7 Grazing livestock in the lowlands

Context

7.1 Approximately 2.4 million hectares of land in lowland England are used for grazing livestock production. Just over 95,000 ha are classed as semi-natural grasslands (excluding woodlands).[1] Nearly 65,000 ha of that area are Sites of Special Scientific Interest (SSSI).[2]

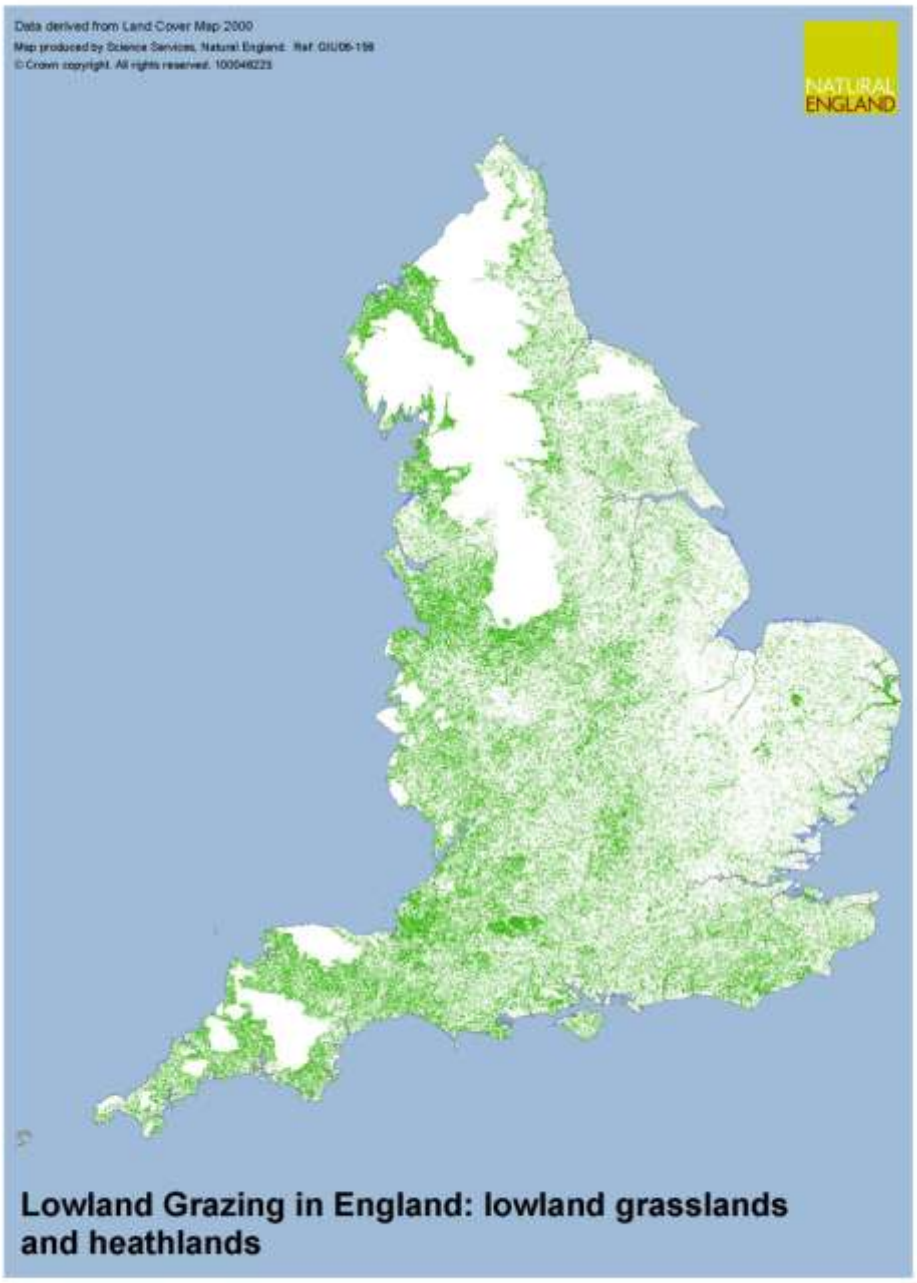

Figure 5 Lowland grazing outside Less Favoured Area

7.2 The map above shows the extent of land classified as grassland, heathland or rough grazing in the English lowlands.

Current industry practice

7.3 Management for lowland grazing livestock enterprises is generally closely associated with high stocking rates, short-term grass leys, high rates of inorganic fertiliser use and the disposal of large quantities of slurry. The average stocking density over all lowland forage area is 0.58 livestock units (which equates to one medium sized suckler cow) per hectare.[3] The average stocking rate on a lowland dairy farm is 2 livestock units (two dairy cows) per hectare.[4] This stocking rate would present manure disposal problems in a Nitrate Vulnerable Zone.[5] Permissible rates for manure application will be raised in autumn 2009, to allow an equivalent of approximately 2.5 cows per hectare.

