difference for 2003 (t = 0.514; df = 3; *P* =0.643). Comparison between Site 1 and Control 3 showed significantly more insects at Site 1 for 2001 (t = 5.124; df = 3; *P* <0.05) and 2003 (t = 7.116; df = 3; *P* <0.01). Comparison between Site 1 and Control 4 showed no difference in the number of insects for 2001 (t = 2.566; df = 3; *P* =0.83). For 2003, there was a significant difference between Site 1 and Control 4 (t = 4.492; df = 3; *P* <0.05).

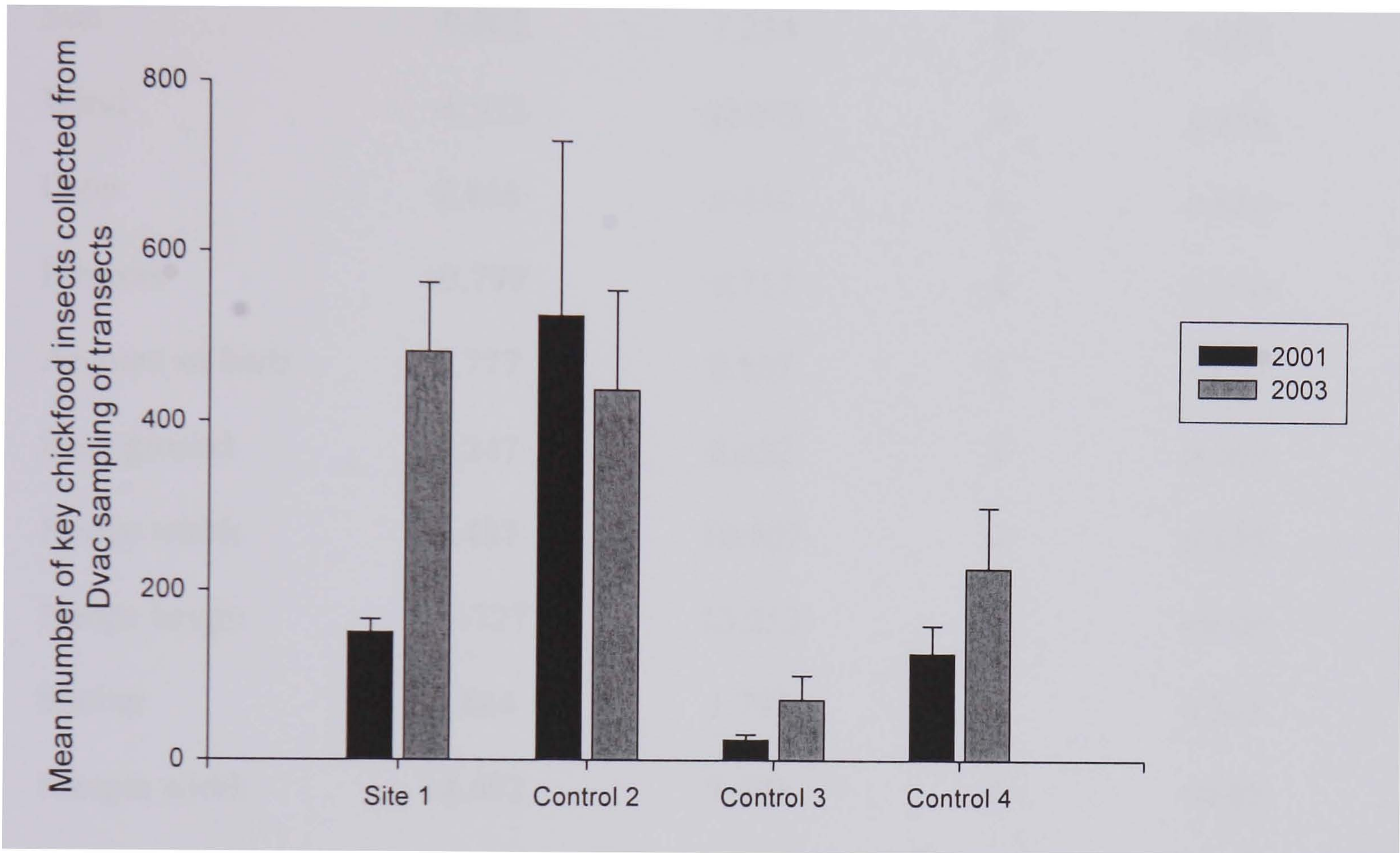
Figure 6.5: Mean number of insects counted in Dvac samples collected from transects across the four sites in 2001 and 2003. The data represent the mean +1SE of the study sites.



The mean number of key chick food insects increased over time (t = -4.110; df = 11; *P* <0.01) in the treatments at Site 1 (Figure 6.6). There was also a difference (F = 17.327; df = 3,24; *P* = 0.001) in the mean number of key chick food insects between sites. Comparison between Site 1 and Control 2 showed significantly more key chick food insects at Control 2 for 2001 (t = -16.837; df = 3; *P* <0.001). However, there were significantly more key chick food insects at Site 1 compared to Control 2 for 2003 (t = 34.821; df = 3; *P* <0.001). Comparison between Site 1 and Control 3 showed significant difference for 2001 (t = 5.647; df = 3; *P* <0.05) and 2003 (t = 178.002; df = 3; *P* <0.001). Comparison between Site 1 and Control 4 showed no significant difference in the number of key chick food insects for 2001 (t = 1.022; df

= 3; P=0.382) but significantly more key chick food insects at Site 1 for 2003 (t = 116.713; df = 3; P <0.001).

Figure 6.6: Mean number of key chick food insects counted in Dvac samples collected from transects across the four sites in 2001 and 2003. The data represent the mean +1SE of the study sites.



6.3.4 Factors affecting butterfly, bumblebee and other insect abundance

The results of the regression analysis for butterflies show that the amount of herb within the transect, the margin width, the age of the margin and hedge height all appeared to explain a significant degree of the variation in the number of butterflies along a transect (P<0.05 to P<0.001) (Table 6.3). The amount of herb and the age of the margin along which the transect was located seem to explain the most variation (P<0.01 and P<0.001 respectively).

Table 6.3: Regression analysis for the variables examined to explain the number of butterflies across all sites.

Variable	B	s.e.	df	Significance
Time of day	-17.959	48.468	4	0.712
Temperature	-37.403	28.478	4	0.194
Sun	-0.005	1.234	4	0.997
Wind	-6.953	42.076	4	0.869
Crop	2.858	6.455	4	0.660
Flowers	-0.799	0.717	4	0.270
Amount of herb	1.777	0.567	4	<0.01
Bare ground	0.247	0.652	4	0.707
Hedge width	6.487	10.407	4	0.535
Hedge height	26.727	13.253	4	<0.05
Shelter	1.864	1.793	4	0.303
Margin width	18.692	7.103	4	<0.05
Margin age	26.074	5.084	4	<0.001

Additional regression analysis of the most abundant species of butterflies (green-veined white, large white, small white and meadow brown) showed some agreement with the regression findings for count data for all butterfly species (see Appendix 7 for regression results). Temperature, the amount of herb, margin width and margin age were indicated as having an effect on some of these butterfly species. In addition, the time of day the surveys were done, the amount of sun, the amount of bare ground along the transect, the amount of shelter all had an effect of some of these four species of butterfly (Appendix 7).

The results of the regression analysis for bumblebees show that the amount of flowers and the amount of herb within the transect, the margin width and the age of the margin explained a significant degree of the variation in the number of bumblebees along a transect (Table 6.4). The width of the margin along which the transect was located and the amount of herb seem to explain the degree of variation to the greatest extent ($P<0.001$).

Table 6.4: Regression analysis for the variables examined to explain the number of bumblebees across all sites.

Variable	B	s.e.	df	Significance
Time of day	-5.702	30.966	4	0.855
Temperature	-31.650	17.973	4	0.084
Sun	-0.668	0.783	4	0.397
Wind	29.910	26.576	4	0.265
Crop	-3.235	4.793	4	0.503
Flowers	-1.362	0.426	4	<0.01
Amount of herb	0.949	0.371	4	<0.05
Bare ground	0.219	0.416	4	0.601
Hedge width	-5.555	6.625	4	0.405
Hedge height	3.500	8.739	4	0.690
Shelter	-0.736	1.151	4	0.525
Margin width	16.140	4.304	4	<0.001
Margin age	13.052	3.517	4	<0.001

As with the butterfly species, additional regression analysis of the most abundant species of bees (*A. mellifera, B. lapidaries, B. Pascuorum* and *B. terrestris/B. lucorum*) showed some agreement with the regression findings for count data for all bee species (see Appendix 8 for regression results). The amounts of flowers and herb, margin width and margin age were indicated as having an effect on some of these bee species. In addition, hedge width, hedge height and the amount of shelter all had an effect of some of these four species of bee (Appendix 8).

The results of the regression analysis for insects show that the amount of herb, the amount of shelter, margin width, the hedge height and width and the age of the margin all explained a significant degree of the variation in the number of insects within the vegetation of a transect (Table 6.5). The amount of herb appears to explain the variation in insect numbers to the greatest degree (P<0.001).

Table 6.5: Regression analysis for the variables examined to explain the number of all insects across all sites.

Variable	B	s.e.	df	P
Crop	32.150	67.786	4	0.638
Flowers	-4.613	6.107	4	0.455
Amount of herb	17.919	4.703	4	<0.001
Bare ground	-1.425	5.251	4	0.788
Shelter	-38.085	15.288	4	<0.05
Margin width	169.908	62.718	4	<0.01
Hedge width	-228.187	87.523	4	<0.05
Hedge height	-244.294	118.024	4	<0.05
Margin age	136.868	48.797	4	<0.01

The results of the regression analysis for key insects show that the crop adjacent to the transect, the amount of herb, the amount of shelter, the hedge width and the age of the margin all explain a significant degree of the variation in the number of key insects within the vegetation of a transect (P<0.05 to P<0.01) (Table 6.6). The age of the vegetation within the margin and hedge width seem to explain the degree of variation to the greatest extent (P<0.01).

Table 6.6: Regression analysis for the variables examined to explain the number of key insects across all sites.

Variable	B	s.e.	df	*P*
Crop	46.889	19.833	4	<0.05
Flowers	-1.250	1.915	4	0.518
Amount of herb	3.361	1.647	4	<0.05
Bare ground	-1.993	1.612	4	0.224
Shelter	-12.757	4.726	4	<0.01
Margin width	31.417	20.857	4	0.140
Hedge width	-80.478	26.704	4	<0.01
Hedge height	-61.105	37.702	4	0.114
Margin age	49.203	14.744	4	<0.01

Additional regression analyses were completed for eleven insect species, six of which were key chick food insect species (Appendix 9). For the non-key chick food item species, the crop adjacent to the transect, the amount of flowers and the amount of bare ground appeared to have an effect. For the key chick food item insect species, the amount of herbs within the transects was the only additional variable that appeared to have an effect on these key chick food item insect species (Appendix 9).

6.4 Discussion

Aspects of agricultural intensification have produced an increasingly sterile environment in and around arable fields (Sotherton, 1998). Cereal field margins were once a rich source of floral diversity, which were utilised by an extensive range of wildlife species from birds and mammals to insects (Kells *et al*, 2001). In recent decades, those boundaries that survived the mass removal of hedgerows to enlarge fields have often been intensively managed and reduced in size to the extent that they offer little in the way of valuable alternative habitat (Rackham, 2000).

The GCT spent many years addressing the problem of declining levels of quality habitat within arable fields, with focus specifically on gamebirds, and created conservation headlands as a solution (Tapper, 1999). Not only did these strips of unsprayed arable headland provide a rich source of insect food for gamebird chicks but also created a buffer protecting hedgerows from spray drift. The success of conservation headlands led to the inclusion of this and other similar prescriptions in AESs. In turn, this provided financial incentives to landowners to manage their property more sympathetically to make improvements in habitat quality. Subsequently, monitoring schemes associated with arable habitats have been used to determine the extent of any improvements in habitat quality following the application of AES prescriptions (MAFF, 1995).

6.4.1 Number of butterflies and bumblebees at treatment sites

Overall, there was a change in the number of butterflies at Treatment sites 1.1 to 1.4 (Figure 6.3), indicating that the creation of the grass margins appeared to alter habitat quality for this insect group. There was a decrease in butterfly numbers between 2001 and 2002 (Figure 6.3), which may have arisen from the failure of some grass strips to establish in their first year (Chapter 4). Thus, some transects were disturbed between 2001 and 2002 as headlands were resown. Furthermore, there may also have been increased weed management, as weed infestation of poorly established field margins and adjacent crop areas were noted in some locations (Chapter 4), which may have produced habitat of a higher quality for butterflies and bumblebees in 2001. A larger number of butterflies were counted in 2003 compared to 2002, suggesting that habitat quality improved following this year of intensive management; headlands were perhaps better established and weed control was reduced allowing some pollen and nectar sources to become established and, thus, attracting the butterflies.

There was no change in the number of bumblebees at Treatment sites 1.1 to 1.4 (Figure 6.4), indicating that the creation of grass margins did not improve habitat quality for this particular group of insects over the period of monitoring at Site 1.This is perhaps because the margins within the treatment site were formed by sowing a seed mix designed to create a thick tussocky grass sward. Such grass mixes are designed to establish quickly to out-compete undesirable vegetation, including weeds and volunteers from the previous years' crop. In so competing, these grass species also out-compete wild flowers, as well as undesirable weed species, that are important nectar sources for butterflies and bumblebees. If wild flowers can become established within a grass margin, it may take longer than three years to occur. The margins at Site 1 were created in the 12 months prior to fieldwork, making them one year old at the start of monitoring and a maximum of three years old in the last year of monitoring.

The relatively young age of the margins may explain why there was not an increase in butterfly and bumblebee numbers. Several reasons may be involved. Firstly, the grass margins may need longer to produce a vegetation mix and structure considered high quality habitat to butterflies and bumblebees. Thomas *et al* (2002) found that beetle banks took ten years to produce a vegetation mix and structure comparable with that of long-established field boundaries. The grass mix used for beetle banks is similar to that used to create the margins at Site 1. Consequently, time is needed for the habitat to become equivalent to that of established uncropped areas. However, proximity to such areas will determine the rate at which margins become established. Hence, grass margins will most likely reach condition similar to uncropped areas at a faster rate than beetle banks. In general, grass margins are adjacent to existing field boundaries. In turn, this makes it easier for species to spread into these features than into beetle banks, which may only be adjacent to field boundaries at either end of their length.

Secondly, the grass mix sown in the margins of the treatment sites was not chosen to create high quality habitat for butterflies and bumblebees. Indeed, pollen and nectar mixes exist as prescriptions in AESs for this purpose, although these were not used at Site 1. Instead, the tussocky grass margins were quick to establish and these prevented undesirable weeds in the field boundary encroaching into the crop edge. Equally, this thick grass sward is also considered high quality habitat for many insects (DEFRA, 2003), particularly important chick food insects. However, studies have shown this type of habitat to be of poor quality for butterflies (Marshall *et al*, 2005) and bumblebees (Pywell *et al*, 2002; Carvell *et al*, 2004). It maybe that grass margins at the treatment site will never provide high quality habitat for butterflies and bumblebees. Alternatively, perhaps, over time, the structure and species composition will alter to create habitat that is more beneficial to these insect groups.

Thirdly, the ability of butterflies and bumblebees to disperse to new areas may significantly affect the rate at which fragmented patches of quality habitat are colonised (Sutcliffe *et al*, 2003). Colonisation of new habitat by a species will be affected by its dispersal ability (Hill *et al*, 1999) and the isolation of the area (Sutcliffe *et al*, 2003; Vandewoestijne *et al*, 2004), with factors such as the effect of barriers and site fidelity also determining colonisation rates (Bhattacharya *et al*, 2003). To date, few studies have examined these aspects of butterfly and bumblebee ecology (Hill *et al*, 1999). Hence, most previous studies have concentrated on rarer species in a bid to determine the potential success of conservation management regimes (Baguette *et al*, 2003).

Therefore, future monitoring of the transects at Site 1 should establish whether age is an important factor in determining if tussocky grass margins can provide high quality habitat for butterflies and bumblebees. However, it would not be possible to determine whether any increase in numbers of either insect group over time was the result of enough time elapsing to allow dispersal, or rather was due to maturation of the grass strips into high quality habitat. Should there be no increase in the number of butterflies and bumblebees over time, it must be concluded that the strips of thick tussocky grass created in the field headlands through the CSS have not produced quality habitat for these insect groups at Site 1.

6.4.2 Numbers of butterflies and bumblebees at treatment and control sites

There was no difference in the number of butterflies and bumblebees at treatment and control sites (Figure 6.3 and 6.4). The baseline data for 2001 showed no difference between Site 1 and Control 2, indicating that the quality of the habitat at Site1 was comparable with that of Control 2 for the first year of data gathering. The headlands at Control 2 have been in place for several years; they are carefully managed to provide nesting and feeding habitat for gamebirds and other wildlife and are part of the set-aside scheme (See Chapter 4 for details). As such they were considered to be well established as wildlife habitat and they have many wild flowers growing within the tussocky grass, acting as important nectar sources for insects. It is believed that Site 1 was comparable with Control 2 in 2001 as the headlands were in the process of being established. Lots of weeds were growing within the headland area as a result of the grass not yet getting established, thus attracting many butterflies. In the following years, the grass of the headlands at Site 1 was more established, out-competing the weed species, thus reducing the amount of nectar and pollen provided by these areas and, therefore, the quality of the habitat for butterflies meaning that Control 2 provided higher quality habitat for butterflies in 2003. Control 2 was found to have more bumblebees than Site 1 for both 2001 and 2003, indicating that these insects considered the well established headlands to be of better quality, perhaps a result of their need for both food sources (flowers) but also tussocky grass for nesting and over-wintering sites (Prys-Jones & Corbett, 2003).

There were significantly more butterflies at Site 1 than Control 3 for 2001 and 2003, indicating that the grass margins did provide higher quality habitat for butterflies than arable crops grown up to the field margin. However, there was no difference in the number of bumblebees at Site 1 compared to Control 3, indicating that the tussocky grass margins created at Site 1 did not provide resources that were of benefit to these insects. Indeed, several studies have found this type of grass margin is of poor quality for insects, such as butterflies and bumblebees, as a result of factors such as a lack of feeding resources (Pywell *et al*, 2002; Meek *et al*, 2002; Carvell *et al*, 2003, 2004). In addition, bumblebees require sites for nesting and overwintering as well as feeding areas; as the grass margins become more established at Site 1, it may be that these areas become higher quality habitat for bumblebees beyond that which is provided by traditionally managed arable field headlands (as discussed in Section 6.4.1).

Alternatively, the large amounts of weeds permitted to germinate within the crop at Control site 3 (see Chapter 2 for details) may have increased the quality of the site as it was providing nectar resources usually absent from arable fields sown up to the boundary. Thus, nectar resources have been shown to positively affect the number of butterflies and bumblebees at a site (Dramstad and Fry, 1995; Sparks and Parish, 1995; Dover and Sparks, 2000; Carvell *et al*, 2003, 2004), while Pywell *et al* (2004) found that weedy patches in crops were of direct benefit to butterflies. Weed control is usually a priority on traditionally farmed land as the price received for the harvested crop will be negatively impacted by weed contaminates (Jones *et al*, 2005). However, mistakes made in seedbed preparation or subsequent herbicide spraying routines can result in an influx of weeds, as seen at Control site 3. In future, it is expected that a lack of weed infestation will result in reduced numbers of insects that require such nectar- and pollen-bearing resources at Control 3.

There was no significant difference in the number of butterflies at Site 1 and Control 4. This indicates that that creation of alternative habitat in the form of uncropped field margins did not increase the quality of the habitat suggesting that shoot management for wild gamebirds did not make habitat of a significantly different quality compared to the habitat management regime for Site 1. Both these sites had newly established headlands, each providing habitat that appears to have been of similar quality for butterflies. In addition, the data may suggest that the substantial number of reared birds released at Site 1 did not significantly reduce the quality of the habitat for butterflies compared to Control site 4, where there no gamebird releasing occurred. However, Control 4 had significantly more bumblebees that Site 1 for both 2001 and 2003, suggesting provision of higher quality habitat for these insects, possibly a result of the phacelia that had been sown in the extensive uncropped field margins designed to provide feeding areas and shelter for gamebird chicks. Such vegetation is likely to provide a rich source of nectar; at Site 1, the tussocky grass mix sown was not mixed with any nectar and pollen seeds and any flowers produced within the headlands were a result of opportunistic weed species.

6.4.3 Insect numbers at treatment sites

Insect monitoring showed there to be no change in the number of insects within the uncropped grass margins at Site 1 (Figure 6.5). In turn, this suggested that these habitat areas did not improve in quality over the three years of fieldwork. This maybe a result of the grass strips being given insufficient time to mature, as also suggested responsible for the lack of increase in the number of butterflies and bumblebees (see Section 6.4.2). However, numbers of key chick food insects increased between 2001 and 2003 (Figure 6.6), indicating that the grass strips had increased in quality for this group of insects. Although conservation headlands are different from the tussocky grass margins in certain characteristics and management, it appears that both features have the potential to provide quality habitat for this insect group. Indeed, the grass margins were chosen as a prescription at Site 1 because of this potential (Countess Sondes, Site 1 landowner, personal communication). However, the extent to which gamebird chicks can feed within the thick tussocks of the grass margins at Site 1 needs further investigation to determine whether such habitat is equivalent to conservation headlands as feeding areas.

6.4.4 Number of insects at treatment and control sites

The numbers of insects at Site 1 did not differ over time. However, there was a difference between treatment sites and control sites. There were more insects at Control site 2 compared to Site 1 for 2001, yet no difference in the number of insects between these two sites in 2003. This suggests that the age of the grass margins has an effect on the quality of the area as habitat for insects; it may be a combination of time being required to allow the vegetation to become established as well as the time necessary to allow for the migration of insects into the newly established habitat.

The were significantly more insects at Site 1 compared to Control site 3, indicating that the grass margins at Site 1 created higher quality habitat in field headlands than in the crop at Control site 3. This is not unexpected as field margins can contain over twice the number of invertebrates compared with similar areas that have been cropped up to the field edge (Meek *et al*, 2002).

There was no difference in the numbers of insects at Site 1 and Control site 4 (Figure 6.5), although there were significantly more insects at Site 1 in 2003. Again, this indicates that headland age is important with regards habitat quality; the headlands at Control site 4 were only allowed to become established for two years before they were resown.

There were more key chick insects at Control site 2 compared to Site 1 in 2001 although no difference was found in 2003. This suggests that the tussocky grass margins in the field headlands at Site 1, once established, were comparable with the well-established headlands at Control site 2 with regards key chick food insect habitat. Such conclusions show that the management regime at Site 1 appeared to be effective in the aims of providing quality habitat that would provide feeding areas for gamebird chicks.

There were significantly more key chick food insects at Site 1 compared to Control site 3 for 2001 and 2003, indicating that, as for the total insect data, tussocky grass headlands provided greater quality habitat compared with similar areas that have been cropped up to the field edge. In order to provide areas that have the potential to be quality feeding areas for gamebird chicks, it is necessary to take field edge areas out of production and convert them into insect habitat, in this case done by sowing tussocky grass.

The number of key chick fod insects at Site 1 showed no difference to Control site 4 for 2001 but a significant difference for 2003. This suggests that the age of the habitat is vital when determining the quality of the habitat, as the more established the headland became at Site 1, the higher the quality in comparison to Control site 4, where the headland was never greater than two years old. The data suggests that, to provide benefits for insects, sown headlands should be left to become more established and not resown regularly. The purpose of the headlands at Control site 4 was to provide cover and feeding areas pheasants, not to provide quality habitat for insect species. However, to provide quality feeding areas for gamebird chicks, the headlands should not be regularly resown. However, the gappy nature of the vegetation in the margins at Control site 4 may make the headland areas more accessible for gamebird chicks than the thick tussocky grass strips at Site 1 and Control site 2, although this suggestion cannot be confirmed within the boundaries of this study.

6.4.5 Factors affecting butterfly and bumblebee numbers

The factors that appeared to affect the numbers of butterflies and bumblebees were generally similar for these two insect groups (Tables 6.3 and 6.4). The key factors for both groups were the amount of herb within the transect, the width of the uncropped margin and the age of the vegetation within the margins. Furthermore, temperature also appeared to affect butterfly numbers, while the amount of flowers within the transects appeared to affect bumblebee numbers.

The effects of these variables on butterfly and bumblebee numbers have been observed in previous studies. Herb species have been shown to provide a valuable nectar source for butterflies and bumblebees (Carvell, 2002; Dover and Sparks, 2000; Carvell *et al*, 2004). The amount of flowers in general has also been shown to positively affect numbers of butterflies and bumblebees (Largerlöf *et al*, 1992; Pywell *et al*, 2004; Marshall *et al*, 2006), although this effect was only observed for bumblebees in this study (Table 6.4). The distinction between all flowering plants and those flowers of herb species was not determined for many of these previous studies, so the positive effect of flower abundance on butterfly numbers found by these studies may actually be an effect of the amount of flowering herb species.

Margin width has been reported to affect butterflies and bumblebee numbers in previous studies (Sparks and Parish, 1995; Dover and Sparks, 2000; Bäckman and

Tiainen, 2002; Pywell *et al*, 2004), perhaps because wider margins are indicative of greater total amounts of this habitat feature. It may also be that wider margins offer greater protection from the effects of agricultural practices occurring in the adjacent arable area, such as buffering from spray drift. Hence, narrow field margins may protect the base of hedgerows whilst receiving a certain amount of chemical application, which subsequently affects insect numbers. Wider margins may mean a proportion of the marginal vegetation is protected from the effects of chemical drift.

The age of the vegetation within the margin has been shown to affect the number of insects associated with uncropped field margins (Hassall *et al*, 1992). Thus, Thomas *et al* (2002) found that beetle banks needed to mature for 10 years before their vegetation structure compared with that of established boundaries. Therefore, the vegetation of a margin may increase in quality over time. This increase may also be a consequence of dispersal rates of insect species (see Section 6.4.1).

The fact that temperature was not significant for butterflies (Table 6.3) was unexpected as many previous studies have shown temperature to be an important factor affecting butterfly distribution (Dover and Sparks, 2000; Pywell *et al*, 2004). Butterflies require a heat source to warm their bodies sufficiently and provide energy with which to be active (Asher *et al*, 2001). In contrast, bumblebees generate heat internally through vibrating muscle fibres (Prys-Jones and Corbet, 1991). Therefore, it was thought that sites with warmer air temperatures would have greater numbers of active butterflies foraging for nectar; in addition, it was thought that south-facing field margins, and field margins sheltered by a thick hedgerow or wooded area, may have warmer micro-climates (Maudsley, 2000). However, for this study, temperature, hedge width and the index of shelter provided by the hedge did not appear to affect butterfly numbers (Table 6.3). However, hedge height was found to be significant as a variable that appeared to determine the presence of butterflies, perhaps due to the higher hedges offering shelter to butterflies and possibly producing a warmer microclimate, thus following the findings of previous studies (Pywell *et al*, 2004) and supporting the idea that butteflies prefer warmer and more shelter areas.

When considering the most abundant species of butterfly and bee, some explanatory variables appeared to show a significant effect that was not evident when considering all butterfly and bee species together (Appendix 7 and 8). It is recognised that different butterfly and bee species have varying requirements from their habitat (Prys-Jones and Corbett, 1991; Pollard and Yates, 1993), hence the differing results for the regression analyses when considering species individually. Should it be desired to enhance the quality of the habitat for a particular species, the results of such analyses would provide useful information relating to the best management regime that would most likely promote habitat quality and lead to an increase in that species abundance at a site.

The additional variables that appeared to have a significant effect on the individual butterfly species were comprised the time of day the surveys were completed, the amount of bare ground along the transect, the amount of shelter, the hedgerow height and the amount of sun. As mentioned previously, shelter has been shown to affect the abundance of butterfly species (Pywell *et al*, 2004), and hedgerow height was used to calculate the amount of shelter provided at a site. As such, it is thought that both factors provided a suitable microclimate at some sites by decreasing the amount of wind. In addition, sun appeared to have an effect, possibly by increase the temperature at a site (shown in the group data regression analysis to have an effect). Bare ground can provide areas within the transects that are suitable for basking (Lamb *et al*, 2002), allowing butterflies to heat up in a sheltered area that radiates heat from the baked earth. Time was the other variable that appeared to have an (negative) effect on individual butterfly species (Appendix 7). This is most likely due to the fact that butterflies roost, finding a site in the afternoon in which to spend the night (Lamb *et al*, 2002). Therefore, the surveys completed in the latter part of the survey time may have been affected by some butterflies having already sought out roosting sites.

The additional variables that appeared to have an effect on individual bee species were hedgerow height and width and the degree of shelter. As with butterflies, it is likely that shelter- an index calculated from the measurements of hedgerow height and width- provided quality micro-climates at certain sites. Although, as already mentioned, bees can generate body heat which permits them to forage when temperatures are lower (unlike butterflies), such behaviour is costly in terms of body energy (Prys-Jones and Corbett, 2003). Therefore, in areas where warmer microclimates are available, it is likely that bees will take advantage and forage without having to expend energy reserves keeping their internal body temperatures elevated.

6.4.6 Factors affecting insect numbers

The amount of herb, shelter, hedge width and margin age appeared to positively affect both insect numbers and the number of key chick food insects within the vegetation of the field margins (Tables 6.5 and 6.6). Furthermore, hedge height and margin width appeared to affect total insect numbers (Table 6.5) and crop appeared to affect the number of key chick food insects (Table 6.6). The presence of certain crop and herb species within the vegetation matrix and adjacent within the field may provide certain insect species with important host plants, explaining the apparent effect of the crop and amount of herb on key chick food insect abundance. Provision of shelter by a hedge (determined by hedge height and hedge width) may affect insect numbers by producing a warmer and more humid microclimate (Maudsley, 2000). Shelter may have had a perceptible effect on insects within the vegetation but had no effect for butterflies, perhaps because the effects of shelter did not extend beyond the confines of the vegetation within which the insects were located, whilst butterflies generally flew above this area. The positive effect of hedge width (and hedge height for total insect numbers) corroborates this assumption, an affect that was also found by Thomas and Marshall (1999). This finding suggests that the thickness of the hedge affected the microclimate at lower levels, specifically where the insects where located, whilst hedge height appeared not to affect insect numbers as it had no effect on the specific ecosystem within the ground vegetation.

Margin age also appeared to positively affect the number of insects and key chick food insects (Tables 6.5 & 6.6), as found in previous studies (Hassall *et al*, 1992; Moonen and Marshall, 2001). As for butterflies and bumblebees (see Section 6.4.5), this is thought related to the maturity of the vegetation within the strip and colonisation rates of insects. Insects and key chick food insects appeared to be affected by the amount of herb (Tables 6.5 & 6.6), similar to the findings for butterflies and bumblebees and is believed to be for comparable reasons; herb provided insects with a valuable nectar source. Margin width appeared to have a positive effect on total insect and key chick food insect numbers, perhaps for similar reasons it appeared to affect butterflies, providing the insects with a greater amount of habitat. Key chick food insect species appeared to be affected by crop (Table 6.6), perhaps due to the type of management associated with the different crop types or because some crops provide beneficial resources for these key chick food insect species.

The additional variable that appeared to have a significant effect on the individual insect (and key chick food item insects) was the amount of bare ground (Appendix 9). As mentioned for shelter (and noted for butterflies) the creation of warmer microclimates by the presence of bare ground could provide some insect species with a desirable habitat.

In conclusion, the grass margins created at Site 1 through the Countryside Stewardship Scheme appeared to have increased in quality over time; specifically, as habitat for butterflies and other insects, including those that are important chick food items. Generally, the number of the different insects within these alternative habitat areas was greater compared to conventionally managed field headlands, indicating that grass margins provide valuable habitat within field headlands beyond that which is available in cropped headlands. Thus, the aim of providing insect-rich feeding areas for gamebird chicks appears to have been a success.

To increase future numbers of butterflies and bumblebees at Site 1, I recommend that nectar and pollen mixes be introduced as a quick solution. Alternatively, new field margins can be left to regenerate naturally, although this can have serious implications for weed control in the adjacent crops (Theaker *et al*, 1995; Kleijn *et al*, 1998). Producing direct benefits for butterflies and bumblebees was never an aim of the new management regime at Site 1, although the thick tussocky grass that was created has potential as nest sites for queen bumblebees (Carvell *et al*, 2004).

Increasing the future number insects at Site 1 may be possible through hedgerow management, by gapping up to increase shelter and sympathetically cutting to allow the hedge to become thicker, thus increasing the degree of shelter. Allowing the grass margins to mature should provide benefits for butterflies, bumblebees and other insects. Providing an additional margin along side the existing tussocky grass, in a fashion similar to that sown at Control site 4, where wheat was with a contaminant, may increase the accessibility of gamebird chicks to insect-rich feeding sources (which may increase the wild gamebird productivity rate) whilst concurrently increasing butterfly and bumblebee numbers through provision of additional nectar sources from the contaminate and the recognised benefits of wider margins.

These alternative habitat features thought beneficial for wild gamebirds, and which appeared to produce some benefits for certain insect groups, were also considered to have potential for increasing songbird density. This premise is examined in the following chapter, which investigate the effects of the new management regime at Site 1 on songbird species (Chapter 7).

Chapter 7
Benefits of Gamebird Shooting: Increases in songbird abundance

7.1 Introduction

7.1.1 Songbirds as indicators of habitat quality

The abundance and diversity of wildlife species are often used as a measure of habitat quality (see Section 6.1.1). Research on the ecology of British bird species suggests that measures of their abundance make them suitable indicators of habitat quality, as high quality habitat is preferentially occupied, while low-quality habitat is only utilised when population numbers are high (O'Connor cited in Van Horne, 1983). Records of songbird abundance are now commonly used as an indicator of habitat quality (Marchant *et al*, 1992; Pain *et al*, 1997) although Chamberlain and Fuller (1999) note that measures of abundance are also valuable for many other species. For agricultural habitats, songbird abundance is commonly used to assess the habitat quality and to monitor the effects of new management regimes. Songbirds are particularly easy to study, and many people are interested in their study, so many previous years of monitoring data are often available (Baillie *et al*, 2002).

Recording of songbird populations to monitor their abundance has been undertaken in Britain for several decades (Furness *et al*, 1993). For example, the British Trust for Ornithology (BTO) started the Common Bird Census (CBC) in 1962, and has surveyed up to 300 plots annually to provide data on breeding populations of common bird species in Britain. This 40-year data set contains valuable information on changes in bird populations, particularly within farmland and woodland habitats (Baillie *et al*, 2002). Indeed, its value has been recognised by the British Government, which has designated it as one of its headline indicators of sustainable development (Marchant *et al*, 1992; Baillie *et al*, 2002).

7.1.2 Methods developed for monitoring British birds

Two main methods have been used in Britain to collect bird population data: the CBC and the Breeding Bird Survey (BBS). The CBC method was originally developed by the BTO in response to a request from the Joint Nature Conservancy Council (JNCC), who had become increasingly concerned over degradation of farmland habitats through agricultural intensification, particularly from the large-scale application of agro-chemicals (Marchant *et al*, 1992; Gilbert *et al*, 1998). Initially targeting agricultural environments and farmland birds, the CBC was later widened to include woodland birds (Baillie *et al*, 2002). The CBC is an extremely efficient and accurate method for estimating breeding bird densities within any given area. A comparison of results derived from the CBC with those from intensive searches for nests found comparable results for 70% of species, confirming the precision of the CBC methodology (Baillie *et al*, 2002).

The CBC involves recording and mapping the position of bird territories within a site for a given breeding season. Territories are primarily identified by the presence of singing males, although signs of breeding, such as active nests or adult birds with food, can also be used to locate successful breeding territories. Between-year comparisons of territory densities can highlight any changes to a breeding population within a site and can show long-term trends over a number of years. The CBC has been useful in highlighting significant decreases in population size for many bird species and has allowed effort to be directed at managing these species in an attempt to halt declines. The corncrake, stone-curlew and cirl bunting are all examples of bird species for which the CBC identified declines in density and range (Section 4.2.1), that in turn led to the application of specific land management regimes to prevent further losses and to attempt a recovery in numbers (Aebischer *et al*, 2000; Swash *et al*, 2000; Peach *et al*, 2001).

The CBC monitoring scheme has been extremely successful in achieving the aims for which it was designed. Species suffering from a reduction in range and abundance have generally been found to have experienced decreases in their habitat quality (Gilbert *et al*, 1998; Siriwardena *et al*, 1998). While the CBC is the most accurate method for assessing the density of bird breeding territories, it is also extremely time-consuming and is not suited to all circumstances, as it limits the number of sites that can be surveyed at any one time. By design, CBC surveys also tend to be restricted to one habitat type per site, limiting the range of habitats for which data can be collated (Marchant *et al*, 1992; Furness *et al*, 1993; Baillie *et al*, 2002).

Consequently, the BTO introduced the BBS in 1994 as an alternative monitoring method to the CBC. Although run alongside each other for several years to allow for calibration of the two methods, the CBC was phased out and ceased being adopted as the main monitoring technique in 2000. The need to change methods was felt necessary because reductions in labour and finances made the CBC unsuitable if the level of monitoring required the same number of sites to be covered. The introduction of the BBS also made it possible to monitor many more habitat types, which is a critical advantage given that areas other than farm and woodland are also experiencing a reduction in habitat quality (Baillie *et al*, 2002). Hence, CBC and BBS methods have different underlying assumptions, benefits and drawbacks. The method chosen for any study requires definition of both research needs and any limitations imposed by factors such as funding and time.

The long-term BTO monitoring schemes have identified abnormal changes in populations of songbirds (Furness *et al,* 1993). Most of these changes have encompassed long-term declines in both range and abundance that have mainly been driven by alterations to farming techniques such as agricultural intensification. However, long-term monitoring can also identify shorter-term population increases resulting from favourable breeding seasons or over-wintering conditions. For example, the great spotted woodpecker (*Dendrocopos major*) experienced a rapid increase in numbers in the 1970's, that was attributed to an increase in available feeding areas, in the form of dead standing trees killed by Dutch Elm Disease. Likewise, magpie (*Pica pica*) numbers have increased since recording began, which has been attributed to their adaptability and to a decrease in corvid control as gamekeeper numbers fell. Similarly, blackcap (*Sylvia atricapilla*) have experienced an increase in numbers since the late 1970's both here in Britain and mainland Europe, but the cause of this trend is not understood (Marchant *et al*, 1992).

Such increases in the range and abundance of bird populations can also result from applying management regimes designed specifically to increase bird numbers, such as those created to increase numbers of stone-curlew and cirl bunting (Chapter 4). Monitoring populations once a management regime has been implemented is vital to identify any increases in species density arising from producing higher quality habitat, which in turn may result in an increased carrying capacity, greater breeding success rate and/or higher over-winter survival (Newton, 1994). As AESs were created to improve biodiversity within agricultural habitats, they are often cited as a possible solution to the general decline in songbird abundance (Bradbury *et al*, 2004; Gillings *et al*, 2005). Monitoring populations is an effective way of assessing how songbird populations have responded to the implementation of such schemes (Greenwood, 2003).

7.1.3 Motivation for and aims of the study

Chapters 7 continues to investigate the premise that the radical new management regime implemented at Site 1 to enhance wild gamebird productivity concurrently produced benefits for wider wildlife. Hence, this chapter examines the effects of gamebird management on songbird populations. As with the insect monitoring, the songbird data gathered from Site 1 were compared over time and with data from control sites to establish whether the density of songbird territories increased.

7.2 Methodology

7.2.1 Monitoring of Songbirds

Of the two main methods adopted in Britain to monitor songbirds (see Section 7.1.2), the CBC method was chosen for this study over the BBS, for four main reasons:

(1) because of the layout of the farmland habitat under study, and the greater flexibility of the CBC methodology to monitor in the desired habitat type, rather than within the habitats that were covered by BBS transects;

(2) because the CBC generates more accurate data than BBS, based on more visits, and more time spent per visit (Gilbert *et al*, 1998).

(3) because the better data also offers a way to account for variability due to factors such as weather. Hence, the mapping methods required in CBC produce much more accurate information than is possible with either point

counts or transects, and allows better understanding of the relationship between counts and the number of birds present (Marchant *et al,* 1992); and,

(4) because concerns over funding and time were not a consideration.

Consequently, the songbird monitoring sought to record the density of bird territories within, and immediately around, the arable habitat of both treatment and control sites. The seven treatment and control sites were surveyed annually through five visits made between May and July during 2001 to 2003. The monitoring of treatment and control sites sought to allow comparison of abundance associated with changing and different land management regimes. The bird monitoring plots ranged in size from *c.* 50 to 70 ha, plot sizes that lay squarely within the limits suggested by the BTO methodology, which for farmland habitat requires a minimum of 40 ha and a maximum of 100 ha, with 60 ha suggested as the ideal plot size (Marchant *et al,* 1992; Bibby *et al*, 1993).

Collection of the songbird data followed the accepted methodology for CBC as stipulated in Gilbert *et al* (1998) and detailed in Bibby *et al* (1993). The monitoring plots for the CBC were established by identifying arable fields within each treatment and control site and determining the best route for the survey, including the preferential choice of fields lying adjacent to one another. Additional factors like field size and connectivity with other fields were also considered in deciding which plots to monitor. For two of the four Treatment sites (1.3 and 1.4), all the arable fields were included in the CBC survey, as was the case for Control site 2. In contrast, the arable area for Treatment sites 1.1 and 1.2, and for Control sites 3 and 4, was too large, so some fields were excluded from the CBC survey.

During monitoring visits, the position of any birds seen or heard was recorded while walking along all boundaries and within 50m of all areas. The sex of the bird was noted, and other relevant observations were also taken, including signs of breeding, such as sightings of nests and individuals carrying food. Birds were recorded using the standard species codes developed by the BTO. The direction of birds in flight was noted from the point that they were first seen until they were no longer visible. Birds of the same species that were close to each other, and heard or seen simultaneously, were connected on the map by a hashed line. Such a notation emphasised that these were two separate individuals and not the same bird observed twice. This technique was important to distinguish territorial males, as failure to identify two separate individuals can result in under-estimating territory densities.

Most monitoring visits took place in the morning, although one or two visits were conducted in the evening to record species that may be more active at dusk. Visits commenced in the first hour after sunrise or *c.* 4 hours before sunset. At least 10 days were allowed to pass between each visit. The route taken on each visit was varied to avoid always surveying the same area at the start or end of the session, when birds maybe more or less obvious due to variations in their activity. Bad weather, such as high wind, fog or rain, resulted in postponing visits, to avoid compromising counts either by bad conditions or reduced bird activity.

All observations were recorded on a pre-prepared map of the study site, which showed all major boundaries and habitat features, and a new map was used for each visit. Once all visits had been completed, the details were transferred on to individual species maps, on which all observations from the five visits were collated. This summary map for each species was used to define territories within the CBC survey sites. A territory was usually identified by a cluster of observations, gathered from different visits and located in the same general area. The majority of territories were defined as observations of male territorial behaviour, usually singing, with a minimum of two observations required to indicate a territory. Other indications of territoriality and breeding, such as repeated alarm calling and other vocalisations, aggressive encounters between individuals, active nests, mating, displaying, or individuals carrying nesting material or food, were also used as indications of a territory. This was when noting individuals observed simultaneously using a hashed line was most useful.

The technique of defining separate breeding territories worked well for many bird species. However, this technique is not appropriate for those species that live in colonies, such as long-tailed tits (*Aegithalos caudatus*), which have territories that consist of more than just a breeding pair, and semi-colonial species, such as linnets (*Carduelis cannabina*), which can often be found in clusters that consist of several breeding pairs (Marchant *et al*, 1992; Bibby *et al*, 1993). For these types of species and for colonial species in particular, estimates focussed on breeding colonies. This highlights the importance of understanding the ecology of the monitored species when determining the boundaries of territories on species maps.

7.2.2 Site Variables

As with changes in gamebird populations (Chapter 5), variables that could potentially affect the relative abundance of songbird territories were also collated. The amount of arable habitat within the monitored area and the length of habitat features, including hedgerow, woodland edge and boundary, were measured using estate data and aerial photographs digitised within a Geographical Information System (GIS) programme (Global Mapper v5), as a way of comparing the heterogeneity of treatment and control sites. These information sources were also used to calculate the total area of CSS habitat, set-aside or equivalent features, in a similar way to the data that were collated for the gamebird analysis. However, the areas encompassed in the CBC monitoring at some treatment and control sites was less than that covered in the gamebird surveys.

7.2.3 Assumptions and limitations

As with the gamebird and insect surveys, there are a number of assumptions and limitations associated with the survey methodology and the data gathered that must be recognised. The songbird surveys provided abundance data for each of the sites and were not a total population density count. By using the same methodology at each of the sites, an index of territory density within each site was generated which allowed for comparison between sites and over time. The technique was limited by the sampling method in that the low number of visit (five per season) would have had an impact on the number territories recorded. However, time constraints meant that it was not possible to undertake more than five visits per site between May and July.

It is assumed that the songbirds at each of the sites responded in the same way to the presence of the observer, meaning that each species of songbird were as observable at each of the sites. Therefore, it was assumed that an equal proportion of the songbird population were observed at each of the sites and in each year. These assumptions meant that the counts were a representation of the number of territories for the songbird populations and permitted the comparison of data between sites and over time.

7.2.4 Data analysis

The analysis of songbird data sought to determine whether the radical new management regime for the arable areas at the treatment sites had benefited songbird populations to the extent that measurable increases in territory abundance were achieved relative to control sites. Songbird species were divided into categories depending on the habitat with which the species are most associated, using ecology data from the BTO (Marchant *et al*, 1992), as well as from studies on British bird species (Siriwardena *et al*, 1998; Fuller *et al*, 2001). These categories are not definitive: many songbird species use a number of different habitat types where available. Categories for species were assigned for that habitat with which the species was most commonly associated, comprising: 1) woodland species; 2) hedgerow species; 3) farmland species; 4) hirundines; and, 5) raptors. Although swifts (*Apus apus*) are not a hirundine species, they were included in this category due to the similarity in their ecology with swallows (*Hirundo rustica*) and house martins (*Delichon urbica*). All these species build nests on buildings, primarily fly in groups and cover a large area when feeding, such that territories are rarely encompassed within monitoring plots.

The territory data were adjusted to account for differences in area of monitoring plots, so that all territories were displayed as per km². However, estimates of species density are not necessarily independent of site area, an effect that has been termed a *density-area relationship* (Gaston *et al*, 1999). Their study examined CBC data collected from sites of different size and showed that there tends to be a decrease in species density as the size of monitoring plots increases. This effect has also been noted for mammals, in which the density of large carnivore species decreased as census area increases (Schonewald-Cox *et al*, 1991). The area of monitoring plots is constrained by the CBC methodology, and although the size of the monitoring plots used in this study fell within the suggested range, there was still some variation in size between the sites. However, studies conducted in farmland habitat experienced this density-area relationship to a far lesser extent than those studies undertaken within woodland plots (Gaston *et al,* 1999). Therefore, it was deemed acceptable to adjust the data on the basis of plot size for this study.

The songbird territory densities for each Treatment site 1.1 to1.4 were combined, and the mean was used for the initial data exploration alongside the single counts for each of the three control sites. The density of songbird territories recorded in the four treatment sites were analysed using repeated measures ANOVA, to compare the variance caused by differences in the data, and to thereby investigate whether density had changed significantly over the three years. This was then repeated for each individual songbird category. The data for hirundine and raptor species were not included in the territory density analysis, because observations of these species were not related to definitive territories. The ranges over which these two groups of species feed can be extensive, and the observations were made during the CBC surveys when these species were in flight and, presumably, feeding. It was not possible determine the exact location of observed individuals territory and it is very possible that the total territory over which an individual ranged whilst feeding included more than one study site. As such it was not appropriate to include data for these two categories in the analysis of the territory data. Instead, observed abundance data for these two categories at each site has been included within the frequency histogram, and combined into "other", while the actual count data for each species of bird are displayed in Appendix 10.