7.4 The majority of ruminant livestock utilise grassland for much of the year. Typically, dairy and suckler cows are housed for approximately 24 weeks over the winter period. Sheep are housed on average only for six weeks over the lambing period.[6]

7.5 Overwintering requires conserved forage. This is viewed as a key product in lowland livestock enterprises. Production of large quantities of forage is usually dependent on high nutrient inputs and, in the case of grass silage, can mean multiple 'harvests' with early initial cutting dates. Effluent from silage is potentially a serious water pollutant. Stringent regulation has resulted in a marked reduction in such pollution events.[7]

7.6 Currently, a large proportion of arable crops such as maize or whole-crop silage, wheat (50%) and barley (over 60%)[8] is used in the livestock sector as a way of providing relatively cheap energy and protein.[9]

Industry trends and pressures

7.7 Land in the English lowlands is generally more versatile than in the uplands so the mix of farming enterprises is more able to change according to the economic climate. Between 1990 and 2006, lowland sheep and beef numbers rose by 18%, whilst dairy cow numbers dropped by 43%.[10] The area of wheat and oilseed rape increased, although total combinable crops decreased slightly.[11] Recent rises in the price of milk have maintained some degree of financial competition with arable crop production.[12] Livestock production is still dominant in those lowland areas where arable cropping is more marginal due to terrain or climate - largely in the north and west of England.

7.8 There has been a gradual polarisation of farm types, so that mixed farming (arable with livestock) has become less common, with arable farming predominating in the midlands and eastern part of the country, and livestock farming predominating in the west.[13]

7.9 In the lowlands, some areas of semi-natural vegetation developed as part of a traditional grazing system. These areas may typically have provided winter grazing to stock from elsewhere. In many predominantly arable areas of England there are insufficient suitable grazing livestock, and as a result undergrazing of conservation areas can be an issue.[14] Keeping stock in these areas, apart from having an economic function, can serve as a major habitat management tool through conservation grazing.

7.10 Livestock may be kept in lowland areas for a number of other reasons: they may be seen as a useful means of converting arable by-products into a more valuable commodity. Many arable farms buy large numbers of young ('store') animals for overwintering on fields which have been sown with late-sown or catch crops, thereby creating a short cropping break, which also has the benefit of adding a certain amount of fertility in the form of dung and urine. Grazing animals on such crops can result in severe soil run-off during bad weather if not managed sensitively.[15]

7.11 Many of the traditional lowland livestock enterprises, particularly where livestock have been used as a break from an arable rotation, have been phased out as land managers have found the increasingly small margins uneconomic, particularly given the comparatively high labour costs.

7.12 Since 2002, nitrogen fertiliser use on grasslands has reduced from an annual average of 89 kg/ha to an average of 65 kg/ha in 2007. Total phosphate applications had reduced from an average of 20 kg/ha in 2002 to 14 kg/ha in 2007.[16,17] The value of slurry and farmyard manure has increased in recent years as in the past it was often overlooked by land managers, both as a source of crop nutrients (high P, K and N values)[18] and as a potential source of energy (methane). The nutrient value and organic matter from farmyard manure can augment arable fertility on mixed farms. Some farmers on intensive livestock holdings have difficulties using all the solids and liquids on the holding within the constraints of Nitrate Vulnerable Zone (NVZ) requirements and the Codes of Good Agricultural Practice.[19]

7.13 With the higher cost of straw and milder winters, stock are being out wintered for longer, with the potential to cause soil compaction[20] and run off problems.

7.14 For current incentives, advice and regulation for lowland grassland farmers, see Annex I to this chapter.

Key impacts

7.15 Land which has been relatively extensively grazed for many years can develop a flora that largely reflects the management system. The habitats which have developed can be diverse and significant. Lowland semi-natural habitats dependent on livestock enterprises include lowland calcareous grassland (53,945 ha), lowland meadows (20,378 ha) and Purple Moor Grass and rush pasture (8734 ha).[21]

7.16 The loss of grazing from these areas (due to poor economic returns, lack of infrastructure, or the high demand in labour) may result in high risk to local or even national biodiversity as the growing conditions provided by grazing are difficult to reproduce by other means. There is therefore a case for maintaining lowland grazing in these areas irrespective of market returns on the basis that they provide a public benefit. Agri-environment funding is available to provide a financial incentive in many such cases.

7.17 The use of rotational crops for livestock may result in a loss of longer term grass leys. These leys have a higher biodiversity value than arable land, above and below ground,[22,23] and store carbon in soil organic matter, which is preserved through lack of cultivation.[24,25] Hay, which is generally cut later in the growing season, is now less common, despite being the most easily transported, largely because of its dependence on good weather during harvesting and its comparatively high labour demand.