Repeated-measures ANOVA was then used to investigate whether there was a difference in the densities of songbird territories between Treatment site 1 and control sites. Repeated-measures was used because analysis was for factors between subjects, or sites under different management practices, and was also tested under different levels due to comparison between years. As with the gamebird and insect analyses, one-sample t-tests were conducted to compare the mean values calculated from one year from treatment sites at Treatment site 1 to the fixed value recorded from one of the control sites.

Regression analyses were undertaken to assess which variables appeared to best explain the variation in the densities of territories at each site. Regression analysis is usually used to identify the most parsimonious model that best explains the data with the least number of terms in comparison with the saturated model. In this case, the regression analysis was used to describe the relationship between the exploratory variables and the dependent variable, and to assess the degree to which the variation was explained (Quinn and Keough, 2003). This was considered appropriate as few variables were included in the analysis, yet a substantial number of environmental variables, many interrelating, could have been responsible for determining the size of songbird populations, as acknowledged by Gates *et al* (1997). Although their study included a large number of variables, many important factors might have been excluded from their regression analysis. As with their investigation (Gates *et al*, 1997), the regression analysis conducted in this study does not imply causation, and instead only indicates the possible importance of variables that may have influenced songbird abundance.

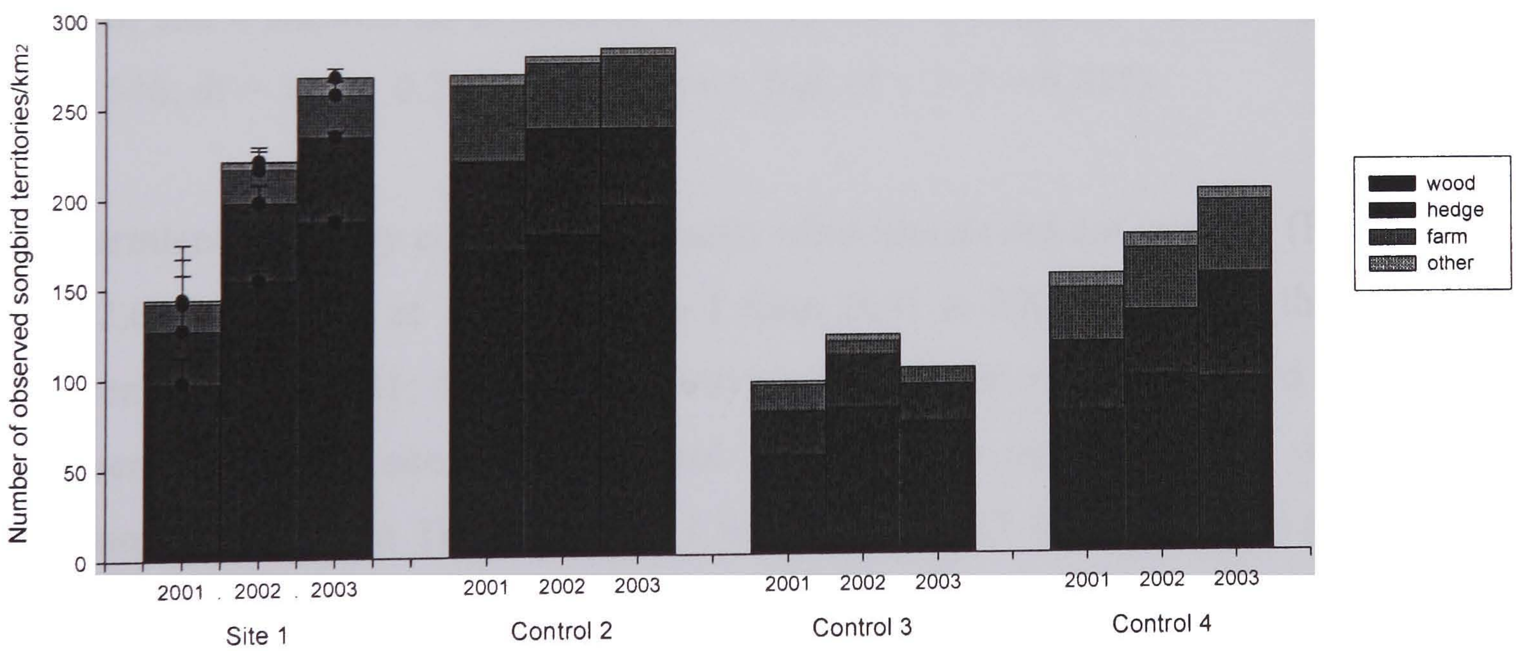
The variables included in the regression analysis were those that might conceivably have affected songbird territory density, based on previous studies showing the effect of habitat size and the availability of its associated resources in exerting density-dependent effects on songbird populations (Fuller *et al*, 1985; Lack, 1993; Gaston *et al*, 1999). Each variable was considered separately one at a time within the regression analysis, which avoided problems of multicollinearity. For each regression analysis, the variability as a result of site and year was accounted for before each variable was analysed to suggest how much variability in songbird abundance it accounted for. The P value provides a measure of the extent to which each variable explains differences in songbird density at each site for each year. As with the previous regression analyses (Chapters 5 and 6), this had the effect of allowing the strength of single factor relationships on songbird density to be assessed, rather than determining the combination of factors that best explained songbird density. This was desired as any benefits derived for songbird populations from the alterations to the new land management regime at Treatment site 1 were circumstantial; the land management adopted was with the purpose of benefiting wild gamebird productivity not to maximise the quality of the habitat for songbirds. It is valuable to have the strength of single factor relationships on songbird density because, should other landowners be interested in adopting one or two of the prescriptions aimed at increasing habitat quality for gamebirds, the particular benefits noted for songbirds may influence the prescriptions they choose.

7.3 Results

7.3.1 Density of songbird territories

Using repeat measures ANOVA, the mean density of all songbird territories increased ($F = 18.708$; df = 2,6; $P<0.05$) at Treatment site 1 from 2001 to 2003 (Figure 7.1). Furthermore, there was a difference ($F = 20.024$; df = 3,6; $P<0.05$) in the overall density of songbird territories between sites (Treatment site 1 and controls). T-tests comparing songbird counts at Treatment site 1 to Control site 2 showed a significant difference in the density of territories for the baseline year of 2001 ($t= -5.913$; df = 3; $P<0.01$). However, there was no difference ($t= -0.319$; df = 3; $P = 0.770$) between territory density at Treatment site 1 and Control site 2 for 2003. Comparison of Treatment site 1 to Control site 3 showed no significant difference ($t= 2.284$; df = 3; $P = 0.107$) in the number of songbirds for 2001. However, there was a significant difference ($t= 3.411$; df = 3; $P<0.05$) for 2003. Comparison of Treatment site 1 to Control site 4 showed no significant differences for 2001 ($t=-0.522$; df = 3; $P=0.637$) or for 2003 ($t= 1.349$; df = 3; $P=0.270$).

Figure 7.1: Overall densities of songbird territories per km² across the treatment and control sites from 2001 to 2003. Data for Treatment site 1 represent the mean ± SE of the four treatment sites. "Other" represents hirundine and raptor species.



For woodland birds, there was also an increase ($F = 18.946$; df = 2,6; $P<0.05$) in the density of territories at Site 1 from 2001 to 2003 (Figure 7.1). Furthermore, there was also a difference ($F = 31.581$; df = 3,6; $P<0.001$) in the density of territories between sites. Comparisons between Treatment site 1 and Control site 2 showed significantly more (t= -5.083; df = 3; P <0.05) woodland territories at Control site 2 for 2001. However, there was no difference (t= -0.253; df = 3; P = 0.817) for woodland bird territories in 2003. Comparisons between Treatment site 1 and Control site 3 tended to significance (t= 2.943; df = 3; P<0.1) for numbers of territories in 2001, and showed a significant difference (t= 3.486; df = 3; P<0.05) for 2003. Comparison between Treatment site 1 and Control site 4 showed no significant difference (t= 1.294; df = 3; P = 0.286) for 2001. However, there tended to be more (t= 2.788; df = 3; P<0.1) woodland territories at Treatment site 1 than Control site 4 for 2003.

For hedgerow birds, the density of territories also increased (F = 9.507; df = 2,6; P <0.05) at Site 1 from 2001 to 2003 (Figure 7.1). However, there was no overall difference (F = 4.105; df = 3,6; P = 0.67) in the density of hedgerow territories between treatment and control sites. T-tests for comparison between Treatment site 1 and Control site 2 showed significantly more (t= -3.483; df = 3; P<0.05) hedgerow territories at Control 2 compared to Treatment site 1 for 2001, However, there was no difference (t= 0.421; df = 3; P = 0.702) in territory density for 2003. Comparison of Treatment site 1 with Control site 3 showed no significant difference (t= 0.952; df = 3; P = 0.412) for 2001. However, there tended to be more (t= 2.671; df = 3; P<0.1) hedgerow territories at Site 1 in 2003. Comparison between Treatment site 1 and Control site 4 showed no difference in the number of hedgerow territories for 2001 (t=-1.546; df = 3; P = 0.220) or 2003 (t=-1.168; df = 3; P = 0.327).

For farmland birds, by contrast, the density of territories did not increase (F = 2.157; df = 2,6; P = 0.197) at Treatment site 1 from 2001 to 2003. However, there was a difference (F = 31.581; df = 3,6; P<0.001) in the density of farmland bird territories between Treatment site 1 and control sites. T-tests comparing the number of farmland territories at Treatment site 1 to Control site 2 found a highly significant difference (t=-11.624; df = 3; P<0.001) for 2001. However, there was no difference (t= -2.226; df = 3; P = 0.112) in densities of territories for 2003. Comparison between Treatment site 1 and Control site 3 showed no difference in the number of farmland bird territories in 2001 (t= 0.122; df = 3; P = 0.910) or 2003 (t= 1.906; df = 3; P = 0.153). Control site 4 had significantly more farmland bird territories than Site

1 in 2001 (t=-6.306; df = 3; $P<0.01$). However, there was no difference in the number of farmland territories for 2003 (t= -2.285; df = 3; $P = 0.106$).

7.3.2 Factors affecting density of songbird territories

The results of the regression analysis for all songbird territories show that the total amount of edge length, the amount of CSS habitat and the degree of gamekeeping each had a significant effect in explaining overall territory density across sites, In contrast, supplementary feeding appeared to have no effect variation in songbird territories across sites (Table 7.1).

Table 7.1: Regression analysis for the four variables examined to explain the variation in the total density of songbird territories at all four sites.

Variable	B	s.e.	df	Significance
Total edge length	0.026	0.004	3	<0.001
CSS	33.987	7.035	3	<0.001
Gamekeeping	39.045	8.772	3	<0.001
Supplementary feeding	-0.082	16.927	3	0.996

The results of the regression analysis for woodland bird territories show that the length of woodland edge, the amount of CSS habitat and the degree of gamekeeping each had a significant effect in explaining the variation in the density of woodland territories across sites. In contrast, supplementary feeding appeared to have no effect in explaining variation in the density of woodland territories across sites (Table 7.2).

Table 7.2: Regression analysis for the four variables relating to density of woodland territories at all four sites.

Variable	B	s.e.	df	Significance
Wood edge length	0.017	0.005	3	<0.01
CSS	20.357	5.239	3	<0.001
Gamekeeping	22.569	6.601	3	<0.01
Supplementary feeding	1.570	11.238	3	0.891

The results of the regression analysis for hedgerow bird territories show that the length of hedgerow, the amount of CSS habitat and the degree of gamekeeping were each had a significant effect in explaining the variation in the density of hedgerow territories across sites. Again, supplementary feeding appeared to have no effect in explaining the variation in the number of hedgerow species (Table 7.3).

Table 7.3: Regression analysis for the four variables relating to density of hedgerow territories at all four sites.

Variable	B	s.e.	df	Significance
Hedge length	0.005	0.002	3	<0.01
CSS	6.471	1.729	3	<0.01
Gamekeeping	8.522	1.862	3	<0.001
Supplementary feeding	2.000	3.615	3	0.587

The results of the regression analysis for farmland bird territories show that the amount of CSS habitat and the degree of gamekeeping effort were each had a significant effect in explaining the variation in the density of farmland songbird territories across sites. In contrast, the area of farmland and supplementary feeding did not appear significant in explaining the degree of variation in the density of farmland territories across sites (Table 7.4).

Table 7.4: Regression analysis for the four variables relating to density of farmland territories at all four sites.

Variable	B	s.e.	df	Significance
Farmland area	-57.197	34.714	3	0.118
CSS	6.796	0.893	3	<0.001
Gamekeeping	7.196	1.393	3	<0.001
Supplementary feeding	-4.112	2.753	3	0.154

7.4 Discussion

Birds are the most studied group among British wildlife (Marchant *et al*, 1992), and the overall decline in their numbers over the last few decades has been well documented (Gilbert *et al*, 1998; Siriwardena *et al*, 1998; Chamberlain and Fuller, 1999; Baillie *et al*, 2002). For some species, the causes of these declines are well understood. Many species of songbirds in the British countryside have experienced significant declines in abundance and diversity, most probably as a result of agricultural intensification (Donald *et al*, 2001, Gilbert *et al*, 1998; Siriwardena *et al*, 1998; Chamberlain and Fuller, 1999). Consequently, it has been assumed that new farming techniques that seek to reverse agricultural intensification will counteract the problem (Chamberlain *et al*, 2000; Osmerod and Watkinson, 2000). However, evidence for the successful recovery of songbird populations is still generally lacking.

Voluntary schemes, in the form of AESs, have been established with the aim of reversing songbird population declines (Bradbury *et al*, 2004). However, such schemes require the cooperation of private landowners and a high level of management to produce the desired quality habitat (Kleijn *et al*, 2001). As noted previously, some farmers receive large sums of money each year for conservation management through AESs (Chapter 4). However, to date these have generally failed to deliver the desired widespread biodiversity benefits (Sutherland, 2004).

Management for gamebird shooting, undertaken privately by landowners and often using large sums of their own money, has been cited as producing significant benefits for songbirds by: (1) providing alternative habitat for nesting, foraging and over-wintering, through practices such as hedgerow creation, planting new woods, and establishment of grass strips (Hill and Robertson, 1988; Stark *et al*, 1999; Rackham, 2000); (2) providing supplementary food, supplied both directly from hoppers and indirectly from cover crops and brood rearing strips that are seed-bearing or rich in insects (Wilson et al, 1997; Stoate, 2002; Critchley *et al*, 2004); and (3) decreasing the impact of predators on both adult songbirds, and on nests and chicks as a result of predator control (Tapper, 1999; Stoate and Szczur, 2001). Those involved in country sports are also more likely to adopt AESs (Macdonald and

Johnson, 2000; Morris *et al*, 2000; Oldfield *et al*, 2003), and the desire to reap real and tangible benefits from the schemes for gamebirds may mean these landowners implement the prescriptions to a higher level than other landowners. However, to date, no research has been conducted to investigate this hypothesis.

Consequently, this chapter sought to determine whether the new management regime undertaken at Treatment site 1 to enhance wild gamebird productivity had a beneficial effect on songbird populations. If such land management can be shown to create biodiversity benefits beyond those produced by AESs alone, it may indicate a need to modify such schemes to include aspects typical of wild gamebird management. In addition, the regression analyses attempted to determine the degree to which each individual variable affected songbird density.

7.4.1 Changes in, and factors affecting, the density of songbird territories densities

AESs are seen by many as the solution to reverse declines in songbird numbers in agricultural habitats over recent years (Bradbury *et al*, 2004; Sutherland, 2004). Similarly, management to promote wild gamebird productivity can produce higher quality habitat for songbirds, leading to increased population densities (Furness and Greenwood, 1993; Stoate and Szczur, 2001). Monitoring annual population sizes is accepted as an appropriate technique to determine the continuing status of songbird populations and to examine their response as indicator species to changes in environmental conditions (Spellerberg, 1991).

The monitoring of songbird populations can be used to assess the habitat quality of a site (Griffiths *et al*, 1999) and to compare between sites. In general, songbird density may reflect habitat quality (Swash *et al*, 2000). Several factors have been identified as influencing habitat quality including the density (Jarvis, 1993), the structure (Lack, 1992; Vanhinsbergh *et al*, 2002) and diversity (Fuller *et al*, 1985; Benton *et al*, 2003) of landscape features. In addition to the composition of the features within a site, the quality of a site for songbirds can also be affected by the practices undertaken to manage the habitat (Osmerod and Watkinson, 2000).

The overall density of songbird territories increased at Treatment site 1 between 2001 and 2003 (Figure 7.1), indicating that the new land management regime was increasing habitat quality. Previous studies that have investigated the effects of wild gamebird management, such as the Allerton project at Loddington, found similar responses in songbird populations (Stoate and Leake, 2002; Draycott and Hoodless, 2004).

Comparison between Treatment site 1 and Control site 2 showed significant difference for 2001 (Figure 7.1), indicating that the well-established habitat and land management for shooting, with an emphasis on wild game, provided higher quality habitat at Control site 2. However, there was no difference in the number of songbird territories in 2003 at Treatment site 1 compared to Control site 2, suggesting the new land management implemented at Treatment site 1 improved the quality of the habitat, resulting in comparable numbers of songbirds at Treatment site 1 and Control site 2. There was no difference when comparing the density of songbird territories at Treatment site 1 to Control site 4 for both 2001 and 2004. Thus, Treatment site 1 could be compared with sites that had well established habitat features (Control site 2) and high levels of gamekeeping effort (Control site 4).

In addition, the total density of songbird territories did not differ between Treatment site 1 and Control site 3 for 2001 (Figure 7.1), but there was a difference for 2003. These results support the view that the increase in songbird territories at Site 1 were the result of the new land management regime increasing habitat quality. The density of songbird territories increased beyond those found on a site that is traditionally farmed and does not support any gamebird management practices. Treatment site 1 and Control sites 2 and 4 would be more heterogeneous in their habitat structure with greater amounts of alternative habitat such as CSS, brood rearing strips and cover crops compared to Control site 3 (Chapter 4). and habitat heterogeneity is known to affect songbird density and diversity (Jarvis, 1993; Burel *et al*, 1998; Benton *et al*, 2003).

Monitoring methods cannot identify the specific causes of changes in bird populations (Chamberlain *et al*, 2000). Although the decreases in population size and range of many British songbird species have been recorded in monitoring programmes and examined in numerous studies, these studies have failed to identify the causes for all but a few species (Gates *et al*, 1997). Factors such as changes to cropping regimes and decreases in the abundance of weeds and insects are just some of the consequences of agricultural intensification assumed to have negatively impacted on songbirds (Newton, 2004). Long-term, intensive research is required if the specific causes are to be clarified. Similarly, in-depth research is needed to understand the positive responses exhibited by songbird populations following alteration of farming regimes. In both cases, changes to population density are likely to arise from several interacting factors (Chamberlain *et al*, 2000). To date, most research has identified correlations between factors and songbird population status rather than causation (Gates *et al*, 1997).

The total amount of edge, gamekeeping effort and amount of CSS best explained the variation in songbird territory densities at Treatment site 1 and the control sites (Table 7.1). The amount of edge habitat probably explained the variation in territory density, because, as the length of edge habitat increases within an arable landscape, so does its heterogeneity. In turn, this provides greater amounts of alternative habitat within which songbirds can feed, nest and shelter (Burel *et al*, 1998). This effect is probably enhanced when CSS features border much of the edge habitat. Indeed, the presence of both habitat types adjacent to each other has been identified as increasing the quality of the habitat overall (Hinsley and Bellamy, 2000).

Previous studies have highlighted the benefits of gamekeeping on songbird populations, including provision of cover crops (Stoate, 2002) and predator control (Reynolds and Tapper, 1996). Therefore, it is highly likely that gamekeeping effort has affected the density of songbird territories at both treatment and control sites as a result of a combination of factors. Surprisingly, supplementary feeding, although a feature of game management, was not significant in explaining songbird abundance at Treatment site 1 and the controls. Previous studies have suggested a significant effect of supplementary feeding on songbird abundance (Draycott, 2004). However, the provision of alternative habitats at Treatment site 1 and the controls may have provided preferential feeding sites, making the artificial feeding areas redundant for songbirds.

7.4.1.1 Trends in, and factors affecting, woodland bird densities

The increase in woodland species at Treatment site 1 between 2001 and 2003 (Figure 7.1) suggests an increase in the quality of habitat utilised by this group of songbirds. The woodland management at Treatment site 1 was not assessed in this study as it focused on arable areas. However, previous studies have highlighted the benefits of woodland management for gamebirds, such as coppicing, ride management and clear-felling, as also providing quality habitat for songbirds (Rackham, 2000; Draycott and Hoodless, 2004). Additionally, while certain species are associated with particular habitat features, they do not make exclusive use of these areas (Griffiths *et al*, 1999; Fuller *et al*, 2001). For example, the fact that the woodland edge was incorporated into the survey sites (where woodland edge bordered arable fields) suggests acceptance that the bird species recorded are those that may prefer the outer regions of woodland blocks because of the close proximity of alternative habitat types.

The difference in the density of woodland bird territories between Treatment site 1 and Control site 2 for 2001 was probably a result of the quality of habitat provided along the woodland edge rather than as a result of the quantity of the woodland habitat, which has been shown to affect songbird density (Gaston *et al*, 1999). The comparison of the 2003 data for Treatment site 1 and Control 2 found no difference in the density of woodland territories. As the amount of woodland at Site 1 was not increased over this period, it is concluded that the quality of the habitat increased as a result of the new land management regime, thereby supporting the views of other studies that the quality of woodland habitat can be a significant factor in determining density (Sparks *et al*, 1996).

Comparison between Treatment site 1 and Control site 3 showed there to be significantly more woodland territories at Treatment site 1. This may indicate that Treatment site 1 provided higher quality habitat for this group of birds even before the establishment of the new game management regime as a result of the basic shooting management that was done. Release pens are located in woods, feeders are usually positioned along woodland edges, and rides would have been maintained to a certain extent at Treatment site 1 to allow access to release pens. In turn, all these factor could have provided habitat of a higher quality than that provided by arable farmland that has no shoot management. The degree of the significance increased from <0.1 to <0.05 over the three years, indicating that the difference between the two sites was increasing, possibly as a result of the new land management regime increasing the quality of Site 1 habitat for woodland songbirds.

Similarly, the comparison of woodland territories between Treatment site 1 and Control site 4 showed no significant difference for 2001 but significantly more territories at Treatment site 1 for 2003, most likely as a result in the increase in the quality of this particular habitat. Woodland at Control site 4 was limited and, therefore, it was not the focus of gamebird management, which was concentrated to the hedgerows and brood rearing strips. Thus, it is likely that Control site 4 was not providing quality habitat for woodland songbirds.

Woodland supports the highest diversity of songbird species of any main British habitat, and most of these species live at the woodland edges (Vanhinsbergh *et al*, 2002). Studies have shown that larger woods have lower songbird densities, probably because there is less edge habitat relative to area (Mason, 2001; Vanhinsbergh *et al*, 2002). This was supported by the analysis in this study that indicated that increased woodland edge explained the variation in woodland songbird numbers. However, the size of each woodland area was not included in this analysis, and so, this study was unable to assess the affect of woodland size on territory density.

The variation in woodland songbird territories was also explained by the amount of CSS. Thus, the positioning of much of the CSS features adjacent to woodland edges most likely enhanced the quality of both habitat features. Gamekeeping also appeared to positively affect woodland songbird territory density and, although gamekeeping activities were not generally directed towards woodland areas, it is likely that some factors, such as predator control, and particularly of species like jays, magpies and squirrels, benefited woodlands species. Supplementary feeding did not appear to explain the variation in woodland songbird numbers, again indicating that heterogeneous habitat provided adequate quality feeding areas.

7.4.1.2 Trends in, and factors affecting, hedgerow bird densities

The increase in the density of hedgerow bird territories at Treatment site 1 over time (Figure 7.1) was most likely a response to an increase in habitat quality, both of the hedgerows themselves and of the surrounding habitats. The quantity of hedgerow is also deemed important and the AES implemented at Treatment site 1 meant new hedgerows were planted over the course of the fieldwork. However, these newly created hedgerows will take several years to become established and were considered to provide little new hedgerow habitat to songbirds during this study. Therefore, the density of hedgerow territories will probably continue to increase at Treatment site 1 as these newly created hedgerows become established and provide increased amounts habitat.

There were significantly more hedgerow bird territories at Control site 2 compared to Treatment site 1 for 2001, although this changed over time and there was no significant difference by 2003. This is believed to be an indication of the increase in quality of these habitat areas at Treatment site 1 as a result of the new land management regime and indicates success in improving these areas. However, the density of hedgerow bird territories did not differ between Treatment site 1 and Control site 4, suggesting that each site was of similar quality in terms of providing habitat for hedgerow species. This was unexpected as the intensive land management regime for Control site 4's wild shoot has been in place for a number of years. Thus, it is concluded that the quality of habitat provided by the land management regime at Treatment site 1 was comparable with that of a wild shoot and that the land management regime at Control site 4 is not including additional components that provide benefits for hedgerow species

There was no difference in the density of hedgerow territories in Treatment site 1 compared with Control site 3 in 2001, although there tended towards a difference ($P < 0.1$) for 2003. This was as expected, as the majority of land management undertaken for CSS, permanent set-aside, and other habitat features such as brood rearing strips, within Treatment site 1 were targeted at land adjacent to hedgerows. Hinsley and Bellamy (2000) found that combining such features increases the quality of the habitat. Consequently, it was expected that additional habitat features bordering hedgerows would increase their quality, leading to greater densities of songbird territories.

The regression analysis showed that the amount of edge habitat, specifically hedgerow length, explained variation in the density of hedgerow bird territories (Table 7.3). This supported the findings of previous studies showing that the density of songbirds increased as hedgerow length increased (Lack, 1992; Jarvis, 1993). In addition, CSS also appeared to explain the variation in hedgerow species. As mentioned, CSS features may have a positive effect on territory density when situated beside hedgerows, which supports the findings of a previous study in showing that increasing the complexity of the habitat by combining features would increase abundance and diversity of songbirds (Hinsley and Bellamy, 2000).

Gamekeeping effort also appeared to explain the variation in territory density for hedgerow species (Table 7.3). This may be because land management for gamebirds also met the requirements of hedgerow species. For example, hedgerow species are vulnerable to predation, particularly from corvids, so predator control may be particularly beneficial. Gamekeeping is often concentrated in arable areas, so high quality habitat for hedgerow species may be produced from the management of hedgerow structure and the vegetation at its base to provide nesting and brood rearing areas for gamebirds. Similarly, planting grass strips and cover crops adjacent to hedgerows and positioning feeders along hedgerows will benefit both songbirds and gamebirds. As with the previous analysis, supplementary feeding did not appear to explain the variation in hedgerow species, suggesting that the alternative habitat created through land management regimes for gamebird shooting was providing quality feeding areas, meaning hedgerow songbirds did not need to access the supplementary feed provided for gamebirds.

7.4.1.3 Trends in, and factors affecting, farmland bird densities

Farmland species failed to increase in density at Treatment site 1 (Figure 7.1), suggesting that habitat quality did not improve to the same extent as other areas. Hence, farming practices did not alter following the implementation of the new management regime, so little benefit was afforded farmland species within the field environment at Treatment site 1. However, farmland species do not confine themselves to arable areas (Marchant *et al*, 1992; Siriwardena *et al*, 1998; Fuller *et al*, 2001). As such, farmland species would have benefited from any increases in the quality of alternative habitat features such as hedgerows and from the provision of grass strips along field boundaries for foraging and nesting. However, the extent to which farmland species would actually benefit is unknown and the data suggests the benefits at Treatment site 1 to be minimal. Specific techniques can enhance the quality of arable areas for farmland birds. For example, undersowing cereals can increase the amount of insect food available (Potts, 1997); spring cropping provides quality habitat in the form of stubbles over winter and can improve breeding densities (Moorcroft *et al*, 2002; Gillings *et al*, 2005); set-aside, if managed correctly, can provide valuable feeding a nesting areas (Sotherton, 1998).

Comparison in between Treatment site 1 and Control sites 2 and 4 showed there to be more farmland territories at the two control sites compared to Treatment site 1 although there was no difference by 2003. This indicates that Treatment site 1 improved in terms of quality for farmland birds over the course of the study to the point where it was comparable with the quality of habitat provided by sites that have better established alternative habitat and thorough wild gamebird management practices. However, comparison between Treatmen site 1 and Control site 3 also showed no difference in the number of farmland territories for 2001 and 2003, indicating similarities in habitat quality for these two sites. Control site 3 has no shoot or alternative land management and no gamekeeping, yet was providing similar quality habitat to that of a site that had increasing levels of land management and gamekeeping designed to provide quality habitat for gamebirds. Thus, it initially appears as though the land management designed to benefit gamebirds does not provide noticeable returns for farmland songbird species, although the P values were tending towards significance over time (P= 0.910 for 2001, P= 0.153 for 2003).

However, the level of gamekeeping explained variation in the density of farmland territories (Table 7.4).

Specific aspects of gamekeeping, such as predator control, may be particularly effective at enhancing the density of farmland songbird territories. Many species classified as farmland specialists are ground nesters and it is possible that they are more vulnerable to predation, especially from ground predators such as foxes, mustelids, rats, hedgehogs and badgers. A study on skylarks found nest survival increased from 12.3% to 40.7% after the start of a thorough predator control programme (Donald *et al*, 2002). In another study on yellowhammer productivity, 64% of nests failed as a result of predation (Bradbury *et al*, 2000). Indeed, an assessment of past research concluded that nesting success and subsequent autumn population sizes of bird species were positively influenced by predator control (Côté and Sutherland, 1997). Therefore, it is not unreasonable to assume that reducing predator numbers could lead to higher breeding densities, should nest and chick predation limit breeding population size. With time, the land management regime at Treatment site 1 may reduce predator numbers to the extent that a difference in the number of farmland territories is found between Treatment site 1 and Control site 3.

The amount of CSS features explained the variation in the densities of farmland territories (Table 7.4), indicating that habitat diversity was important to this category of songbirds, and supporting the findings of previous studies (Chamberlain *et al*, 1999b; Perkins *et al*, 2002).

Farmland area did not appear to explain any variation in farmland songbird territory density indicating this factor was not important in determining the density of territories within a site (Table 7.4). In general, previous studies have shown that populations of farmland songbirds have decreased in density to a greater extent than other categories of songbird (Greenwood, 2003). Hence, the densities of farmland species may be limited by factors other than farmland area. Alternatively, territory density may depend on habitat quality rather than farmland area. As mentioned, farmland species do not confine themselves to the field habitat, and instead use other areas such as hedgerows and grass strips. Indeed, Chamberlain *et al* (1999b) found evidence that habitat diversity positively influenced the abundance of skylarks, a farmland species that has experienced a 50% decline in population size since the mid-1970's (Wakeham-Dawson and Aebischer, 1998). Differences in habitat quality between sites, however that is defined, may have produced variations in farmland bird density which negated any effect of farmland area, such that smaller fields of higher quality habitat contain more territories than would be expected from farmland area alone (Siriwardena *et al*, 2000).

Supplying feed through the establishment of cover crops and feed hoppers has been shown to benefits farmland birds. Previous studies, for example, have shown that species such as yellowhammer and skylark exploit these provisions (Stoate and Szczur, 2001; Stoate *et al*, 2004). However, the findings of the regression analysis for this study do not agree with this previous research, with supplementary feeding not appearing to affect territory density of farmland birds.

7.4.1.4 Observations of hirundine and raptor species

A number of individuals included in the hirundine category were observed at each of the sites over the three years of the study. Swallows (*Hirundo rustica*) appeared to be the most prevalent species (Appendix 10). Observations suggested that house martins (*Delichon urbica*) were to be found in greatest number at a single site (Appendix 10). As mentioned previously, the large areas over which these species feed make it extremely difficult to determine the number utilising a single site. The same limitation is also apparent for raptors. Very few individuals of species included in this category were observed during the course of this study (see Appendix 10), which was expected due to the large territories that these species generally occupy (Marchant *et al*, 1992).

7.4.2 Overall conclusions on songbird abundance

Studies have shown that AESs do not appear to be delivering the widespread benefits for songbirds that were hoped at the start of these schemes (Carey *et al*, 2002; Kleijn and Sutherland, 2003). The songbird monitoring undertaken during this study suggests that the new management regime at Treatment site 1 has successfully produced benefits for songbirds, as shown by the increases in territory density. Although this new management regime included an AES, a large portion of the work was concerned with modification of the gamekeeping, concentrating on work that has been proven to enhance wild game productivity and that simultaneously benefits songbird species. Therefore, it can be concluded that there is strong evidence that management designed and implemented to improve wild gamebird productivity also appears to produce significant benefits for songbird populations.

To conclude, it appears that the availability of habitat features is the most important factor influencing the density of songbird territories. However, it is not always convenient for farmers to plant more hedgerows or woodland. Dividing fields with hedgerows is often undesirable. The area of land required to establish woodland of a suitable size to benefit songbirds, or gamebirds if that is the motivating factor, and the cost in terms of money and labour often negates any benefits for the landowner. Management of existing habitat maybe better as it is cheaper, less time consuming and more immediate in producing high quality habitat for songbirds. Cutting rides through woods and creating skylights, gapping-up hedges and alternating their cutting regime to once every two years may be more appropriate options (Hill and Robertson, 1988; Robertson *et al*, 1988; Robertson, 1992).

Although AES features, in the form of grass strips and beetle banks, can take time to become established, it takes less time than producing mature hedgerows and woodlands from new, involves less work in creating, and farmers can receive financial recompense whilst providing valuable habitat for gamebirds concurrently with songbirds. Aspects of gamekeeping, such as supplementary feeding, planting of cover crops and predator control have also been shown to positively influence songbird densities (Hill and Robertson, 1988; McKelvie, 1991; Stoate and Szczur, 2001), and are probably more immediate in their effect, which means these measures should result in increased songbird densities more quickly.

It is not possible to determine which aspects of the land management regime produced the greatest benefits for songbirds. Several factors were probably important in producing the increase in territory densities at Treatment site 1 and different species are likely to respond to the various aspects of the new regime to varying degrees. The data indicate that all types of songbird increased in density. This finding, coupled with the knowledge that species do not generally confine themselves to one habitat feature within the landscape (Marchant *et al*, 1992; Siriwardena *et al*, 1998; Fuller *et al*, 2001), supports the idea that increasing the quality of all areas within a site is essential to make gains for songbird populations. This enforces the concept of whole site management rather than directing it at specific features, as can be promoted by AESs. In short, the findings of this study suggest that habitat management aimed at increasing productivity of wild gamebird productivity also seems to meet many of the habitat requirements of the songbird species associated with agricultural habitats. By combining AESs with other management practices, such as gamekeeping and careful use of set-aside, landowners can create high quality habitat for gamebirds and songbirds alike, supporting the view that gamebird shooting is valuable in promoting wider conservation of biodiversity (McKelvie, 1991; Cobham, 1993).

These wider conservation benefits seen at Treatment site 1 (Chapters 6 and 7) have been provided alongside a commercial shoot that releases a substantial number of reared gamebirds. Indeed, implementation of the new land management regime has been initiated by the presence of the shoot. Chapter 8 examines the future of commercial gamebird shooting in the event of potential regulations being introduced that would significantly alter the structure of gamebird shooting, and explores the possible repercussions for the benefits, including conservation, generated by gamebird shooting.

Chapter 8
Willingness-to-pay: the future of commercial gamebird shooting

8.1 Introduction

8.1.1 An uncertain future for commercial gamebird shooting?

Stakeholder groups voiced concern during the focus group discussions about the large sizes of many current gamebird bags (Chapter 3). Should government impose a system of regulation on the industry, stakeholders felt that the primary target would be the release of large numbers of reared gamebirds, which would seriously affect the ability of shoots to offer large bag days.

Many shoot owners rely on 'guns' paying to shoot gamebirds on their land. In turn, the money generated is used to pay for land management, for wages of employees on the shoots, and to supplement the reduced income that landowners currently face from farming (Chapter 1). For commercial gamebird shoots to survive in the event of future regulation of released birds, 'guns' would still need to be willing to pay for smaller gamebirds bags. If commercial gamebird shoots were to cease, there could be serious repercussions for the rural economy. As noted previously (Sections 1.3 and 3.4.5), many people are employed and much money is generated, both as direct and indirect consequences of gamebird shooting (Cobham, 1993; Cox *et al*, 1996).

8.1.2 Motivation for and aims of the study

It is essential to determine whether commercial gamebird shoots could continue to be economically viable if future government regulation sought to reduce the numbers of released gamebirds. Therefore, this chapter seeks to investigate whether 'guns' would still be willing to pay for shoot-day with reduced bags. Chapter 8 deals with the construction and analysis of the willingness to pay survey and assessment of possible consequences of banning the release of reared gamebirds in Britain.

8.2 Methodology

8.2.1 The willingness-to-pay questionnaire

The willingness-to-pay (WTP) questionnaire investigated the willingness of respondents to pay for a hypothetical day's gamebird shooting following regulation of the industry through a ban on the release of reared gamebirds. The technical process of developing a questionnaire has been thoroughly reviewed in the social science literature, as the success of surveys in generating useful information depends on the design of the questions (Frank-Nachmias and Nachmias, 1996; May, 2001; Neuman, 2003).

For this study, a postal questionnaire was considered the most appropriate method as it could be sent to a large number of individuals interested in gamebird shooting over a wide geographical area in a limited amount of time. The primary disadvantage of a self-administered postal questionnaire survey is that it can result in a low response rate. Reasons for this include targeting non-specific populations with no interest in the subject or a recipient discarding the questionnaire because it is too long and complicated. Furthermore, there is no control or consistency over the circumstances under which respondents complete the questionnaire with the researcher not present, and it is impossible to know whether it has been completed by the target respondent (May, 2001; Neuman, 2003; David and Sutton, 2004).

All aspects of questionnaire design and subsequent piloting followed the accepted methodologies as outlined in social research textbooks (May, 2001; Fowler, 2002; Neuman, 2003; David and Sutton, 2004). To maximise the likelihood of respondents understanding each question, this questionnaire was repeatedly piloted throughout its development. During initial construction, face-to-face interviews were conducted once trial respondents had completed the survey, allowing them to identify problems over specific questions. Piloting of the questionnaire highlighted important differences between this survey and those conducted in other WTP studies, which identified the need for questions on the specific type of shooting bought by each respondent. Once near completion, the questionnaire was piloted further by volunteer stakeholders, who completed the questionnaire under similar conditions to those during the actual survey.

The types of shooting purchased in lowland Britain are extremely varied. Questions were principally concerned with the type of gamebird shoot, whether wild, reared or mixed, and bag size. The price that respondents currently pay for a typical day's gamebird shooting was established using pre-determined price categories, followed by questions concerning typical bag size and the usual number of 'guns' present. This information was used to calculate the most basic units of price for gamebird shooting: (i) the price per bird, measured as the total price for the day divided by the bag size; and (ii) the price of a days shooting [?necessary: as a whole], measured as the price per 'gun' multiplied by the number of 'guns'.

The WTP aspect of the survey was based on the general methodology of contingent valuation (CV) surveys, but included adaptations of the version of the method implemented by Walpole *et al* (2001) in a study that investigated the willingness of tourists to pay to visit Komodo National Park in Indonesia. A hypothetical scenario was described in which future regulation would prohibit the release of reared gamebirds. A grounding in reality is important in contingent valuation (CV) surveys, as respondents provide a more accurate maximum WTP bid if they believe the hypothetical scenario is a realistic possibility (Cummings and Taylor, 1998). This study was grounded in reality through the information provided in both the WTP questionnaire and the cover letter. The ban on the release of reared gamebirds in the Netherlands was used to highlight the realistic possibility of a similar ban in Britain. Also, the recent ban on hunting with hounds in England and Wales emphasized the vulnerability of countryside sports in Britain.

The hypothetical future scenario of gamebird shooting could depend solely on wild gamebird stocks. In turn, this could limit the bag sizes available for purchase, while also providing wild gamebirds that many would consider to be of higher quality. Bag size was limited to a maximum of 100 birds per day, and respondents were asked whether they would be interested in purchasing such a day's gamebird shooting. If yes, respondents were then asked if they would be willing to pay the price they currently pay. If they responded negatively, respondents were then asked whether they would pay 25% less. If they responded positively, they were asked whether they would pay 25% more. Respondents were then asked to state the maximum amount they would be willing to pay for the future day's shooting.

CVM normally provides respondents with one identical situation on which to bid. However, gamebird shooting is extremely varied, so respondents were asked to relate the hypothetical future scenario to estates on which they typically purchase shooting. Therefore, respondents were asked their WTP for a bag size of 100 wild gamebirds on shoots with which they could easily relate. This removed design bias that can mean individuals struggle to comprehend the hypothetical scenario on which they are being asked to bid, an inherent problem of CVM studies (Pearce and Moran, 1994).

Many contingent valuation studies advocate the use of discrete choice (DC) over open-ended (OE) questions (Cooper, 1994; Langford, 1994; Brown *et al*, 1996; Halvorsen and Sœlens, 1998). DC questions are considered a more reliable method of investigating WTP as they imitate a realistic payment system of 'take-it-or-leave-it' as found in the market place, providing a purchasing scenario where respondents were asked whether they would be prepared to spend a specified sum on a particular item or service. Asking respondents the maximum they would be willing to pay, as for OE questions, requires the respondent to produce a price which requires more thought and processing of available information than is generally the case in a market scenario and generally generates more conservative mean WTP amounts than the DC method (Brown *et al*, 1996).

The use of both DC and OE questions was necessary for this survey because of the complex nature of the payment system in gamebird shooting. If each respondent currently paid the same amount for a day's gamebird shooting, the structure of the WTP survey would have followed the method laid down in Walpole *et al* (2001), which had a selection of starting bid amounts in an attempt to remove starting point bias. Starting point bias was not considered a problem in this study as it was set at the amount the respondents currently pay for gamebird shooting. By having the two DC questions concerning paying 25% more and less than the starting amount, there was a possibility that WTP values at the two extremes of the price range would not be captured. Requesting the maximum WTP value with an OE question solved this problem. Furthermore, having this question after the DC questions provided a point of reference from which respondents could contemplate the maximum amount they would be willing to pay.

A total of 1150 WTP questionnaires were sent out. Of these, 150 were sent to shoot purchasers who were clients of two sporting agents. A further 1000 questionnaires were sent out to individuals on the membership list of the GCT. This large number of questionnaires was sent out because it was not known which GCT members purchased gamebird shooting. A cover letter explaining the motivation for the study, instructions, the WTP questionnaire and a pre-paid return envelope were sent to each recipient. A cover letter from the organisation responsible for providing the postal details of the recipient was also included, whether the GCT or the two sporting agents, expressing their support for the study and emphasising the importance of completing the questionnaires.

8.2.2 Test of Validity

It is possible for WTP surveys to fail in capturing the full range of values that individuals are willing to pay. As stipulated in Walpole *et al* (2001), if 10% or less of respondents were willing to pay the highest bid amount, WTP surveys are considered to have encompassed the full range of willingness to pay values. This method was also adopted for examining whether the full range of current payment prices were captured.

8.2.3 Analysis of Results

Returned questionnaires in which respondents failed to provide a price for the amount they currently pay per 'gun', the bag size for a day, and the number of 'guns' were rejected from the analysis. Likewise, so were questionnaires where respondents noted that they would purchase the future day's gamebird shooting, but failed to give the price they would be willing to pay. The price per bird and the price per day were calculated for all fully completed questionnaires, and all values were assigned to price categories. The same pricing categories were used for current and future prices per 'gun', per bird and per day.

Price per day was calculated by taking the price paid per 'gun' per day and multiplying by the number of 'guns' for the day. Thus, this gave the monetary value generated by all the 'guns' for the day for a particular shoot. The price per bird was calculated by taking the value of the price per day and dividing it by the bag size, or number of birds shot in a day. Therefore, this calculation gave a value of how much money was spent in total by the guns for each bird shot.

The data were analysed using non-parametric and parametric statistics. Chi square analysis was used to examine the distribution of responses for the categorical data to determine whether there was a difference in the type of shooting purchased. Chi square analysis was also used to examine differences in the data for current shooting, whether price currently paid per bird, per person, per day and bag size, between categories of shoot type, whether wild, reared and mixed. Categories were used in the questionnaire for respondents to provide their information, as trials of the questionnaire showed this made the questionnaires easier to answer and, thus, more likely to be answered. The answers from these initial category choices were what the respondents used to generate answers for the price they were willing to pay in the future for shooting. Therefore, all data was categorical.

Despite log transformation, the data were significantly different from a normal distribution when divided into the three shoot categories. Therefore, the three sets of data were also not considered homogenous in terms of their variances. As both factors violate the assumptions of ANOVA, all further analysis was undertaken using the non-parametric test of Kruskal-Wallis.

A paired sample t test was used to compare the means of the sums of money currently paid by respondents with the future price they would be willing to pay. For the WTP analysis, I used the mid-point value of the price range categories. For the future prices, those respondents not willing to purchase the future days shooting were allocated a price of £0.

8.3 Results

Of the 1000 WTP questionnaires sent out to GCT members, a total of 306 (30.6%) were returned. In contrast, of the 150 questionnaires sent out to shoot purchasers by sporting agents, 89 (59.3%) were returned. Therefore, an overall total of 395 (34.3%) of the 1150 WTP questionnaires were returned. Furthermore, the data from 381

(33.1%) questionnaires were suitable for inclusion in the analysis, as respondents had answered all the appropriate questions.

8.3.1 Distribution of the respondents

Of the 381 respondents, 357 (93.7%) had their main residence in England, 12 (3.1%) had their main residence in Wales, three (0.8%) had their main residence in Scotland, one (0.3%) had their main residence in Northern Ireland and one (0.3%) had their main residence in another country of Europe. Seven (1.8%) respondents failed to answer the question on where they live. Those respondents who provided the data came from 42 of the 47 English counties, seven of the 22 Welsh counties and two of the 31 Scottish counties.

8.3.2 Validity of results

The percentage of respondents in each price category for the current amount paid per person for a day's shooting (Figure 8.1) and future day's shooting (Figure 8.2) show that less than 10% of respondents were in the highest and lowest price categories, indicating that the pricing categories successfully captured the extremes of the price ranges.

Figure 8.1: Proportions of respondents within each price category for current price paid per person for a day's shooting (n = 381).