7.18 Modern high-output forage systems have a high potential for risk to the environment from loss of semi-natural habitat and release of nutrients into surface and ground water. Agriculture is a source of over 60% of nitrates, up to 40% of phosphorous and approximately 25% of silt in UK waters.[26] It is also responsible for 85% of ammonia emissions, particularly from the dairy sector.[27]Since 2000 there has been a gradual reduction in nitrate and phosphate levels in English rivers.[28]

7.19 Early cutting dates for silage have been shown to have a detrimental effect on the breeding success of most ground nesting birds.[29] High nutrient input and early cutting dates have contributed to the loss of traditional hay meadow habitats.[30]

7.20 For further factual background to this to this chapter, see Annex II.

Summary of impacts

Biodiversity

7.21 Many important lowland ecosystems, including coastal areas, are dependent on low intensity grazing to maintain the desired vegetation mix and structure. Economics and lack of local infrastructure have often resulted in difficulties securing animals for this purpose. Sometimes referred to as undergrazing, this can result in loss of important habitat.

7.22 The pressures on biodiversity in the lowlands have increased as the agricultural sector has responded to economic forces by concentrating on intensive production. In the livestock sector, the drive to produce large quantities of high quality conserved fodder has resulted in areas of dense, heavily fertilised grasslands, which are cut early in the season, reducing botanical diversity and displacing or killing ground nesting birds.

Resource protection

7.23 In recent years, fertiliser use has been reduced, along with a reduction in stock numbers. There has also been increased focus on sources of agricultural pollution. Since 2000, the industry's record has improved in terms of point-source pollution incidents involving livestock. Agriculture is still a significant source of water pollutants and a major contributor of ammonia emissions.

7.24 Lowland livestock farmers are increasingly reliant on rotational crops such as maize (see Maize Production Case Study) and wheat for whole-crop silage. This has a potential negative effect on carbon sequestration, soil stability and biodiversity, above and below ground. The exception to this is where overwintering birds may benefit from whole-crop barley stubble.

Greenhouse gases

7.25 Ruminant livestock emit large quantities of greenhouse gases, principally methane, which can be managed as a fuel but, given high capital costs and modest returns, is more commonly not managed at all.

7.26 Grasslands can sequester carbon from the atmosphere, but this is largely released if they are ploughed up in a rotation. Intensive grasslands (both cut and grazed) are also the largest source of N_2O emissions across all agricultural systems.

7.27 Ammonia emissions are considered in the chapter on 'Nutrient and pollution management - intensive livestock'.

Landscape

7.28 Many lowland landscapes, such as the downs of southern England and the grazing marshes and lowland meadows of the Broads and Upper Thames, are dependent on extensive grazing.

7.29 Earthworks and other archaeological sites generally survive best on grazed land. Despite this, they can be seriously damaged by erosion by stock and around access routes. The maintenance of appropriate stocking levels to avoid erosion and control the spread of scrub is essential for the continued conservation and public appreciation of historic earthworks.

Annex I Current incentives, advice and regulation for lowland grassland farmers

Incentive

Environmental Stewardship and the earlier Environmentally Sensitive Area and Countryside Stewardship schemes incentivise a number of activities to enhance biodiversity on grasslands:

- A reduction or cessation of fertiliser applications on potentially high value grasslands.
- Late cutting dates for traditional hay meadows and making of field dried hay, to encourage seed setting.
- Creation of species-rich hay meadows.
- Field operations such as chain-harrowing limited to prevent damage to ground nesting bird populations.
- Maintenance of structural heterogeneity to encourage waders.
- Raised water levels to restore or recreate wet grassland habitats.

The Catchment Sensitive Farming (CSF) initiative provides free advice to farmers and land managers on all issues relating to water management and soil protection on land within river catchment areas.

Regulation

- *Wildlife and Countryside Act* - protection of vegetation on designated sites from overgrazing or undergrazing.
- *Countryside and Rights of Way Act* - prevention of Operations Likely to Damage.
- *Cross Compliance - GAEC 9*- overgrazing and supplementary feeding damage of semi-natural habitats.
- *Environmental Impact (Agriculture) regulations* – protection of unimproved grassland from agricultural improvement
- Cross Compliance also requires that nationally there should be no net loss to permanent grassland from the national extent in 2003.[31] As yet this condition has not been required, as census results show no overall loss.
- Water Framework Directive - overarching water quality requirements.