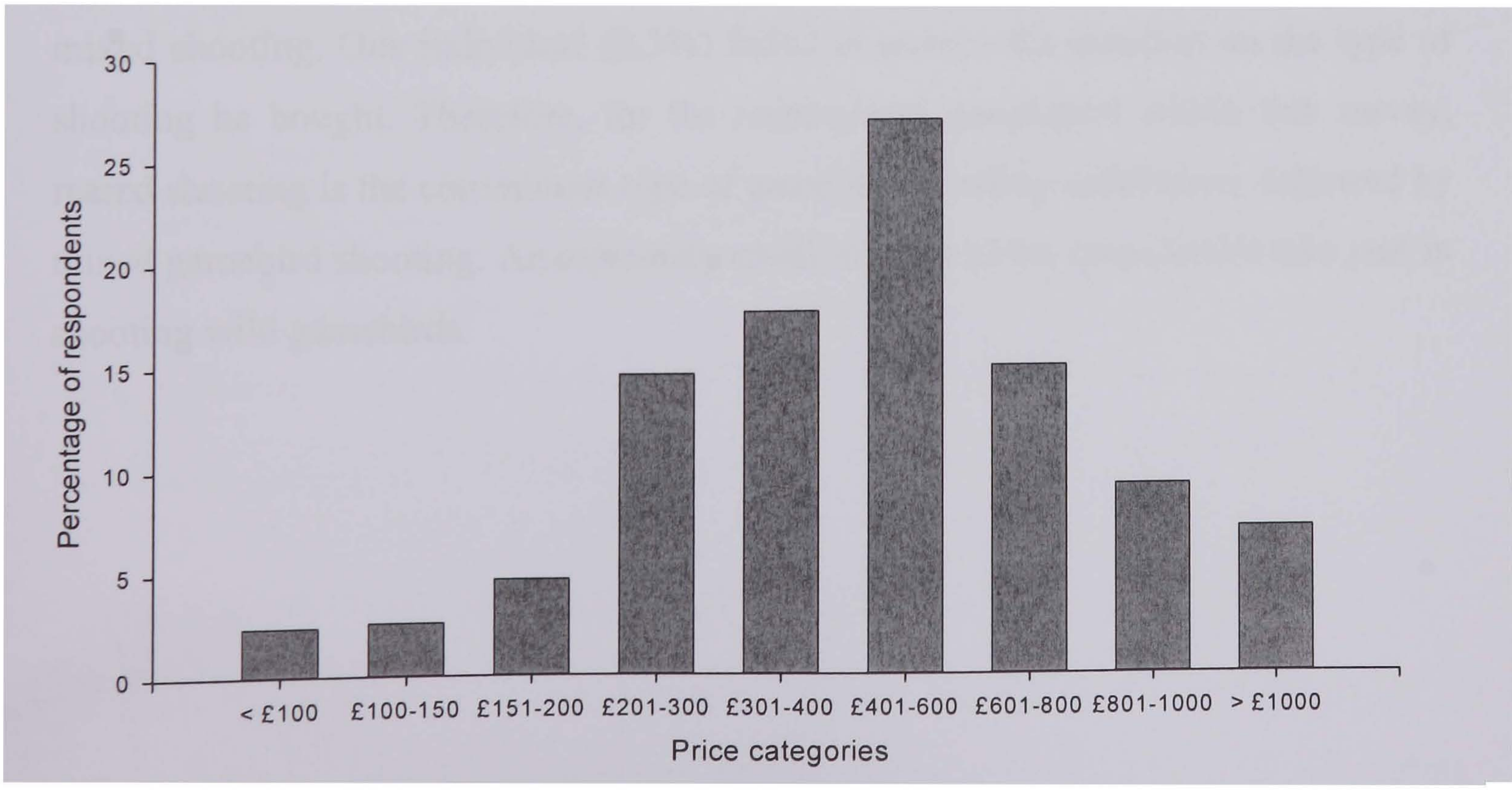
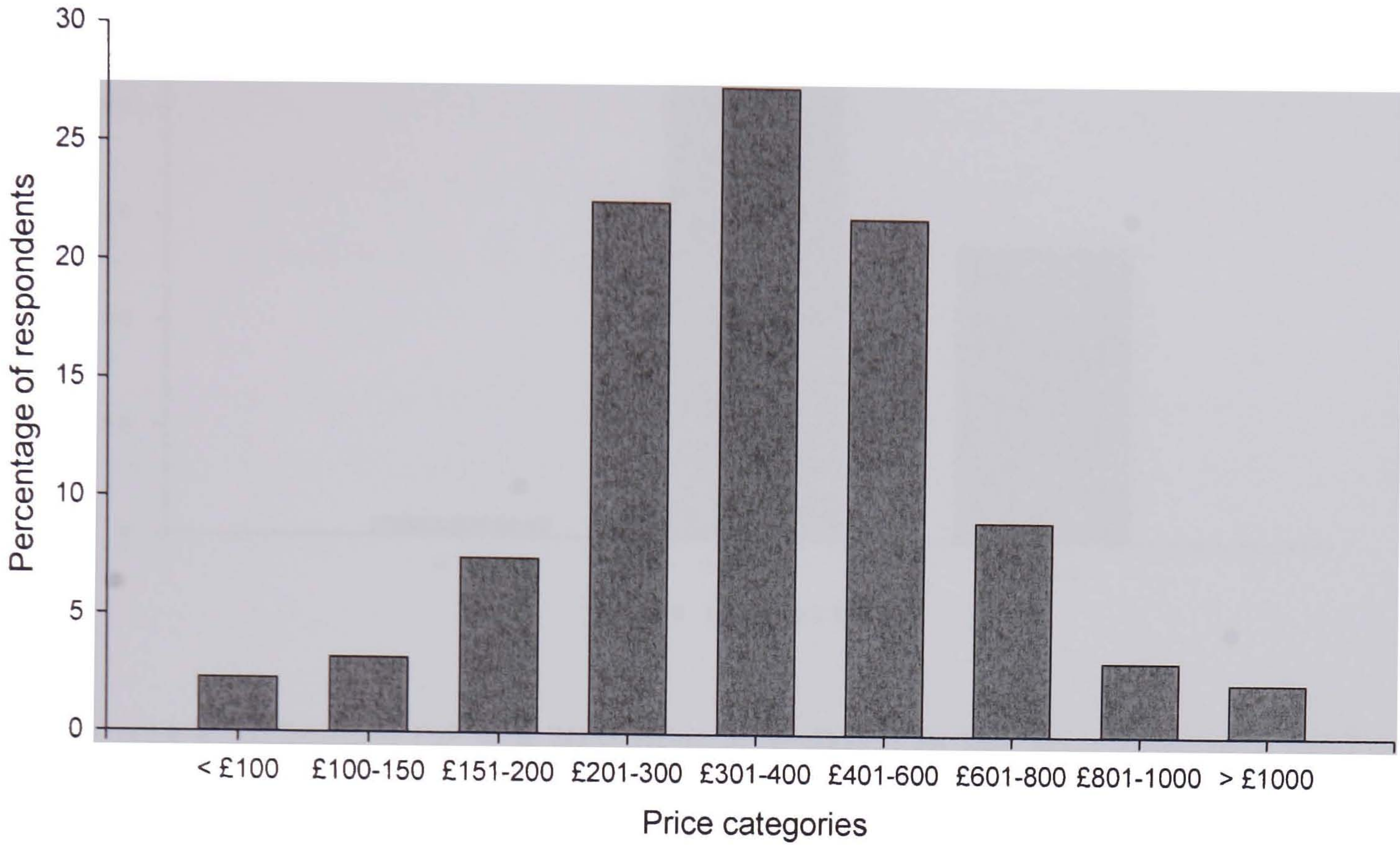


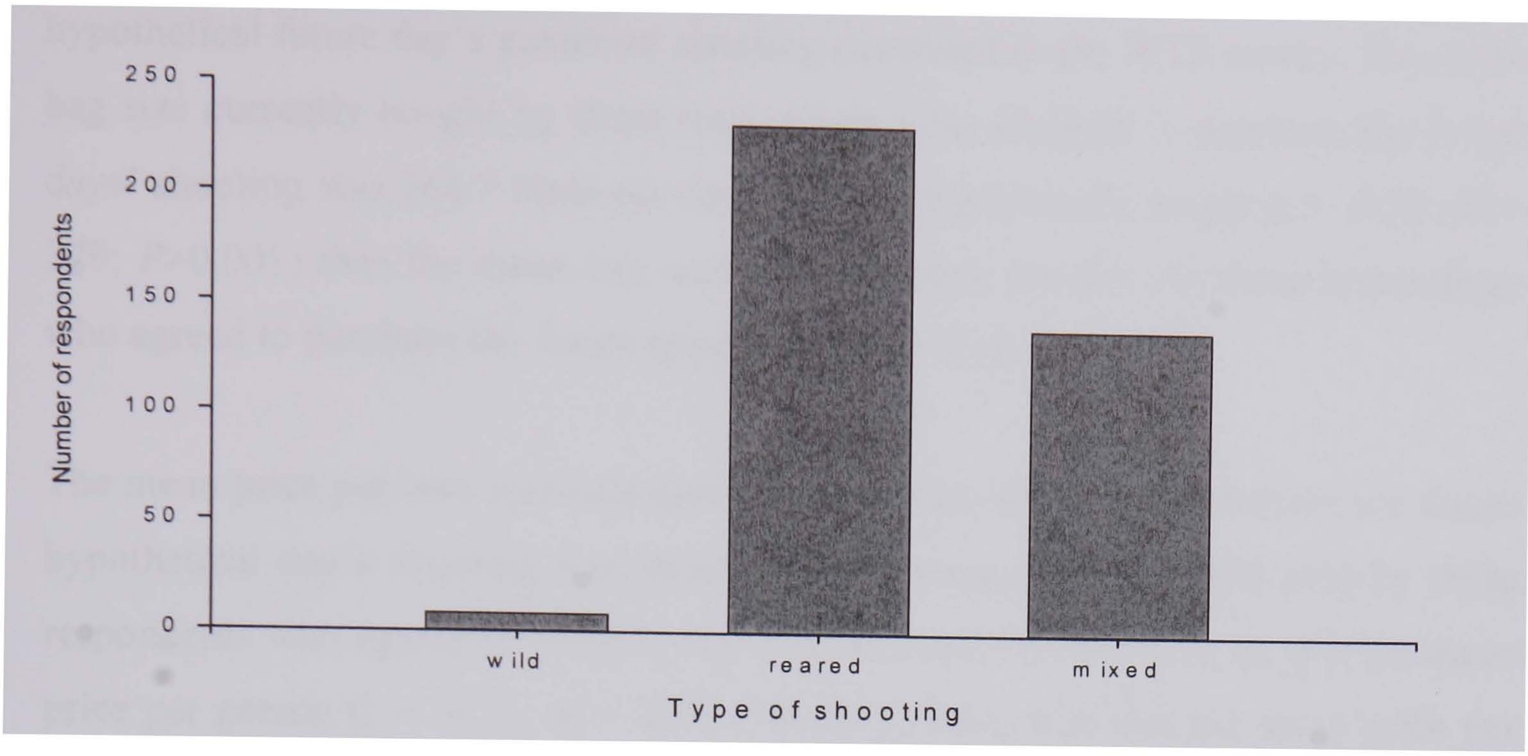
Figure 8.2: Proportions of respondents within each price category for the future price per person each respondent was willing to pay for a day's shooting (n = 348).



8.3.3 Comparison of the different types of gamebird shooting

There was a difference (χ^2 = 182.95; df = 2; P<0.001) in the type of shooting currently bought by respondents (Figure 8.3). Of the 381 respondents, 8 (2.1%) bought wild shooting, 232 (60.9%) bought reared shooting, and 140 (36.7%) bought mixed shooting. One individual (0.3%) failed to answer the question on the type of shooting he bought. Therefore, for the respondents questioned within this survey, reared shooting is the commonest type of gamebird shooting undertaken, followed by mixed gamebird shooting. An extremely small number of the respondents take part in shooting wild gamebirds.

Figure 8.3: The number of respondents who currently purchase different types of gamebird shooting.



There was a difference (χ^2 = 8.205; df = 2; P<0.05) in the price currently paid per bird between shoot types (Table 8.1). Respondents paid the most for birds on wild shoots, which attracted a mean price of £26.49 per bird. The cheapest birds were on mixed shoots, which attracted a mean price of £18.96 per bird. In contrast, the three shoot types tended to differ for the current price paid per person (χ^2 = 4.809; df = 2; P= 0.090) and per day (χ^2 = 5.628; df = 2; P= 0.060) (Table 8.1). Furthermore, bag sizes did not differ (χ^2 = 2.583; df=2; P= 0.275) between the shoot types (Table 8.1). Therefore, wild shoots were the most expensive per bird, while mixed shoots were the cheapest per bird. However, there was no difference between shoot types for the cost per person or per day.

Table 8.1: Mean ± SE price paid for a day's shooting and mean bag size for each type of shoot

	Wild (n = 8)	Reared (n = 233)	Mixed (n = 140)
Mean price per bird	26.5 ± 7.12	21.7 ± 0.56	19.0 ± 0.62
Mean price per person	750.0 ± 237.97	557.6 ± 21.89	495.9 ± 27.42
Mean price per day	5956.3 ± 1976.00	4524.1 ± 175.86	3954.5 ± 211.31
Mean bag size	175.0 ± 28.35	203.9 ± 4.90	207.9 ± 11.76

8.3.4 Current and future prices of gamebird shooting

Of the 381 respondents, 348 (91.3%) stated that they would be prepared to buy the hypothetical future day's gamebird shooting described in the WTP survey. The mean bag size currently bought by those respondents who declined to purchase the future days' shooting was 266.7 birds per day, was and significantly larger ($t = -3.70$; $df = 379$; $P>0.001$) than the mean bag size of 198.3 birds per day for those respondents who agreed to purchase the future hypothetical day's shooting.

The mean price per bird currently paid by those who declined to purchase the future hypothetical day's shooting was larger than the mean price per bird paid by those respondents who agreed ($t = -3.67$; $df = 379$; $P<0.001$) (Table 8.2), as was the mean price per person ($t = -4.73$; $df = 379$; $P<0.001$) (Table 8.2) and the mean price per day ($t = -4.71$; $df = 379$; $P<0.001$) (Table 8.2). Therefore, those respondents who stated they were not willing to purchase the future days shooting currently bought larger bag days and spent more on those shoot days, whether per bird, per person or per day, than those respondents willing to buy the future day's shooting.

Table 8.2: Mean as above price currently paid by respondents who agreed and declined to purchase the future hypothetical day's shooting

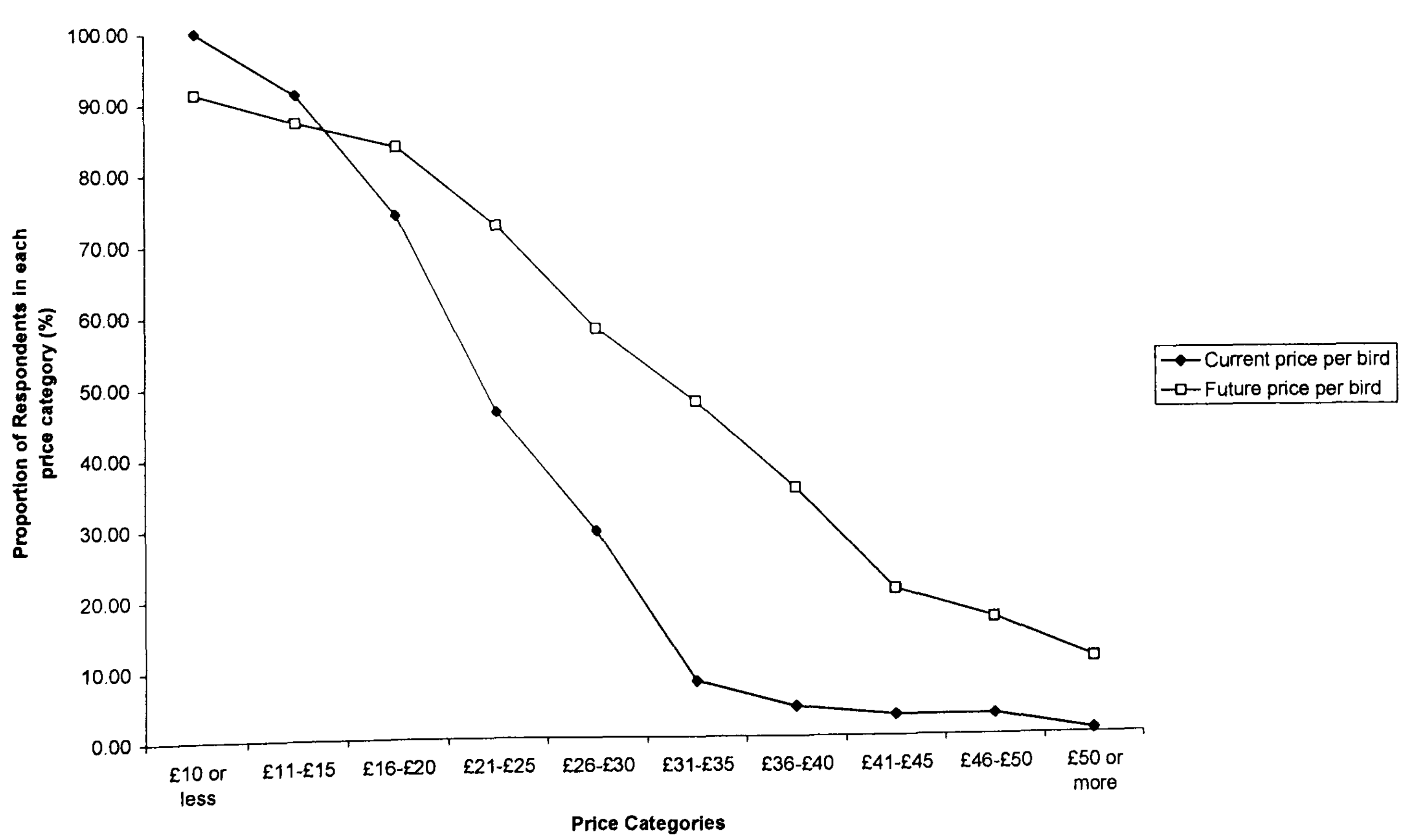
	Agreed to purchase future shooting (£) n = 348	Declined to purchase future shooting (£) n = 33
Per bird	20.3 ± 0.45	25.9 ± 1.69
Per person	507.1 ± 16.93	875.8 ± 75.94
Per day	4099.9 ± 135.16	6928.8 ± 585.25

Table 8.3: Mean price currently paid and the mean price respondents are willing to pay for future shooting (n = 381).

	Current Price (£)	Future Price (£)
Per bird	20.8 ± 0.44	33.4 ± 1.09
Per person	539.0 ±17.52	412.1 ± 13.19
Per day	4344.88 ± 139.29	3334.7 ± 109.08

The mean price per bird currently paid by respondents is £20.80 (Table 8.3), but prices range from £3 to £54. In contrast, the future mean price paid per bird was stated as being £33.40 (Table 8.3) and ranged from £0 to £180. Apart from the first two price categories, there were more respondents willing to pay a particular price range category per bird for the hypothetical future day's shooting compared to the current day's shooting (Figure 8.4). The mean price respondents were willing to pay per bird in the future was higher than the current mean price paid per bird ($t = -13.21$; $df = 280$; $P < 0.001$).

Figure 8.4: Proportion of respondents who currently pay, and are willing to pay, each price category per bird for a day's gamebird shooting.



At no point were more respondents willing to pay a particular price range per capita for the hypothetical future day's shooting compared to the price they currently pay for a day's shooting (Figure 8.5). Indeed, in contrast to the findings for the price per bird, the mean price currently paid per person for a day's shooting was more than the future price respondents would be willing to pay per person for the future hypothetical day's shooting ($t = 7.87$; $df = 380$; $P < 0.001$), contrasting with the findings for price per bird. Therefore, respondents currently pay more per person for a day's shooting compared to the price they would be willing to pay per person for the hypothetical day's shooting.

Figure 8.5: Proportion of respondents who currently pay and are willing to pay each price category amount per person for gamebird shooting.

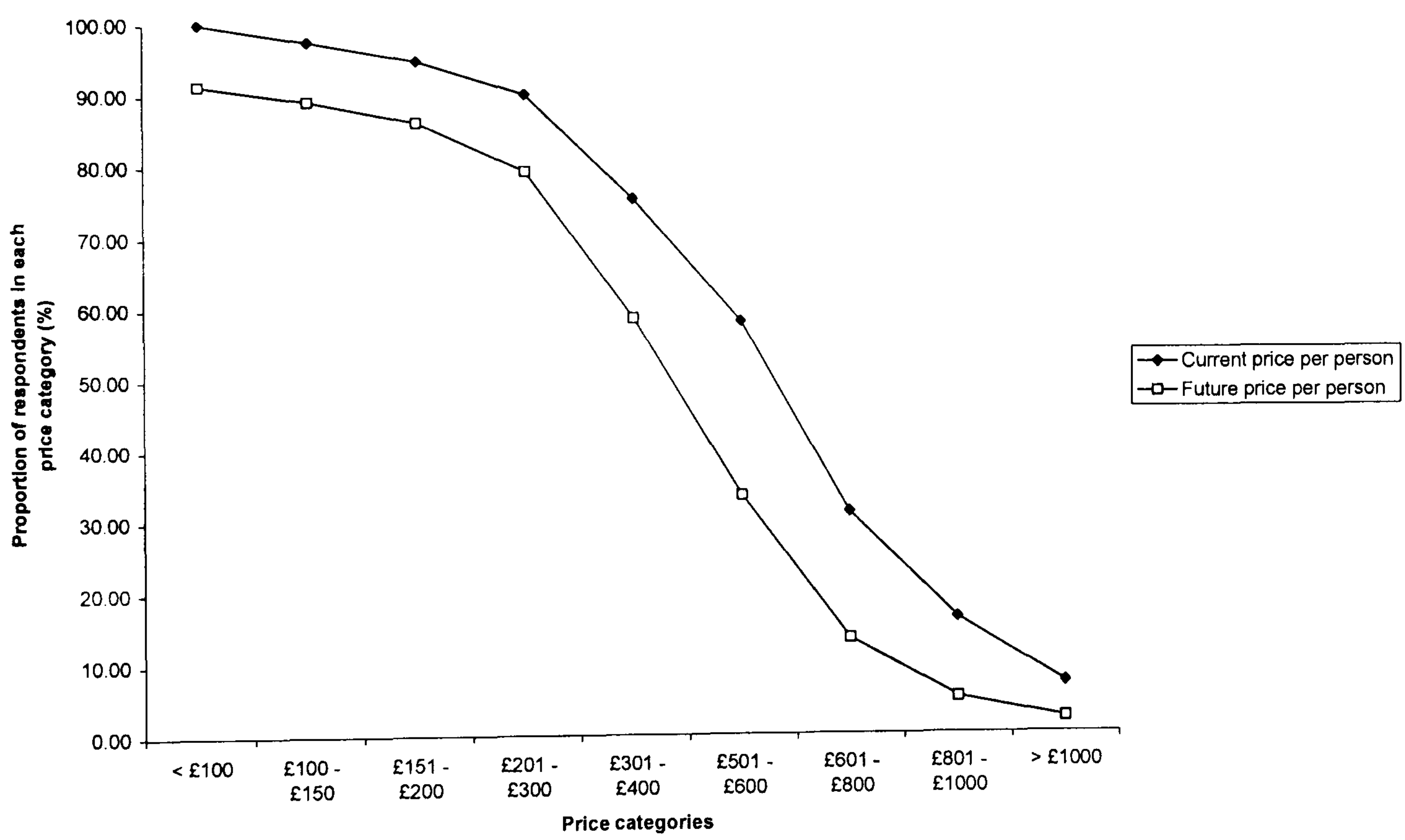
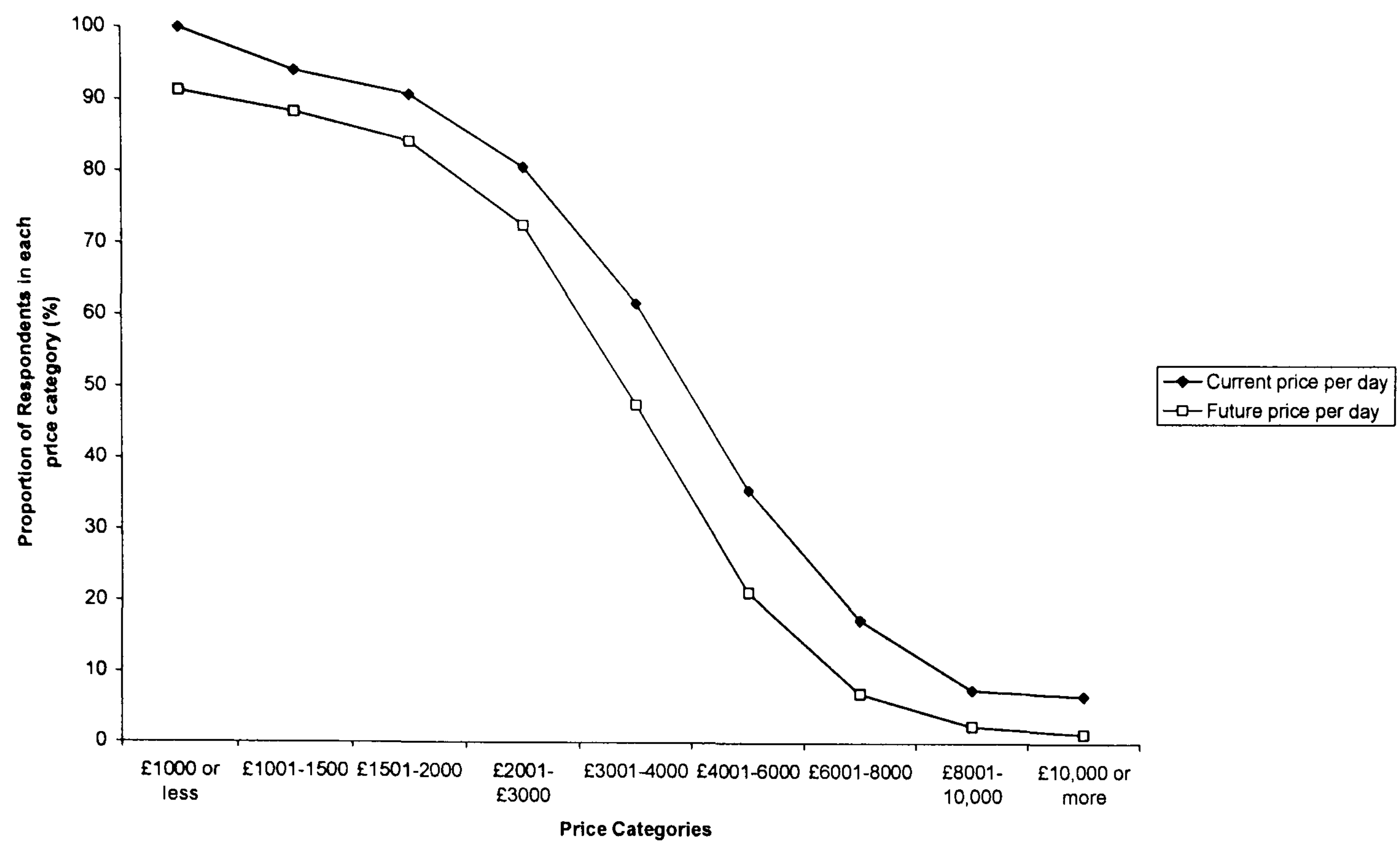


Figure 8.6: Proportion of respondents who currently pay and are willing to pay each amount per day for gamebird shooting.



The trend of the data for current and future price per day (Figure 8.6) is similar to that for price per person (Figure 8.5). However, some differences arise because of variation in the number of 'guns' in a shoot team. Although the size of shoot teams ranged from 4 to 12 guns, shoot teams comprised 8 'guns' for the majority (73.8%) of respondents. The mean price for a current days shooting is higher than the mean price respondents were willing to pay for the hypothetical days shooting ($t = 7.93$; df = 380; $P < 0.001$), indicating that respondents currently pay more for a day's shooting compared to the price they would be willing to pay for the hypothetical day's shooting.

8.4 Discussion

The majority of CVM studies investigate the willingness of individuals to pay for non-use of resources (Bateman and Kerry Turner, 1993; Kontogianni *et al*, 2000), in order to establish the total use value for that resource (Bateman and Kerry Turner, 1993; Freese et al, 1996). Hence, providing an estimate of non-use values is a major advantage of CVM (Pearce and Moran, 1994; Venkatachalam, 2004). For example, White and Lovett (1999) investigated the value of the North Yorkshire Moors in terms of the hypothetical value people would be willing to pay to protect specific habitat types within the site that they used for recreational activities. Similarly, White *et al* (1997) investigated the values assigned to mammals of different conservation concern. Previous studies that have examined the economics of gamebird shooting (such as Cox *et al*, 1996 and Cobham Resource Consultants, 1997) have differed from many other economic studies in that they have investigated the direct-use value of the resource. This study differs in that it has used CVM to establish the direct-use value of *future* gamebird shooting.

Poor return rates are an important problem when conducting postal questionnaires (Edwards *et al*, 2004), making this methodology inappropriate for many surveys (Frank-Nachmias and Nachmias, 1996; May, 2001; Neuman, 2003). The overall return rate of the WTP questionnaires in this study was 34.3%, which would be considered good for many studies. However, this figure does not reflect the success of this survey, as many among the 1000 GCT members who received the questionnaire would not have been shoot purchasers. Of the 150 questionnaires sent to known shoot purchasers via the two shoot agents, the much higher return rate of 59.3% probably better reflects true success of the survey than the overall return rate. This survey enjoyed a good return rate compared to many postal surveys because of the concern this subject engenders among its stakeholders. As shown in the focus group meetings (Chapter 3) many involved in gamebird shooting feel the future of their sport is threatened, following the ban on hunting with hounds. The cover letter that accompanied the postal questionnaires emphasised the importance of research in reshaping the form of gamebird shooting and in protecting its future, thereby encouraging the involvement of recipients. Hence, this unusual opportunity to be proactive with respect to gamebird shooting and its future, motivated many recipients to complete the questionnaire, resulting in the high return rates.

8.4.1 Distribution of respondents

Most respondents had their main residence in England (see Section 8.3.1), which may be a consequence of several factors. Firstly, the survey was expressly concerned with lowland gamebird shooting, specifically pheasant and partridge, which meant that those who shoot in upland areas or shoot alternative quarry were not polled. Those living in upland areas maybe more inclined to shoot locally, perhaps explaining why few respondents from such areas were qualified to complete the survey.

Secondly, the three membership lists used to find the recipients of the questionnaire were focussed largely on England, although the GCT and the two sporting agents do operate across all areas of Britain and, to some extent, in Europe. The two sporting agents specifically targeted clients who purchase pheasant and partridge shooting when choosing those who would receive a copy of the questionnaire. Furthermore, although the GCT randomly chose recipients of the questionnaire from their membership list, the majority of their 22,000 members come from England (Corinne Duggins, Membership Co-ordinator of the GCT, personal communication), further explaining why most respondents were from England.

Respondents, nevertheless, came from 42 of the 47 English counties (see Section 8.3.1), indicating that the questionnaire achieved a wide reach across the country, and emphasising the random choice of questionnaire recipients. This wide coverage across England meant that any differences in gamebird shooting due to the location of the shoot or the area in which the respondents lived should have been captured by the survey.

8.4.2 Validity of results

The validity test indicated that the pre-determined pricing categories successfully captured the highest prices, both for the current (Figures 8.1) and future prices (Figure 8.2) paid for shooting. Furthermore, the categories also discriminated well between price categories, as less than 10% of respondents bought shooting priced in each of the highest and lowest categories. If pre-determined price categories are too wide, many respondents could fall into very few categories, blurring distinction in the pricing trends, and making it difficult or impossible to determine WTP (Boman and Bostedt, 1995). Therefore, research and piloting of the questionnaire was fundamental to the success of allocating the pre-determined price categories.

8.4.3 Type of gamebird shooting

Respondents bought fewer shooting days for wild birds than for reared or mixed shoots, and the most common shoot type bought was of purely reared birds (Figure 8.3). Assuming questionnaire recipients were chosen at random, which there is no good reason to believe otherwise, there are two possible reasons for the patterns of shoot types bought: (1) respondents preferentially wish to shoot reared or mixed gamebird bags; or (2) the availability of gamebird shooting types is uneven, and only a limited number of wild shoots can be purchased on the market, while reared gamebird shoots are more commonly available. Unfortunately, there is a real lack of information regarding many aspects of gamebird shooting in Britain, and there are no concise figures showing the proportions of the different types of shooting that are available. However, those involved in the sport recognise that the majority of pheasant shoots either rely completely on reared birds or are a mixture of reared and wild (Jeff Handy, head gamekeeper, personal communication). It is estimated that approximately 70% of pheasants shot each year are reared birds (Robertson *et al*, 1993). However, this figure does not capture the proportion of gamebird shoots involved in producing these bags of reared birds, relative to the total number of shoots in the country. In general, most wild shoots have small bag sizes and tend to be privately owned, with shooting by invitation only (Jeff Handy, head gamekeeper, personal communication).

Currently, the mean price paid per person or per day did not differ across the three types of shoots (Table 8.1), indicating that these prices did not influence the type of shooting bought. Furthermore, the mean bag size did not differ for the three types of shoot (Table 8.1), indicating that bag size also did not influence the type of shooting bought. In contrast, the mean price per bird did differ between types of shoot (Table 8.1). However, this difference is most probably determined more by price per day and bag size, rather than by respondents discriminating between the prices they pay per bird when choosing the shooting they will purchase. Instead, price per bird is an important factor for shoot owners to consider as a unit of measurement of cost that can be compared with the cost of producing each bird, in determining their rates of return.

The data suggest that far fewer commercial wild bird shoots are currently available for purchase than are mixed or reared shoots. This could have considerable implications for the future of commercial gamebird shooting should the releasing of reared gamebirds be banned. In the event of a possible future ban, the majority of shoots would have to convert to becoming wild or to cease to exist. Many shoots rely on the release of reared gamebirds as the habitat and/or management does not allow for sufficient wild gamebird productivity to sustain a commercial shoot (Hill and Robertson, 1988; McKelvie, 1991). Many of these shoots lack suitable habitat, so adapting to a purely wild bag would not be possible. Furthermore, for those shoots with more suitable habitat, the cost entailed in turning entirely wild, and in sustaining the shoot over time, makes this option both unappealing and also untenable for many shoot owners wishing to make a return on their investment.

8.4.4 Current and future prices of gamebird shooting

Most respondents agreed to purchase the future hypothetical day's shooting (see Section 8.3.4), indicating that the prospect of shooting a small(er) bag of wild birds was preferable to giving up shooting in lowland Britain. Several factors may explain why very few (8.7%) respondents declined to purchase the future hypothetical day's shooting. The mean bag size currently bought by these individuals was larger than the mean bag size for respondents willing to buy the 100 bird day (see Section 8.3.4). This suggests that bag size may influence the current choice of shoot-day bought by respondents not willing to buy the future hypothetical day's shooting. Thus, a bag with a maximum size of 100 birds may not be appealing to this 8.7% of shoot purchasers, who consequently would rather cease shooting in lowland Britain rather than switch to a smaller bag.

Another factor may be the attitude of respondents in terms of what they expect from a day's shooting. The mean price per bird, per person and per day paid by respondents who declined to buy the future hypothetical day's shooting were all higher than the mean prices paid by those who agreed to purchase the future hypothetical day's shooting (Table 8.2). This implies that those who would not buy the future hypothetical day's shooting currently spend a large amount each time they shoot. Hence, these individuals maybe willing to spend considerable sums of money provided they can purchase the type of shooting they wish. Being subject to regulation may be so unappealing to some potential shoot purchasers that they would rather forego the opportunity to shoot. It is possible that these individuals would spend their money on shooting abroad, or may turn to an alternative activity.

Finally, it is possible that some respondents declined to purchase the future hypothetical day's shooting as a form of protest bid. WTP surveys can incur strategic bias, in which respondents provide answers in a tactical manner instead of answering survey questions honestly, as they fear their answers may be used to determine the future course of events (Jakobsson and Dragon, 1996). Some respondents may have felt that agreeing to purchase the future hypothetical day's shooting would send the wrong message to those proposing future regulation. In other words, shoot purchasers would continue to buy gamebird shooting regardless of its form. Of those respondents who agreed to purchase the future hypothetical day's shooting, protest bids may have been recorded in the maximum value some claimed they would be willing to pay. Hence, by stating a lower price than the true amount they would be willing to pay, individuals may have been trying to highlight a negative aspect of a ban on rearing and release. However, there is no opportunity to identify whether the bid amounts agreed in a WTP study represent the truth and reality, except through implementing the future scenario.

The mean price respondents were willing to pay per bird in the future was higher than the mean current price (Table 8.3). When considering comparable units, this difference suggests that respondents would be willing to pay more in the future to shoot, even though a proportion of respondents stated they would not buy future shooting. This difference in price may arise because the amount respondents currently pay is below the maximum the majority of current shoot purchasers would be prepared to pay. Alternatively, they may deem it is worth paying more for the future hypothetical day's shooting in terms of price per bird. Therefore, these individuals may have a great desire to shoot in the future, and would be willing to pay more for what may become a less widespread activity. Hence, the strong desire of many 'guns' to see gamebird shooting continue, could mean they would be willing to pay even more to ensure its future.

However, the price paid per bird does not reflect the reality of buying a day's shooting for the shoot purchaser. Instead, price per bird is generally a unit of price calculated by shoots that rear, in order to determine revenue generated per bird in the bag per season against cost of producing a bird from rearing expenses. It also does not indicate the total amount of money spent as 'guns' currently purchase shoot days with very different bag sizes. The current mean price per person is higher than the future mean price per person (Table 8.3), indicating that it will cost shoot purchasers less to go gamebird shooting should the future hypothetical scenario become a reality. Furthermore, this may explain why most respondents were willing to accept the future hypothetical scenario of gamebird shooting.

The difference in the amount respondents were willing to pay per person for the future hypothetical day's shooting also means that the price paid per day would be less (Table 8.3). Therefore, less money would be generated for shoot owners if gamebird bags were reduced by future regulations. As discussed by focus groups in Chapter 3, the sale of shoot days is essential to fund the management of many shoots, which barely break even or run at a loss. Chapter 4 shows that the shoot at Site 1 experienced a mean shortfall of approximately £7184 a year between 2001 and 2004. Therefore, the hypothetical decrease in the amount of money generated by future gamebird shooting could mean that many shoots will fail to continue as the costs to shoot owners will be too great. For the few shoots that are currently run at a profit, the loss of those profits may also mean that these shoots cease to exist as the owners no longer consider gamebird shooting a viable business option.

Overall, the WTP study indicates that a future ban on the release of reared gamebirds will lead to a reduction in the sale of commercial gamebird shooting, and a reduction in the amount of money entering the sport. This could have an enormous impact on the number of shoots operating in lowland Britain. In turn, this will have a number of knock-on effects, and the financial repercussions could affect many social groups. Shoot owners will lose what is to many a vital source of income that diversifies earnings from their land. Local businesses, such as rural hotels and public houses, will lose custom as the number of visiting 'guns' decreases. The closing of shoots will lead to job redundancies, both directly through the loss of positions such as shoot manager and gamekeeper, and indirectly via the subsequent affect on rural hospitality businesses. Consequently, reduced income and less need for employees will impact on businesses such as game farmers, game dealers, and feed merchants. As noted previously in Sections 1.3 and 3.4.5, past studies have established that the annual income from gamebird shooting, whether direct and indirect, is substantial. An estimated £25.8 million was generated per year in England in the early 1990's (Cox *et al*, 1996). Annual revenues for stalking and gamebird shooting in Great Britain were estimated to exceed £650 million in the late 1990's (Cobham Resource Consultants, 1997). Such studies show the extent to which gamebird shooting is important for rural communities in financial terms. This study further suggests that the continuation of commercial gamebird shooting and, in turn, the generation of what are significant sums of money in the rural landscape, will rely on the continued release of reared gamebirds.

The results of the biodiversity surveys (Chapters 6 and 7) along with the findings of previous studies (Tapper, 1999; Rackham, 2000; Stoate and Szczur, 2001) suggest that gamebird management also provides significant benefits to a range of wildlife species. Therefore, any decrease in the numbers of gamebird shoots would have serious repercussions for conservation in lowland areas of Britain. The subsequent end of gamebird management would mean a loss of the benefits provided to wider wildlife from aspects such as supplementary feeding, habitat creation, predator control, and woodland management. The amount of alternative habitat would be likely to decrease as landowners would no longer see a purpose for its existence. Instead, such areas maybe converted or returned to arable land, in order to increase the income attainable from farming. As shown in previous studies, gamebird shooting is often the primary motivating encouraging landowners to adopt AESs (Macdonald and Johnson, 2000; Stoate *et al*, 2001; Oldfield *et al*, 2003; Morris, 2004). Hence, the loss of shoots around the country may lead to a reduced rate of uptake or renewal of participation in such schemes and with it, the loss of potentially valuable habitat and management techniques.

Lastly, the final, major repercussion resulting from the loss of commercial gamebird shooting through a possible future ban on reared gamebirds would be its effect on the social cohesion of rural communities. As the focus group meetings noted (Chapter 3, Section 3.4.5), and as identified in previous social science research (for example, Newby, 1985), rural people have been losing their sense of community and identity. The ban on hunting with hounds has exacerbated the problem by removing one of the last vestiges that linked many individuals within rural communities. The subsequent loss of the local shoot may irrevocably damage the structure of traditional rural communities. The fact that gamebird shooting is a British tradition that spans centuries is, for many, also a good reason to preserve the activity. Indeed, Article 8(j) of the Convention on Biological Diversity recognises the importance of tradition in conservation.

Chapter 9
Conclusions and Recommendations

9.1 Research findings and conclusions

Most of rural Britain is covered with farmland. However, agricultural intensification since World War II has seen farmland reduced in quality as wildlife habitat, to the extent that many associated species have significantly declined in numbers and range (O'Connor and Shrubb, 1986; Sotherton, 1998; Chamberlain *et al*, 1999). The approaches to conservation followed world-wide, such as creating extensive protected areas, are not options for wildlife conservation in Britain, as most land is privately-owned. Therefore, attempts have been made to halt and even reverse the declines of wildlife populations through legislation and agri-environmental schemes (AESs). Nevertheless, these measures have achieved little success to date (Peach *et al*, 2001; Kleijn and Sutherland, 2003; Carey *et al*, 2005).

Gamebird shooting has been intimately associated with agricultural areas of rural Britain for many centuries. Indeed, shooting has been a major influence on the way farmland has been managed for centuries (The Game Conservancy Trust, 1997; Rackham, 2000). Studies have shown that significant benefits result for wider wildlife from features of management implemented to benefit game species (Hill and Robertson, 1988; McKelvie, 1991; Stoate and Szczur, 2001). Britain is uncommon in that landowners have property rights over the wildlife on their land. Indeed, these property rights appear to be a motivational force that encourages landowners who shoot gamebirds to undertake land management that is of high conservation value (Oldfield *et al*, 2003). Furthermore, the commercial consumptive use of gamebirds provides an economic benefit for shoot owners and for rural communities alike.

In the last 150 years, and particularly after World War II, the use of reared gamebirds on shoots has become more common to the point where, today, approximately 70% of pheasants shot each year are reared (Robertson *et al*, 1993). Modern agricultural has reduced the quality of habitat for gamebirds alongside other wildlife species

(O'Connor and Shrubb, 1986; Sotherton, 1998; Chamberlain *et al*, 1999; Macdonald and Johnson, 2000; Critchley *et al*, 2004) and increased reliance on reared gamebirds to produce shoot bags (Hill and Robertson, 1988). The ease with which gamebirds could be reared meant some shoots have increased in size (in terms of number of birds in the bag) to levels that are deemed by most to be unacceptable (McKelvie, 1991). Indeed, with no regulations, such shoots often contribute little to the conservation of the countryside, relying instead on a "put and shoot" approach to gamebird shooting (Jeff Handy, head gamekeeper, personal communication). This has the effect of detrimentally impacting on the overall impression expressed regarding gamebird shoots in Britain, particularly at a time when many shoot owners are attempting to be more sympathetic in the way they run their shoots (Countess Sondes, shoot owner, personal communication; Lee-Pemberton shoot owner, personal communication). Indeed, it was the desire of Countess Sondes to manage the shoot at Lees Court Estate, Kent, in a more conservation orientated manner whilst maintaining the commercial aspect that initiated this study.

The financial costs of producing a commercial shoot are considerable (Chapter 4) if sufficient gamebirds are to be produced (Chapter 5). However, of the new land management regime generated considerable conservation benefits wild gamebirds (Chapter 5) and also appears to have produce significant benefits for wider biodiversity (Chapter 6 and 7). For the first time, the attitudes of those involved in gamebird shooting have been examined (Chapter 3). This study has shown this approach is necessary if the scope for changing practice is to be implemented successfully. The future of commercial gamebird shooting has also been explored following a willingness-to-pay study (Chapter 8), investigating the potential effects of the introduction of regulations that would significantly alter the future form of the industry.

9.2 Social attitudes and scope for change within gamebird shooting

It is vital to understand the attitudes of stakeholders if changes to a current system are to be successfully implemented and adopted (Roe *et al*, 2000; Mushove and Vogel, 2005). This study documented the social attitudes of the four main stakeholder groups involved in gamebird shooting. Stakeholders believed that gamebird shooting generated four primary benefits: (1) conservation of wildlife species and vulnerable habitats that would otherwise be lost to agriculture or development; (2) financial benefits, both direct and indirect, for shoot owners, rural communities and other businesses; (3) development of social cohesion, a focal point around which members of rural communities can join and unite through their involvement; and, (4) maintenance of a rural tradition. The importance of maintaining gamebird shooting, so that it could continue generating each of these benefits, was considered even more important following the ban on hunting with hounds.

The degree of importance assigned to these various benefits differed between stakeholder groups, and reflected the different priorities of each group. Regardless of group, all stakeholders considered that conservation and financial benefits for rural communities were the most important arguments for protecting the future of gamebird shooting. All groups stressed the importance of shoot owners in spending, sometimes substantial, amounts of private money on creating of these benefits. Indeed, Chapter 4 illustrated the high costs incurred by a Kent owner who had prioritised a change in land management to produce, still commercial, shooting with high conservation potential. Although, land owners can adopt a CSS to offset some of their costs, and earn income from the sale of shoot days, Chapter 4 also showed that commercial shoots can often run at a loss.

The focus group meetings also identified various problems that result from gamebird shooting. The most negative aspect of lowland gamebird shooting is the number of birds reared and released. In turn, this causes a range of other problems, including husbandry problems of rearing on a large scale, the conservation problems of releasing a large number of alien birds onto a limited amount of land, the ethical issue of shooting a large number of birds on big bag days, and the appropriate disposal or sale of the resulting game meat. The different stakeholder groups failed to accept responsibility for the problems, but instead accused the other groups of creating them. Nevertheless, each group agreed that there was scope for change to resolve the issues that may be detrimental to the future of gamebird shooting.

The findings of the focus groups led to the conclusion that, although there is obvious conflict between stakeholder groups in terms of opinions and negative attitudes towards each other, there is potential to harness the desire of each stakeholder group to protect the future of gamebird shooting to implement change. The success of such a process will depend on the acceptance by each group of any suggested regulation or self-regulation. Acceptance or rejection of each suggestion by a stakeholder group will most likely be determined by the degree to which that regulation affects their role within gamebird shooting.

9.3 The biodiversity benefits of wild gamebird management on a commercial shoot

Previous studies have shown that significant increases in wild gamebird productivity can be achieved through altering existing, and adopting new, land management techniques (Hill and Robertson, 1988; Reynolds *et al*, 1988; Tapper, 1999; Sage and Robertson, 2000). However, this study is the first to show these same effects on pheasant populations located on land that supports a commercial gamebird shoot that releases a substantial number of reared birds (Chapter 5). The apparent increase in habitat quality on the main study site of the Lees Court Estate, was also experienced by some insect species (Chapter 6) and by songbirds (Chapter 7). This again confirmed the findings of previous research that such land management regimes can provide conservation benefits for wider wildlife (Stamp, 1969; Robertson *et al,* 1988; Tapper, 1999; Stoate and Szczur, 2001). However, as with the gamebird study, this study was the first to confirm such findings on a commercial shoot on which substantial numbers of reared birds are released.