Annex II Impacts of lowland grazing livestock production on environmental sustainability

Table 9 Impacts of lowland grazing livestock production on environmental sustainability

Habitat quality and diversity	• Grazing has a direct effect on habitats though defoliation, trampling and deposition of dung and urine. This can be desirable or undesirable, depending on the objective for the habitat. Historically, areas of lowland SSSI have deteriorated through inappropriate grazing. • Undergrazing is currently an important factor in degradation of semi-natural lowland habitats.[32] • Grazing has been used in many areas as a tool for maintaining or restoring habitats. This requires careful management and monitoring.[33] • Extensive outwintering of livestock can produce large areas of bare ground, which provide useful winter feeding opportunities for overwintering birds.[34] Findings are variable, suggesting that more intensive trampling may have the opposite effect.[35,36] This area is still being researched. Such outwintering may be considered in breach of Cross Compliance regulations relating to damage to sites from supplementary feeding. • Lack of profitability in grazing enterprises has resulted in grassland being ploughed up for arable production. Defra census indications are that this is predominantly rotational (short term) grass leys.[37] Habitats which have been created (directly or indirectly) by and are maintained due to lowland livestock enterprises are: • Culm grasslands • Lowland wet grassland • Calcareous grassland • Lowland wet and dry heath • Lowland acid grassland • Wood pasture • Orchards • Lowland meadows. Lowland priority habitats which are threatened by inappropriate livestock management: • Wood pasture • Lowland meadows • Chalk Downland.

Table continued...

Species abundance and diversity	• The environmental impacts of outwintering livestock are currently being researched through a number of nationally funded projects. Early indications are that light damage to topsoil and vegetation resulting from treading (poaching) by extensively outwintered cattle can benefit some birds and possibly encourage botanical diversity.[38] Key lowland species which have benefited from livestock enterprises are: • Low growing forbs, for example Early Marsh Orchid and Marsh Gentians proliferate where grazing maintains space for recruitment and an open sward in lowland wet heath.[39] • Overwintering birds which can benefit from whole-crop silage stubbles, particularly whole-crop barley, where grass and maize silage fields are of less value.[40] Key lowland species which are threatened from lowland livestock are: • Ground nesting birds which have been adversely affected by grass silage production - earlier (and repeated) cutting dates and fewer seeds in the fed product.[41] • Traditional pasture and meadow plant species - outcompeted by intensive grassland methods.[42]
Water level control	• In some circumstances, it can be advantageous to livestock farmers to maintain a high water table, to ensure good herbage growth throughout the season.[43] • Drainage operations are rarely cost effective on livestock farms, where the main benefit would be to raise stocking rates. To raise the stocking rate from 1.75 cows/ha to 2 cows/ha would improve annual Gross Margin by £150/ha.[44] Cost of draining 1 ha is approximately £2500.[45]
Sediment loads in water	• A study in the River Sem suggests that about 25% of silt comes from agricultural topsoils, with some 18% from road verges and the majority coming from channel banks and subsurface sources.[46] • Where grazing exposes or destabilises soil, it becomes prone to run-off, erosion and transfer of sediments to watercourses. This can be a particular problem where livestock concentrate at foddering sites during the winter.[47] • Hedges and ungrazed field margins can act as buffer zones against run-off.[48] • Maize crops present a high risk in terms of soil run-off due to extensive periods of low ground cover and the need to harvest late in the year, often in sub-optimal weather conditions.[49] • Poor yard drainage from housed livestock can result in high volumes of dirty water run-off.[50]

Table continued...

Nutrient loads in water	• Run-off from areas of compacted or poached soil can add to phosphates and nitrates entering the water.[51] • High application rates of slurry and inorganic N, such as on intensive dairy farms, can result in nitrate leaching.[52] • Since 1984, there has been a 50% reduction in the use of nitrogen fertilisers on grassland in England[53] (20% since 1998).[54] This bears little relation to Environment Agency data on nitrate concentration in rivers, which has stayed relatively stable since 1995[55], suggesting either that nutrient runoff is largely due to organic fertiliser applications, or that the livestock industry is not the main source of nitrate pollution. • Currently, agriculture accounts for approximately 60% of the nitrate in river water.[56] • Between 1990 and 2006, the percentage of rivers of good biological quality in England rose from 60% to 71%. In 2006, 66% of English rivers were of good chemical quality, compared with 43% in 1990.[57] • Traditional hay meadows are low impact on water quality, being managed using very low nutrient inputs.[58]
Pesticide control in water	• Sheep dip is potentially a major pollutant of water. See Sheep Dip Case Study for more information. • There is evidence that manures from livestock treated with ivermectins can have an adverse effect on field springtail and enchytraeid populations[59]. Fears have been expressed that bat populations may be affected by reduced insect populations, but as yet there is little evidence to support this view.
Other pollutants	• Water quality may be affected directly through introduction of bacteria such as *Cryptosporidium* and *Giardia*, generally via the faeces of grazing livestock. This is a particular issue with cattle.[60] • Silage effluent has very high Biological Oxygen Demand (BOD). Milk has a higher BOD than silage effluent.[61] Both are specifically recorded by the Environment Agency in their data on pollution incidents in watercourses.[62] • Recorded pollution incidents from the livestock industry show that the highest percentage stems from slurry stores and tanks. Other major sources are: land run-off, yard washing and silage effluent.[63] • Nationally, between 2001 and 2007, recorded pollution incidents involving silage effluent fell from 79 to 32. Incidents involving slurry fell from 690 to 283.[64]

Table continued...

Greenhouse gases	• Grazing can affect air quality through direct emissions of methane from grazing ruminants and emissions of ammonia and nitrous oxide from dung and urine. Optimal grazing is likely to have a net benefit in terms of C sequestration, but there is considerable variation between systems and soils.[65] • Uncovered slurry stores as well as livestock themselves were the source of nearly 38% of all methane in the UK in 2006 (most recent data).[66] • Grasslands in the UK (both for cutting and for grazing) are the major source of agricultural N_2O emissions. Grassland produces on average almost three times as much N_2O per hectare as arable crops.[67] • N_2O emissions from agriculture in England have decreased by almost 22% since 1990, mainly due to a reduction in fertiliser use.[68]
Air quality: pollutants	• Livestock housing, slurry storage and slurry application are major sources of ammonia from agriculture.[69]
Soil stability (erosion)	• Grazing affects soils through physical compaction or erosion associated with trampling. This is usually associated with exposure and/or destabilisation resulting from removal of vegetation and physical disturbance from hooves or scraping/rubbing.[70] • Growing maize for silage involves extended periods of bare soils and often vehicle access (for harvesting), when soils are wet and prone to rutting and smearing, both of which are a high erosion risk.[71]
Soil function	• Grazing livestock can affect the soil chemically and biologically, through deposition of nutrients (as dung and urine), and through the effect on vegetation, which can change plant litter inputs, soil microbiota and the temperature regime.[72] • Surface compaction and poaching caused by maintaining stock on wet soils, and compaction caused by heavy machinery used in silage operations, especially when ground conditions are wet, can significantly depress yields by reducing microbial activity, nutrient mobility and water infiltration.[73] • Late harvesting of maize can involve adverse weather conditions, which may lead to extensive rutting, smearing and soil compaction.[74] • High levels of inorganic fertiliser use can reduce soil mycorrhizal activity, which depresses competitive ability of some herb species. This can affect overall biodiversity.[75]
Landscape character	• Grazing has affected landscape through our development of landscape scale structures to enable the management of the grazing livestock. This has led to distinctive patterns of field boundaries and agricultural buildings.

[1] Centre for Ecology and Hydrology, *Land Cover Map 2000* (Wallingford, CEH, 2000)

[2] Natural England (2008), *Site of Special Scientific Interest database,* URL: **www.english-nature.gov.uk/special/sssi/**. Accessed January 2009

[3] Defra (2007), *Economics and statistics,* URL: **https://statistics.defra.gov.uk/esg/**. Accessed January 2009

[4] Nix, J,. *Farm management pocketbook* (London, Imperial College, 2007)

[5] Defra (2008), Guidance for Farmers in Nitrate Vulnerable Zones. Leaflet 5. The livestock manure N farm limit. URL: **http://www.defra.gov.uk/environment/water/quality/nitrate/pdf/leaflet5.pdf**. Accessed January 2009

[6] Defra (2006), *Farm Practices Survey 2006: England*, URL: **http://statistics.defra.gov.uk/esg/publications/fps/FPS2006.pdf**. Accessed January 2009

[7] Environment Agency (2008), *Environmental facts and figures*, URL: **www.environment-agency.gov.uk/business/sectors/34331.aspx**. Accessed August 2008

[8] Defra (2007), *Agriculture in the UK 2007*, URL: **https://statistics.defra.gov.uk/esg/**. Accessed January 2009

[9] Garnett, T., *Animal feed, livestock and greenhouse gas emissions: What are the issues?* Paper presented to the Society of Animal Feed Technologists, Coventry, 25 Jan 2007

[10] Defra, *Economics and statistics, op.cit.*

[11] Defra, *Agriculture in the UK 2007, op.cit.*

[12] Nix, *op.cit.*

[13] Defra, *Agriculture in the UK 2007, op.cit.*

[14] PACEC, *A study of the economic, environmental and social impacts of a loss of grazing livestock in the East of England: Phase 2.* Final Report (Cambridge, PACEC 2007)

[15] Angell, B. and Phillips, K., *An analysis of the role of the beef and sheep industries in achieving Defra's strategic objectives*. Report DLB2406 (Defra, 2006)

[16] Defra, *The British Survey of Fertiliser Practice: Fertiliser use on farm crops for crop year 2006* (Defra, 2006)

[17] Defra, *The British Survey of Fertiliser Practice: Fertiliser use on farm crops for crop year 2007* (Defra, 2007)

[18] Chambers, B., Nicholson, N., Smith, K., Pain, B., Cumby, T. and Scotford, I., *Making better use of livestock manures on arable land* (ADAS, 2001)

[19] Christensen, P. (pers. comm.)