Butterflies and bumblebees did not increase in numbers over the study, suggesting the management did not increase habitat quality for these insect groups. The CSS prescriptions implemented were identified as those most likely to improve habitat quality for gamebirds by providing nesting sites and insect-rich feeding areas for chicks. The key chick food insects did indeed increase, indicating that this prescription was the appropriate choice. The provision of increased numbers of insects, along with other land management such as supplementary feeding and predator control, also appear to have benefited songbirds. However, these prescriptions were recognised to have little potential for providing quality habitat for butterflies and bumblebees. Some AESs indeed contain specific prescriptions designed to benefit these insect groups through nectar and pollen mixes. However, butterfly and bumblebee numbers may increase over time at Lees Court Estate if wild flowers become established within the uncropped field margins.

The level to which the wild productivity of gamebirds on Lees Court Estate would increase can only be determined through more years of monitoring. Therefore, the extent to which rearing could be further reduced as wild birds supplemented the population could not be determined from this study. However, the potential for further recruitment of more wild birds into the Lees Court Estate population is apparent. Stakeholders view a reduction in the numbers of gamebirds reared and released in lowland Britain as advantageous (Chapter 3), and that such a reduction could be implemented in a way that would see current opposition agreeing to allow gamebird shooting to continue in the future. The extent to which songbird and insect populations will increase can also be determined through future monitoring. Identifying the limiting factors and addressing them may allow certain species to increase beyond the levels permitted through the new management regime.

9.4 The future of gamebird shooting in lowland Britain

The willingness-to-pay study highlighted the future vulnerability of commercial gamebird shooting in Britain. Thus a ban on releasing reared gamebirds for shooting, which many consider will happen in a similar way to the Netherlands (Chapter 3), will lead to a significant reduction in the sums of money spent purchasing gamebird shooting. As many shoots perhaps break even or are already run at a loss, as demonstrated by the financial records of Lees Court Estate in Chapter 4, it is likely that such a ban will result in the closure of many commercial shoots. A further decrease in income generated through the sale of shoot days will mean that shoot owners can no longer afford to operate. Such an eventuality would result in a loss of the various benefits created by gamebird shoots.

9.5 Overall conclusions

The focus groups (Chapter 3) and the analysis of the cost of a commercial shoot (Chapter 4) showed that landowners with property rights over the gamebirds on their land are motivated to invest in land management. In turn, this investment of money and resources increases the conservation value of the habitat for both gamebirds and wider biodiversity, whilst also providing numerous benefits for rural communities. The conservation benefits associated with gamebird shoot management appear to exceed those provided by AESs; indeed, the benefits of AESs has yet to be proven (See Section 4.2.1). The findings of this and other studies suggest that several aspects of gamekeeping have positive effects on various wildlife species, and could be incorporated into AESs. Furthermore, removing the rights or ability of landowners to support a gamebird shoot on their property would result in a significant reduction of conservation benefits for British wildlife, as well the loss of the associated financial and social benefits for rural communities, without any evident or realistic alternative opportunities to provide these benefits.

9.6 Recommendations

The study of insects and songbirds confirmed that gamebird management can create benefits for wider biodiversity. However, the short-term nature of this study could not determine the factors that best explained the increased quality of the habitat for gamebirds and songbirds. Indeed, several factors probably produced the observed increases in gamebird, songbirds and insect numbers. Further research is necessary to understand the effects of specific aspects of gamebird management on other wildlife species with the view to incorporating these features into AESs. Indeed, the failure of current AESs to deliver conservation benefits, and the benefits created by gamebird management as shown in this and other studies, indicate that several crucial factors are missing from land managed using only AES prescriptions. It is also important to assess whether AES prescriptions implemented on land that is also managed for gamebird shooting are generally better implemented than those on land not managed for gamebird shooting. Indeed, this and other studies suggest that the desire to create quality habitat for gamebirds may encourage landowners to invest more time, money and effort when undertaking AESs.

The focal groups drew attention to potential conflict between the principle stakeholder groups, which may jeopardise future attempts to introduce self-regulation in a collective bid to help gamebird shooting become a more acceptable activity. Although scope for change was suggested by each group, it is apparent that the groups will have to work together to implement any changes successfully. For example, a single "umbrella" organisation under which the separate shoot organisations work may be necessary if consistent advice and policy directives are to be issued on behalf of the shooting community. The primary concern of any future umbrella organisation should be to develop codes of conduct on all aspects of the gamebird shooting industry, and to promote these codes to all stakeholder groups in an attempt to gain their wide scale acceptance.

The focus groups and willingness-to-pay studies showed that different stakeholder groups will need to compromise to maintain commercial gamebird shooting whilst reducing the negative aspects created by the release of large numbers of reared birds. A limit on the size of bags per day and the number of days per season for each shoot could be linked to the area of each shoot, and this may go some way to reducing the excesses of large bag shoot days. However, it is important that any future limitations on rearing does not reduce bag sizes to a level such that results in shoot purchasing declines. Likewise, purchasers need to be encouraged to pay a fair price for shooting. If excessive rearing is limited and codes of conduct are promoted, those strongly commercial shoots that currently run as a result of massive rearing programmes, and that sell a vast number of cheap days per year, will have to scale down on their excesses. Greater emphasis needs to be placed on producing quality shooting through sensible rearing and land management programmes that permit all shoot types to continue, while continuing to support the rights of land owners to utilise resources on their property.

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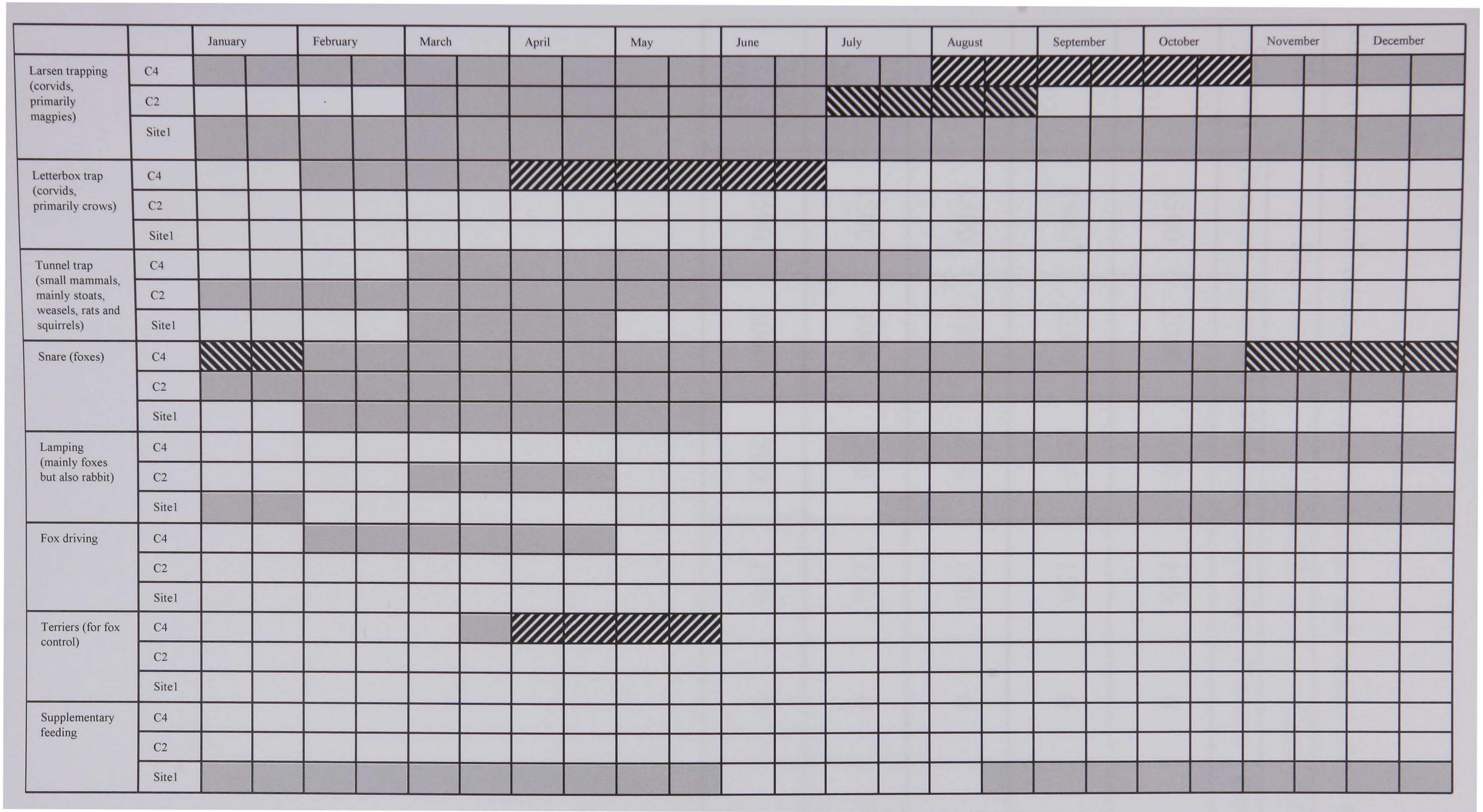
Summary of gamekeeping practices at Site 1 and Controls 2 & 4

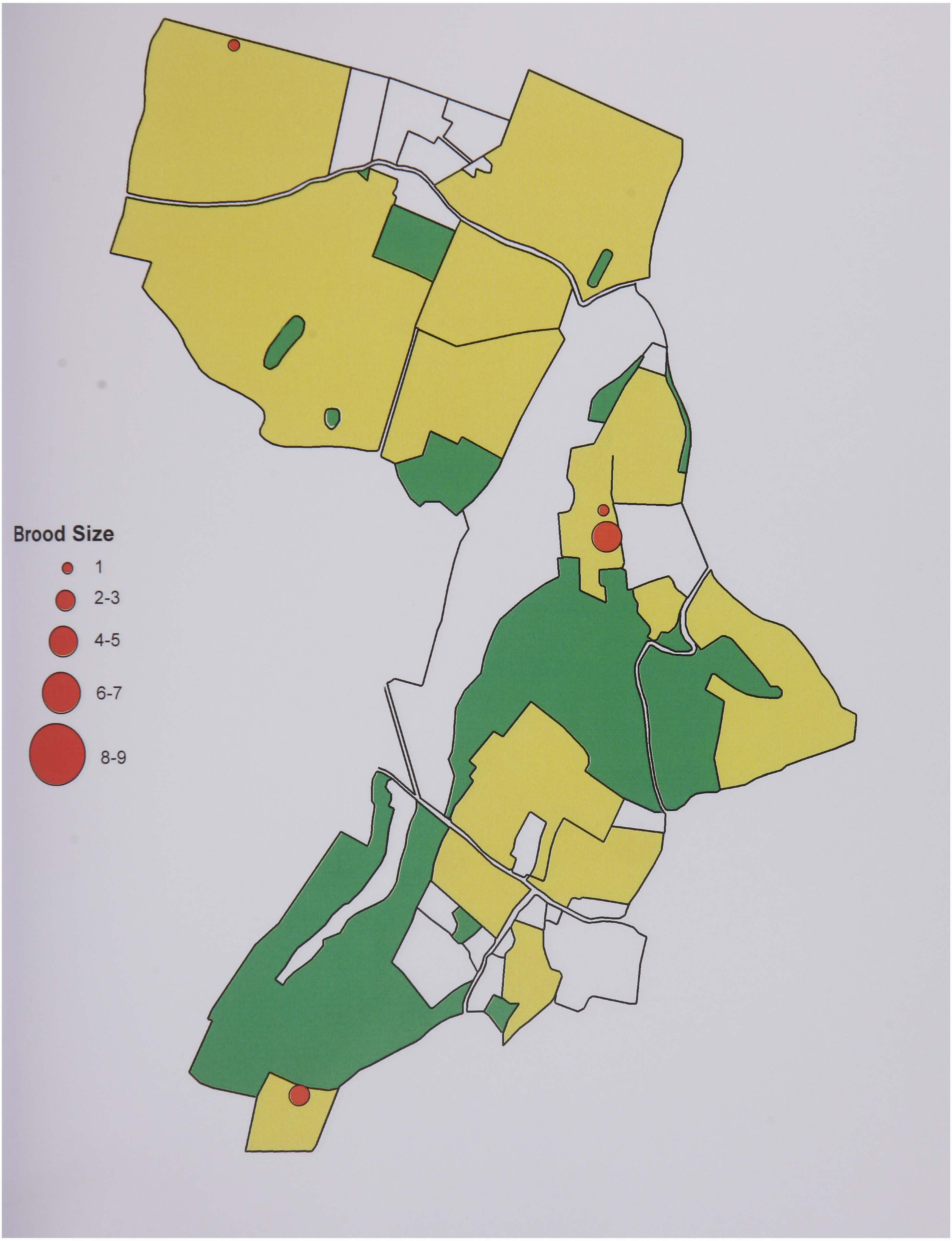


- Appendix 1 provides information on the degree of gamekeeping management undertaken at Site 1 and Controls 2 and 4. For Site 1, the total amount of gamekeeping has been recorded rather than dividing it for the separate treatment sites. The shading represents those months when each type of management practice is undertaken. The striped shading represents those months when the activity may be undertaken depending on factors such as the degree of necessity and time allowance.
- Control site 3 is not included in the table as there was no gamekeeping management occurring at the site as the property did not support a gamebird shoot.

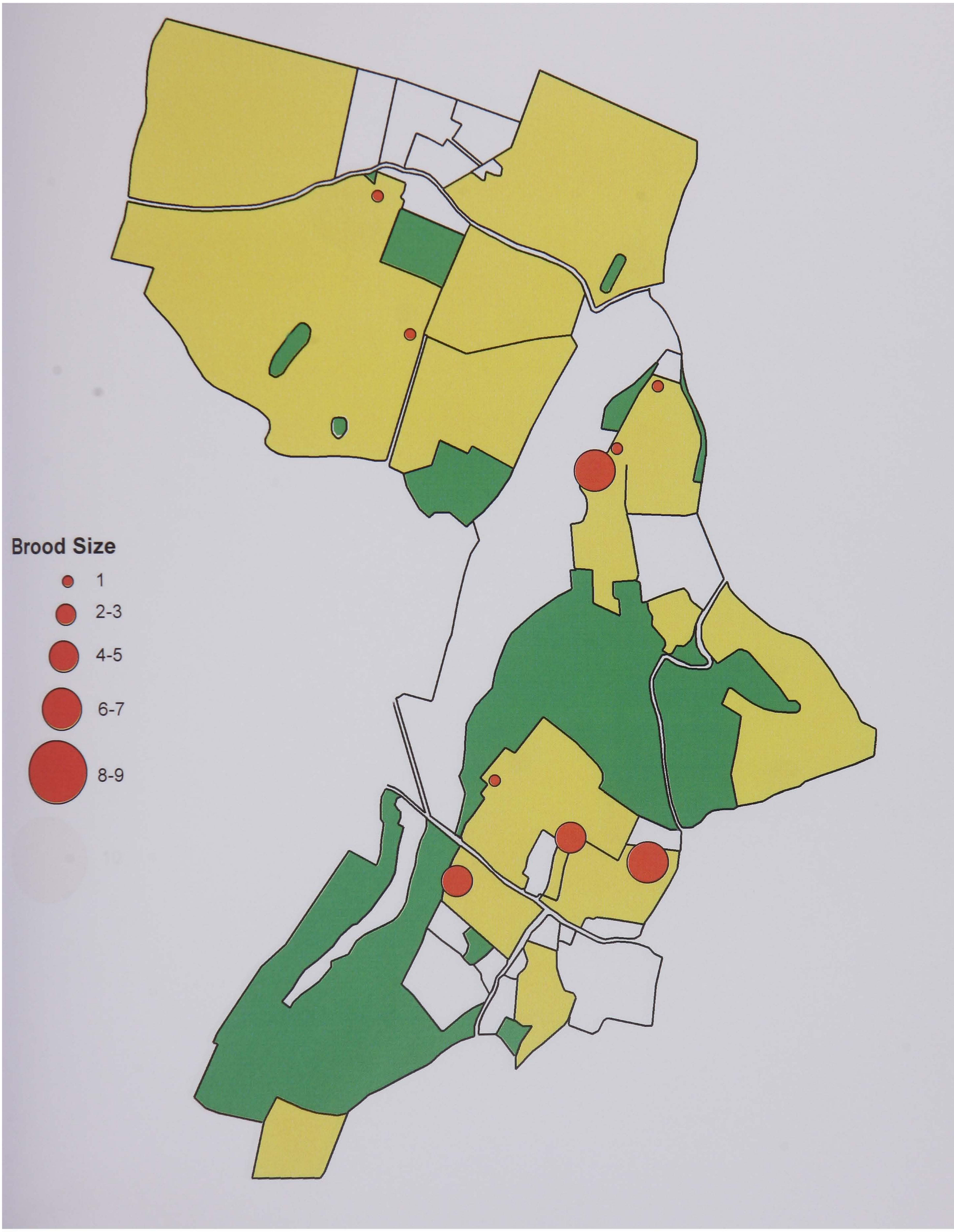
Number of gamebirds released each season on Site 1 and Control sites 2 & 4

Shoot Season	Site 1		Control 2		Control 4	
	Pheasant	Partridge	Pheasant	Partridge	Pheasant	Partridge
2000/ 2001	8500	2000	500	150	0	0
2001/ 2002	8500	2000	500	150	0	0
2002/ 2003	8500	3000	500	150	0	0
2003/ 2004	8500	3000	500	150	0	0
2004/ 2005	8500	3000	500	150	0	0

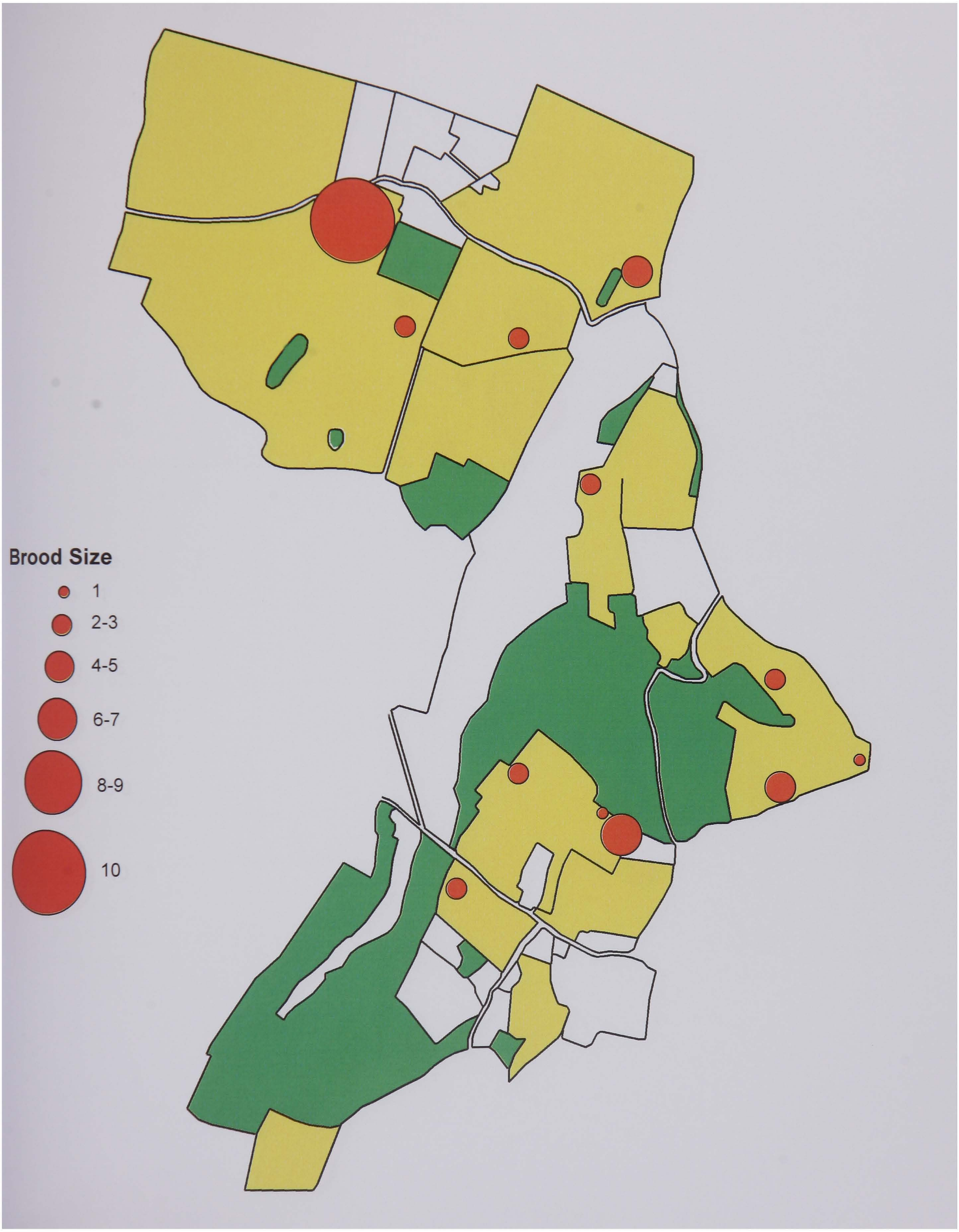
Map to show position and size of pheasant broods on Site 1 in 2001



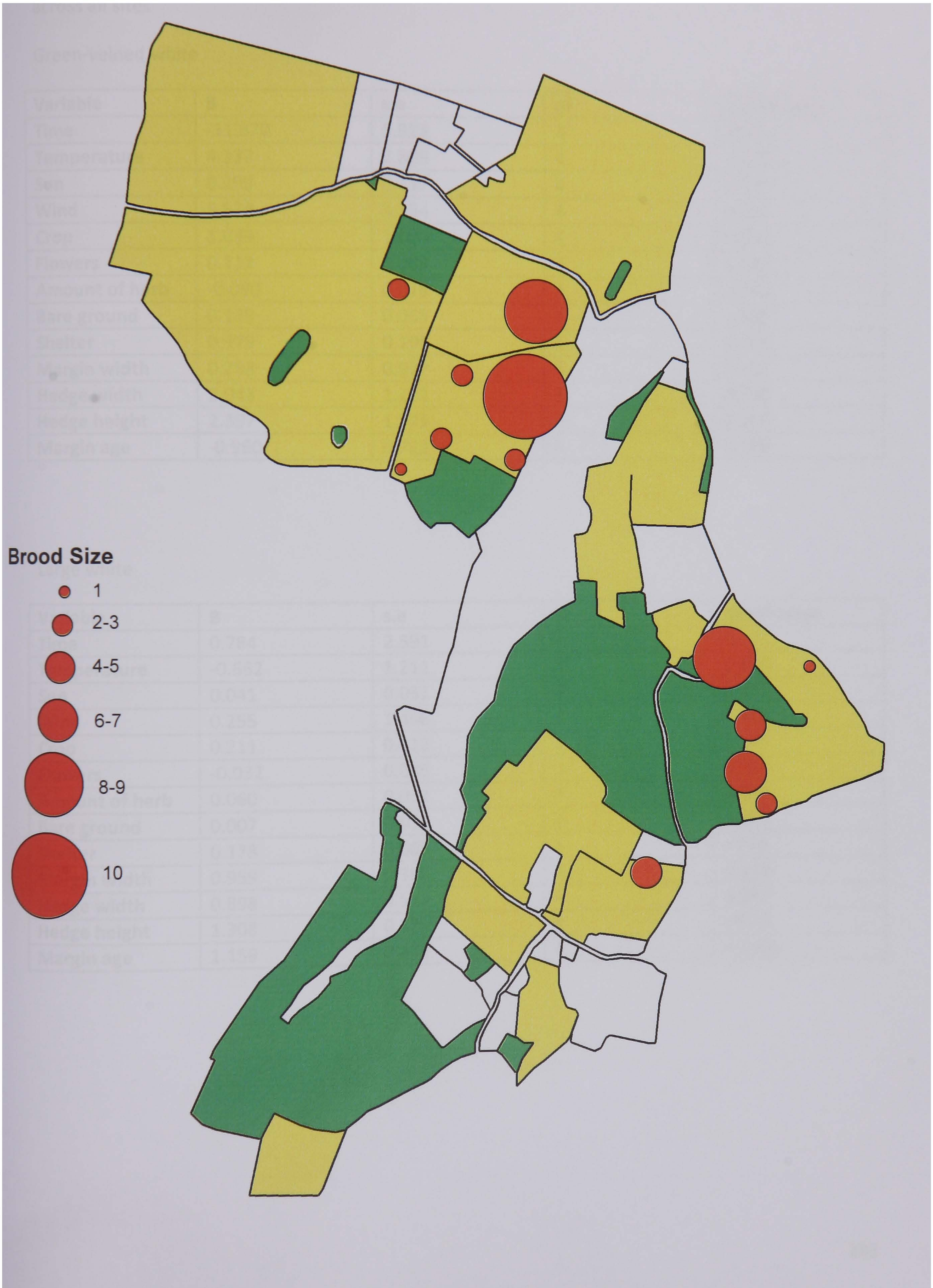
Map to show position and size of pheasant broods on Site 1 in 2002