[20] Cranfield University, *Scoping study to assess soil compaction affecting upland and lowland grassland in England and Wales*. Final Project Report BD2304 (Defra, 2007)

[21] UK Biodiversity Action Plan (2006), *Targets review information*, URL: **www.ukbap.org.uk/BAPGroupPage.aspx?id=98**. Accessed January 2009

[22] Bardgett, R.D., 'Integrating below ground ecology into sustainable grassland management' in Jarvis, S.C., Murray, P.J. and Roker, J.A. (eds.), *Optimisation of nutrient cycling and soil quality for sustainable grasslands* (Wageningen, 2005), pp. 45-52

[23] Bardgett, R.D., Smith, R.S., Shiel, R.S., Tallowin, J.R.B., Mortimer, S.R., Brown, V.K., Pilgrim, E.S., Millward, D., Lawson, C., Harrison, K.A., Edwards, A.E., Hobbs, P.J., Sanderson, R., Harris, S.J., Beaumont, D.A., Murray, A.M. and Quirk H., 'Diversification of grassland through manipulation of plant-soil interactions: The DIGFOR experiment' in Hopkins, J.J., Duncan, A.J., McCracken, D.I., Peel, S. and Tallowin, J.R.B. (eds.), *High Value Grassland: Providing biodiversity, a clean environment and premium products,* BGS Occasional Symposium No. 38 (2007)

[24] Vleeshouwers, L.M. and Verhagen, A., 'Carbon emission and sequestration by agricultural land use: a model study for Europe', *Global Change Biology,* 8 (2002), 519-30

[25] Freibauer, A., Rounsevell, M.D.A., Smith, P. and Verhagen, J., 'Carbon sequestration in the agricultural soils of Europe', *Geoderma,* 122 (2004), 1-23

[26] Defra (2008), *ECSFDI: The first phase: A compendium of advice activity examples,* URL: **www.defra.gov.uk/FARM/environment/water/csf/pdf/ecsfdi-compendium.pdf**. Accessed January 2009

[27] Defra, *Rural development programme for England 2007-2013* (Defra, 2007)

[28] Defra (2007), *The Agricultural Change and Environment Observatory Programme,* URL: **http://statistics.defra.gov.uk/esg/ace/da3_data.htm**. Accessed January 2009

[29] Fuller, R., 'Relationships between recent changes in lowland British agriculture and farmland bird populations: An overview' in Aebisher, N., Evans, A., Grice, P. and Vickery, J. (eds), *Ecology and conservation of lowland farmland birds* (British Ornithologists Union, 2000), pp. 5-16

[30] Blackstock, T.H., Rimes, C.A., Stevens, D.P., Jefferson, R.G., Robertson, H.J., Mackintosh, J., and Hopkins, J.J., 'The extent of semi-natural grassland communities in lowland England and Wales: A review of conservation surveys 1978-96', *Grass and Forage Science,* 54 (1999), 1-18

[31] Defra (2008), *The guide to cross compliance in England*, PB12904, URL: **www.rpa.gov.uk/**. Accessed January 2009

[32] Williams, J.M. (ed.), *Common standards monitoring for designated sites*. First Six-Year Report (Peterborough, JNCC, 2006)

[33] Bakker, J.P., *Nature management by grazing and cutting* (Dordrecht, Kluwer, 1989)

[34] Buckingham, D. (pers. comm.)

[35] Buckingham, D.L., Peach, W.J. and Fox, D.S., 'Effects of agricultural management on the use of lowland grassland in the UK by foraging birds', *Agriculture, Ecosystems and Environment*, 112 (2006), 21-40

[36] Perkins, A.J., Whittingham, M.J., Bradbury, R.B., Wilson, J.D., Morris, A.J. and Barnett, P.R., 'Habitat characteristics affecting use of lowland agricultural grassland by birds in winter'. *Biological Conservation*, 95 (2000), 279-94

[37] Defra (2005), *June Agricultural Survey* (1990-2005), URL: **https://statistics.defra.gov.uk/esg/**. Accessed January 2009

[38] Buckingham, *op.cit.*

[39] Marrable, C.J., *Ashdown Forest: A review of grazing*. R 535 (Peterborough, 2003)

[40] Peach, W.J., Dodd, S., Westbury, D.B., Mortimer, S.R., Harris, S.J., Brook, A.J., Lewis, P., Buckingham, D.L. and Chaney, K., 'Cereal-based wholecrop silage: A potential conservation measure for farmland birds in pastoral landscapes' in Hopkins, J.J., Duncan, A.J., McCracken, D.I., Peel, S. and Tallowin, J.R.B. (eds.), *High Value Grassland: Providing biodiversity, a clean environment and premium products*. BGS Occasional Symposium No. 38 (2007)

[41] ADAS, *The environmental impact of livestock production*. Report for FFG. (Defra, 2007)

[42] Crofts, A. and Jefferson, R.G., *The lowland grassland management handbook.* (English Nature/The Wildlife Trusts, Peterborough, 1999)

[43] Gowing, D.J. and Mountford, J.O., 'Water management in wet grasslands' in Hopkins, J.J., Duncan, A.J., McCracken, D.I., Peel, S. and Tallowing, J.R.B. (eds.) *High Value Grassland: providing biodiversity, a clean environment and premium products.* BGS Occasional Symposium No. 38 (2007)

[44] Nix, *op.cit.*

[45] Nix, *op.cit.*

[46] Defra (2008), *ECSFDI, op.cit.*

[47] ADAS, *The environmental impact of livestock production*, *op.cit.*

[48] Walker, K.J., Critchley, C.N.R., Sherwood, A.J., Large, R., Nuttall, P., Hulmes, S., Rose, R., Moy. I., Towers, J., Hadden, R., Larbalestier, J., Smith, A., Mountford, J.O. and Fowbert, J.A., *Effectiveness of new agri-environment schemes in conserving arable plants in intensively farmed landscapes: Defra cereal field margin evaluation. Phase 3: Evaluation of agri-environment cultivated options in England*. Project MA 01017 (Defra, 2006)

[49] IGER, *Soil erosion control in maize*. Final Project Report SP0404 (Defra, 2001)

[50] Environment Agency, *Improving environmental performance: environmental plan for dairy farming*, URL: **http://publications.environment-agency.gov.uk/pdf/GEHO0906BLDH-e-e.pdf**. Accessed January 2009

[51] ADAS, *op.cit.*

[52] ADAS, *op.cit*.

[53] Defra (2008), *Economics and statistics. Observatory monitoring framework: Indicator data sheet. Indicator C4: Fertiliser use*, URL: **https://statistics.defra.gov.uk/esg/ace/c4_data.htm**. Accessed January 2009

[54] Defra, *The British Survey of Fertiliser Practice* (2006), *op.cit.*

[55] Defra, *Economics and statistics. Observatory, op.cit.*

[56] ADAS (2007), *Nitrates in water: The current status in England (2006)*, ADAS report to Defra, URL: **www.defra.gov.uk/environment/water/quality/nitrate/pdf/consultation-supportdocs/d1-nitrateswater.pdf**. Accessed January 2009

[57] Environment Agency, *Environmental facts and figures* (2008), *op.cit*

[58] Crofts, *op.cit.*

[59] Jensen, J., Krogh, P.H., Sverdrup, L.E., 'Effects of the antibacterial agents tiamulin, olanquindox and metronidazole and the anthelmintic ivermectin on the soil invertebrate species *Folsomia fimetaria* (Collembola) and *Enchytraeus crypticus* (Enchytraeidae)'. *Chemosphere,* 50:3 (2003), 437-43

[60] Keeley, A. and Faulkner, B.R., Influence of land use and watershed characteristics on protozoa contamination in a potential drinking water resources reservoir. *Water Research* 42:10-11 (2008), 2803-13

[61] University of Reading ECIFM, *Biological oxygen demand,* URL: **www.ecifm.rdg.ac.uk/bod.htm**. Accessed January 2009

[62] Environment Agency, *Environmental facts and figures* (2008), *op.cit.*

[63] Environment Agency, *Environmental facts and figures* (2008), *op.cit.*

[64] Environment Agency, *Environmental facts and figures* (2008), *op.cit.*

[65] Smith, P., Martino, D., Cai, Z., Gwary, D., Janzen, H., Kumar, P., McCarl, B., Ogle, S., O'Mara, F., Rice, C., Scholes, B. and Sirotenko, O., 'Agriculture' in *Climate change 2007: Mitigation*. Working Group III contribution to the Fourth Assessment Report of the IPCC. (Cambridge, Cambridge University Press, 2007)

[66] AEA Energy and Environment (2006), *UK emissions of carbon dioxide, methane and nitrous oxide by national communication source category,* URL: **www.defra.gov.uk/environment/statistics/globatmos/download/xls/gafg08.xls**. Accessed January 2009

[67] Brown, L. and Jarvis, S., *Estimation of nitrous oxide emissions from UK agriculture* (IGER Innovations, 2001)

[68] National Atmospheric Emissions Inventory (2008). Greenhouse Gas Emissions Reports. URL: **www.naei.org.uk/reports.php?list=GHG**. Accessed January 2009

[69] Misselbrook, T., *Underpinning evidence for development of policies to abate ammonia emissions*. Project AQ06022007 (Defra, 2007)

[70] Palmer, R.C., *Soil structural conditions in the Camel catchment (including the De Lank and Allen tributary catchments) during February 2005* (Cranfield, NSRI, 2005)