Map to show position and size of pheasant broods on Site 1 in 2003



Map to show position and size of pheasant broods on Site 1 in 2004



Regression analysis for the variables examined to explain the number of certain butterfly species across all sites

Green-veined white

Variable	B	s.e	df	significance
Time	-11.870	5.923	4	<0.05
Temperature	4.337	2.809	4	0.128
Sun	0.209	0.117	4	0.078
Wind	5.538	3.384	4	0.107
Crop	1.039	1.090	4	0.345
Flowers	0.112	0.083	4	0.183
Amount of herb	-0.090	0.078	4	0.249
Bare ground	0.139	0.069	4	<0.05
Shelter	0.379	0.198	4	0.061
Margin width	0.288	0.977	4	0.769
Hedge width	2.043	1.222	4	0.100
Hedge height	2.397	1.379	4	0.087
Margin age	-0.960	0.722	4	0.189

Large white

Variable	B	s.e	df	significance
Time	0.784	2.591	4	0.763
Temperature	-0.662	1.211	4	0.586
Sun	0.041	0.051	4	0.417
Wind	0.255	1.466	4	0.862
Crop	0.211	0.412	4	0.610
Flowers	-0.032	0.035	4	0.375
Amount of herb	0.060	0.032	4	0.070
Bare ground	0.007	0.030	4	0.807
Shelter	0.178	0.083	4	<0.05
Margin width	0.959	0.396	4	0.018
Hedge width	0.898	0.517	4	0.087
Hedge height	1.308	0.575	4	<0.05
Margin age	1.159	0.273	4	<0.001

Small white

Variable	B	s.e	df	significance
Time	-1.720	6.006	4	0.776
Temperature	7.028	2.666	4	<0.05
Sun	0.325	0.110	4	<0.01
Wind	6.218	3.304	4	0.065
Crop	1.217	0.804	4	0.137
Flowers	0.149	0.080	4	0.070
Amount of herb	0.076	0.076	4	0.326
Bare ground	0.247	0.063	4	<0.001
Shelter	-0.190	0.199	4	0.343
Margin width	2.060	0.924	4	<0.05
Hedge width	-0.748	1.224	4	0.543
Hedge height	-0.513	1.387	4	0.713
Margin age	-0.647	0.715	4	0.369

Meadow brown

Variable	B	s.e	df	significance
Time	1.491	20.479	4	0.942
Temperature	-21.292	9.193	4	<0.05
Sun	-0.465	0.397	4	0.246
Wind	-27.594	11.029	4	<0.05
Crop	0.927	2.638	4	0.727
Flowers	-0.526	0.273	4	0.059
Amount of herb	0.560	0.253	4	<0.05
Bare ground	-0.155	0.238	4	0.518
Shelter	0.570	0.680	4	0.405
Margin width	6.872	3.154	4	<0.05
Hedge width	1.884	4.178	4	0.654
Hedge height	7.551	4.632	4	0.108
Margin age	10.471	2.055	4	<0.001

Regression analysis for the variables examined to explain the number of certain bumblebee species across all sites

A. mellifera

Variable	B	s.e	df	significance
Time	96.655	185.861	4	0.605
Temperature	-19.292	87.175	4	0.826
Sun	0.037	3.649	4	0.992
Wind	-133.769	103.932	4	0.203
Crop	70.809	32.818	4	<0.05
Flowers	0.219	2.561	4	0.932
Amount of herb	-1.998	2.376	4	0.404
Bare ground	-0.928	2.170	4	0.671
Shelter	-4.039	6.196	4	0.517
Margin width	-29.286	29.545	4	0.325
Hedge width	-17.293	37.997	4	0.615
Hedge height	-0.295	43.034	4	0.995
Margin age	6.478	22.303	4	0.772

B. lapidarius worker male

Variable	B	s.e	df	significance
Time	-7.026	8,907	4	0.433
Temperature	-7.887	4.068	4	0.057
Sun	-0.212	0.173	4	0.225
Wind	3.203	5.046	4	0.528
Crop	-0.681	0.796	4	0.396
Flowers	-0.135	0.122	4	0.274
Amount of herb	0.360	0.105	4	<0.001
Bare ground	-0.025	0.104	4	0.810
Shelter	-0.401	0.294	4	0.178
Margin width	4.867	1.289	4	<0.001
Hedge width	-1.572	1.818	4	0.391
Hedge height	-1.974	2.053	4	0.340
Margin age	-0.131	1.073	4	0.903

B. pascuorum worker male

Variable	B	s.e	df	significance
Time	-8.593	7.214	4	0.238
Temperature	-2.577	3.401	4	0.451
Sun	-0.310	0.137	4	0.028
Wind	1.732	4.121	4	0.676
Crop	-0.544	1.317	4	0.681
Flowers	-0.243	0.095	4	<0.05
Amount of herb	0.030	0.094	4	0.749
Bare ground	-0.030	0.085	4	0.725
Shelter	-0.612	0.231	4	<0.01
Margin width	0.880	1.161	4	0.425
Hedge width	-3.960	1.402	4	<0.01
Hedge height	-3.577	1.623	4	<0.05
Margin age	0.762	0.869	4	0.384

B. terrestris worker male

Variable	B	s.e	df	significance
Time	-9.817	14.972	4	0.515
Temperature	-10.422	6.906	4	0.136
Sun	-0.432	0.289	4	0.140
Wind	-1.666	8.493	4	0.845
Crop	-1.568	2.414	4	0.519
Flowers	-0.632	0.190	4	<0.001
Amount of herb	0.443	0.184	4	<0.05
Bare ground	-0.105	0.175	4	0.552
Shelter	-0.016	0.502	4	0.975
Margin width	5.518	2.296	4	<0.05
Hedge width	-0.847	3.068	4	0.783
Hedge height	1.154	3.468	4	0.740
Margin age	6.415	1.602	4	<0.001

Regression analysis for the variables examined to explain the number of certain insect species across all sites

Insects not considered key chick food items

Araneae

Variable	B	s.e.	df	Significance
Crop	10.411	5.829	4	0.82
Flowers	-1.109	0.457	4	<0.05
Amount of herb	-1.073	0.359	4	0.315
Bare ground	0.512	0.504	4	<0.01
Shelter	-0.488	1.325	4	0.714
Margin width	7.101	6.257	4	0.263
Hedge width	-3.645	8.104	4	0.655
Hedge height	-2.308	9.179	4	0.803
Margin age	19.906	3.367	4	<0.001

Orthoptera

Variable	B	s.e.	df	Significance
Crop	-0.471	0.465	4	0.317
Flowers	0.001	0.038	4	0.974
Amount of herb	0.005	0.040	4	0.895
Bare ground	0.029	0.031	4	0.340
Shelter	0.022	0.103	4	0.829
Margin width	-0.239	0.493	4	0.630
Hedge width	0.005	0.632	4	0.994
Hedge height	-0.635	0.707	4	0.375
Margin age	-0.305	0.355	4	0.396

Aphididae

Variable	B	s.e.	df	Significance
Crop	-7.504	3.620	4	0.045
Flowers	-0.118	0.308	4	0.703
Amount of herb	0.268	0.318	4	0.405
Bare ground	0.907	0.205	4	<0.001
Shelter	-1.075	0.817	4	0.196
Margin width	2.891	3.972	4	0.471
Hedge width	-7.029	4.972	4	0.167
Hedge height	-3.038	5.758	4	0.601
Margin age	-4.826	2.797	4	0.092

Staphylindae

Variable	B	s.e.	df	Significance
Crop	1.359	1.839	4	0.464
Flowers	-0.008	0.150	4	0.959
Amount of herb	0.049	0.156	4	0.752
Bare ground	0.117	0.120	4	0.337
Shelter	0.148	0.405	4	0.717
Margin width	1.172	1.935	4	0.548
Hedge width	-0.660	2.482	4	0.792
Hedge height	0.712	2.806	4	0.801
Margin age	3.286	1.310	4	<0.05

Nematocera

Variable	B	s.e.	df	Significance
Crop	4.969	2.751	4	0.078
Flowers	-0.275	0.227	4	0.233
Amount of herb	0.222	0.238	4	0.357
Bare ground	-0.263	0.183	4	0.159
Shelter	-0.509	0.622	4	0.418
Margin width	1.093	2.998	4	0.717
Hedge width	-2.966	3.809	4	0.441
Hedge height	-5.462	4.253	4	0.206
Margin age	4.489	2.058	4	0.035

Insects considered key chick food items

Homoptera

Variable	B	s.e.	df	Significance
Crop	61.142	20.093	4	<0.01
Flowers	-3.922	1.693	4	<0.05
Amount of herb	1.351	1.865	4	0.473
Bare ground	-2.223	1.420	4	0.125
Shelter	-10.974	4.568	4	<0.05
Margin width	17.858	23.233	4	0.447
Hedge width	-72.561	27.622	4	<0.05
Hedge height	-52.673	32.777	4	0.116
Margin age	58.833	14.190	4	<0.001

Heteroptera

Variable	B	s.e.	df	Significance
Crop	2.461	2.492	4	0.329
Flowers	0.127	0.203	4	0.535
Amount of herb	0.301	0.207	4	0.154
Bare ground	0.021	0.165	4	0.899
Shelter	-0.378	0.550	4	0.495
Margin width	-0.157	2.648	4	0.953
Hedge width	-2.307	3.364	4	0.497
Hedge height	-4.442	3.761	4	0.244
Margin age	1.670	1.901	4	0.385

Lepidoptera

Variable	B	s.e.	df	Significance
Crop	0.487	0.262	4	0.071
Flowers	-0.052	0.021	4	<0.05
Amount of herb	0.058	0.021	4	<0.01
Bare ground	-0.010	0.018	4	0.582
Shelter	-0.016	0.060	4	0.793
Margin width	0.371	0.281	4	0.194
Hedge width	-0.249	0.364	4	0.499
Hedge height	0.096	0.414	4	0.818
Margin age	0.870	0.156	4	<0.001

Symphyta

Variable	B	s.e.	df	Significance
Crop	0.145	0.381	4	0.706
Flowers	-0.062	0.029	4	<0.05
Amount of herb	0.014	0.032	4	0.655
Bare ground	-0.046	0.024	4	0.061
Shelter	0.058	0.083	4	0.486
Margin width	0.075	0.400	4	0.852
Hedge width	0.114	0.511	4	0.825
Hedge height	0.308	0.577	4	0.597
Margin age	1.045	0.239	4	<0.001

Carabidae

Variable	B	s.e.	df	Significance
Crop	2.248	1.045	4	<0.05
Flowers	-0.204	0.083	4	<0.05
Amount of herb	0.141	0.090	4	0.125
Bare ground	-0.137	0.069	4	0.054
Shelter	-0.297	0.237	4	0.218
Margin width	0.784	1.152	4	0.500
Hedge width	-1.586	1.459	4	0.281
Hedge height	-2.442	1.629	4	0.142
Margin age	1.495	0.806	4	0.071

Curculionidae

Variable	B	s.e.	df	Significance
Crop	0.807	0.559	4	0.157
Flowers	0.067	0.045	4	0.146
Amount of herb	0.012	0.048	4	0.810
Bare ground	0.013	0.038	4	0.734
Shelter	0.190	0.122	4	0.128
Margin width	0.586	0.595	4	0.331
Hedge width	1.428	0.735	4	0.059
Hedge height	0.962	0.856	4	0.268
Margin age	0.060	0.436	4	0.891

Species included in each group for CBC surveys and their abundance (per km²)

Woodland species

Year	Site	Blackcap	Blue Tit	Bull Finch	Chaffinch	Chiff Chaff	Coal Tit	Cuckoo	Garden Warbler	Gold Finch	Great SW	Great Tit	Green Finch	Green WP	L-T Tit	M. Thrush	Robin
2001	1.1	2.84	12.77	0.00	14.18	2.84	0.00	1.42	0.00	1.42	1.42	7.09	2.84	2.84	1.42	1.42	4.26
2001	1.2	1.79	14.29	0.00	17.86	1.79	0.00	0.00	0.00	1.79	3.57	7.14	7.14	5.36	0.00	1.79	3.57
2001	1.3	4.17	29.17	0.00	31.25	4.17	0.00	2.08	0.00	0.00	2.08	10.42	0.00	4.17	14.58	0.00	10.42
2001	1.4	4.40	19.78	0.00	26.37	6.59	0.00	0.00	0.00	2.20	2.20	8.79	4.40	2.20	0.00	0.00	6.59
2001	2	4.08	38.78	0.00	24.49	18.37	0.00	0.00	0.00	6.12	0.00	14.29	6.12	6.12	6.12	0.00	12.24
2001	3	1.85	11.11	0.00	12.96	0.00	0.00	0.00	0.00	1.85	1.85	7.41	1.85	3.70	0.00	0.00	5.56
2001	4	4.76	9.52	0.00	11.11	7.94	0.00	0.00	0.00	1.59	0.00	9.52	4.76	4.76	1.59	0.00	4.76
2002	1.1	5.67	8.51	0.00	18.44	4.26	1.42	0.00	0.00	1.42	1.42	9.93	5.67	2.84	1.42	0.00	9.93
2002	1.2	3.57	10.71	0.00	21.43	7.14	0.00	0.00	0.00	1.79	1.79	10.71	3.57	5.36	0.00	0.00	10.71
2002	1.3	6.25	25.00	0.00	50.00	14.58	2.08	0.00	0.00	0.00	4.17	16.67	4.17	6.25	6.25	0.00	37.50
2002	1.4	6.59	19.78	0.00	30.77	8.79	2.20	2.20	0.00	4.40	4.40	15.38	4.40	4.40	4.40	0.00	24.18
2002	2	10.20	18.37	0.00	26.53	12.24	2.04	0.00	0.00	0.00	2.04	16.33	4.08	6.12	6.12	4.08	22.45
2002	4	1.85	11.11	0.00	18.52	1.85	0.00	0.00	0.00	1.85	1.85	5.56	1.85	5.56	0.00	0.00	9.26
2002	5	4.76	6.35	0.00	15.87	6.35	1.59	1.59	0.00	3.17	1.59	6.35	6.35	1.59	4.76	3.17	6.35
2003	1.1	7.09	15.60	0.00	24.11	0.00	0.00	1.42	0.00	0.00	2.84	8.51	4.26	2.84	2.84	2.84	12.77
2003	1.2	3.57	12.50	0.00	21.43	3.57	0.00	1.79	0.00	1.79	1.79	8.93	3.57	3.57	3.57	3.57	16.07
2003	1.3	18.75	16.67	0.00	47.92	22.92	2.08	2.08	0.00	2.08	2.08	27.08	4.17	4.17	8.33	4.17	41.67
2003	1.4	15.38	21.98	0.00	43.96	6.59	0.00	2.20	0.00	2.20	4.40	15.38	13.19	4.40	4.40	4.40	19.78
2003	2	14.29	18.37	0.00	28.57	14.29	0.00	2.04	0.00	2.04	2.04	18.37	4.08	4.08	8.16	4.08	26.53
2003	3	3.70	5.56	0.00	20.37	1.85	0.00	0.00	0.00	0.00	0.00	5.56	1.85	0.00	0.00	0.00	11.11
2003	4	1.59	4.76	0.00	22.22	4.76	0.00	1.59	0.00	3.17	1.59	6.35	9.52	1.59	1.59	1.59	11.11

Abbreviations:

Great SW – Great Spotted Woodpecker

L-T Tit – Long-tailed Tit

Green WP – Green Woodpecker

M. Thrush – Mistle Thrush

Woodland species continued

Year	Site	S.Thrush	Tree Creeper	Willow Tit	Willow Warbler	Wren
2001	1.1	5.67	2.84	0.00	1.42	4.26
2001	1.2	7.14	0.00	0.00	0.00	7.14
2001	1.3	10.42	0.00	0.00	0.00	12.50
2001	1.4	6.59	0.00	0.00	0.00	15.38
2001	2	10.20	0.00	0.00	10.20	14.29
2001	3	3.70	0.00	0.00	0.00	3.70
2001	4	6.35	0.00	0.00	1.59	11.11
2002	1.1	11.35	2.84	0.00	0.00	17.02
2002	1.2	14.29	0.00	0.00	0.00	12.50
2002	1.3	25.00	0.00	0.00	2.08	25.00
2002	1.4	17.58	0.00	0.00	2.20	37.36
2002	2	14.29	0.00	0.00	10.20	24.49
2002	3	5.56	0.00	0.00	0.00	16.67
2002	4	11.11	0.00	1.59	4.76	11.11
2003	1.1	14.18	2.84	1.42	1.42	25.53
2003	1.2	17.86	3.57	1.79	0.00	26.79
2003	1.3	22.92	0.00	0.00	2.08	33.33
2003	1.4	21.98	4.40	2.20	4.40	30.77
2003	2	16.33	0.00	0.00	6.12	26.53
2003	4	7.41	0.00	0.00	0.00	16.67
2003	5	9.52	0.00	0.00	3.17	12.70

Species included in each group for CBC surveys and their abundance (per km^2)

Hedgerow species

Year	Site	Blackbird	Dunnock	White Throat
2001	1.1	9.93	2.84	2.84
2001	1.2	17.86	3.57	3.57
2001	1.3	22.92	8.33	6.25
2001	1.4	24.18	6.59	8.79
2001	2	26.53	10.20	12.24
2001	3	11.11	5.56	7.41
2001	4	19.05	6.35	12.70
2002	1.1	12.77	5.67	2.84
2002	1.2	19.64	7.14	7.14
2002	1.3	43.75	10.42	8.33
2002	1.4	21.98	10.99	24.18
2002	2	32.65	10.20	16.33
2002	3	12.96	7.41	9.26
2002	4	14.29	6.35	15.87
2003	1.1	25.53	2.84	1.42
2003	1.2	23.21	5.36	1.79
2003	1.3	45.83	14.58	8.33
2003	1.4	37.36	19.78	2.20
2003	2	28.57	8.16	6.12
2003	3	14.81	0.00	5.56
2003	4	22.22	15.87	20.63

Species included in each group for CBC surveys and their abundance (per km^2)

Farmland species

Year	Site	Barn Owl	Collared Dove	Corn Bunting	Linnet	Little Owl	Pied Wagtail	Sky Lark	Turtle Dove
2001	1.1	0.00	1.42	0.00	1.42	0.00	0.00	4.26	0.00
2001	1.2	0.00	0.00	0.00	0.00	0.00	0.00	7.14	0.00
2001	1.3	0.00	0.00	0.00	0.00	0.00	0.00	6.25	0.00
2001	1.4	0.00	0.00	0.00	4.40	0.00	0.00	8.79	0.00
2001	2	0.00	0.00	0.00	6.12	2.04	2.04	16.33	0.00
2001	3	0.00	0.00	0.00	0.00	0.00	0.00	9.26	0.00
2001	4	0.00	1.59	0.00	9.52	0.00	0.00	9.52	4.76
2002	1.1	0.00	1.42	2.84	1.42	0.00	0.00	5.67	0.00
2002	1.2	0.00	1.79	3.57	1.79	0.00	1.79	5.36	1.79
2002	1.3	0.00	0.00	0.00	4.17	0.00	0.00	6.25	2.08
2002	1.4	0.00	0.00	0.00	6.59	0.00	0.00	6.59	2.20
2002	2	0.00	0.00	0.00	8.16	0.00	2.04	12.24	2.04
2002	3	0.00	0.00	0.00	0.00	0.00	0.00	7.41	0.00
2002	4	0.00	1.59	1.59	12.70	0.00	0.00	9.52	1.59
2003	1.1	0.00	1.42	2.84	1.42	0.00	0.00	4.26	0.00
2003	1.2	0.00	1.79	3.57	0.00	0.00	0.00	5.36	0.00
2003	1.3	0.00	4.17	0.00	6.25	0.00	0.00	8.33	6.25
2003	1.4	0.00	2.20	0.00	21.98	0.00	0.00	6.59	0.00
2003	2	0.00	2.04	0.00	6.12	0.00	2.04	12.24	4.08
2003	3	0.00	0.00	0.00	0.00	0.00	0.00	9.26	0.00
2003	4	0.00	1.59	1.59	17.46	0.00	0.00	12.70	3.17

Species included in each group for CBC surveys and their abundance (per km^2)

Hirundine species

Year	Site	House Martin	Swallow	Swift
2001	1.1	0.00	0.00	0.00
2001	1.2	0.00	3.57	0.00
2001	1.3	0.00	2.08	0.00
2001	1.4	0.00	2.20	0.00
2001	2	0.00	4.08	0.00
2001	3	0.00	1.85	0.00
2001	4	0.00	3.17	1.59
2002	1.1	4.26	0.00	0.00
2002	1.2	0.00	3.57	3.57
2002	1.3	0.00	2.08	0.00
2002	1.4	0.00	2.20	0.00
2002	2	0.00	4.08	0.00
2002	3	0.00	3.70	0.00
2002	4	0.00	1.59	1.59
2003	1.1	11.35	0.00	0.00
2003	1.2	8.93	0.00	0.00
2003	1.3	10.42	2.08	0.00
2003	1.4	0.00	0.00	0.00
2003	2	0.00	2.04	0.00
2003	3	0.00	0.00	0.00
2003	4	0.00	1.59	0.00

Species included in each group for CBC surveys and their abundance (per km²)

Raptor species

Year	Site	Buzzard	Hobby	Kestrel	Marsh Harrier	Sparrow Hawk
2001	1.1	0.00	0.00	0.00	0.00	0.00
2001	1.2	0.00	0.00	0.00	0.00	0.00
2001	1.3	0.00	0.00	0.00	0.00	0.00
2001	1.4	0.00	0.00	0.00	0.00	0.00
2001	2	0.00	0.00	2.04	0.00	0.00
2001	3	0.00	0.00	0.00	0.00	0.00
2001	4	0.00	0.00	1.59	0.00	1.59
2002	1.1	0.00	0.00	1.42	0.00	0.00
2002	1.2	0.00	0.00	0.00	0.00	0.00
2002	1.3	0.00	0.00	0.00	0.00	0.00
2002	1.4	0.00	0.00	0.00	0.00	0.00
2002	2	0.00	0.00	0.00	0.00	0.00
2002	3	0.00	0.00	0.00	0.00	0.00
2002	4	1.59	1.59	1.59	0.00	0.00
2003	1.1	0.00	0.00	0.00	0.00	0.00
2003	1.2	0.00	0.00	1.79	0.00	0.00
2003	1.3	2.08	0.00	0.00	0.00	0.00
2003	1.4	2.20	0.00	0.00	0.00	0.00
2003	2	0.00	0.00	2.04	0.00	0.00
2003	3	0.00	0.00	0.00	0.00	0.00
2003	4	1.59	0.00	1.59	0.00	1.59