[71] IGER, *op.cit.*

[72] ADAS, *op.cit.*

[73] Cranfield, *op.cit.*

[74] IGER, *op.cit.*

[75] Bardgett, *op.cit.*

Case study: Maize production

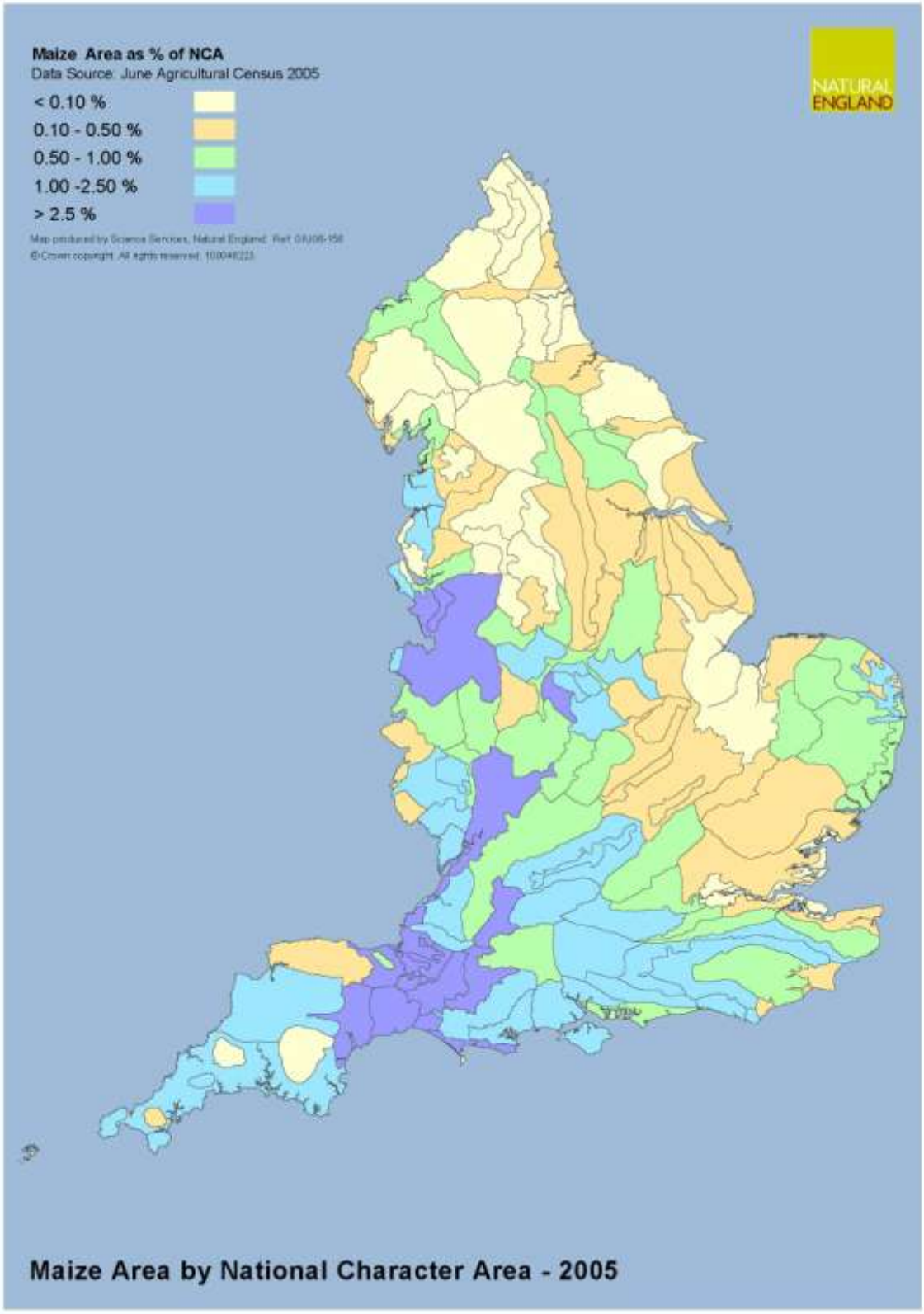

Figure 6 Maize 2005

Over the last 20 years the use of maize for wholecrop silage has become more widespread, due to its comparatively high yields and potential for high intake by livestock.

The area of maize grown for silage in England has increased from approximately 21,000 ha in 1980 to approximately 118,500 ha in 2005.[1] The total reported land area used for arable silage in 2003 was 38,000 ha.[2] Since 1980 the area of permanent grassland (grass leys over 5 years old) in England has stayed relatively constant (3.1 million ha), whilst short-term leys have decreased, suggesting that in the last 25 years, silage from maize and arable crops has mostly impacted on rotational, rather than permanent grassland.[3]

The map above shows the distribution of maize production in England. A warmer climate could result in further spread northwards.

Maize production has the potential to present some serious environmental problems: biodiversity is affected due to cultivations at establishment, and the use of residual sprays to avoid weed competition. The crop has a high nutrient demand, often addressed by heavy applications of slurry and farmyard manures, as well as inorganic fertilisers. Soils are exposed to erosion for an extended period during the crop's development, and harvesting (in late September or October) presents a high risk of soil structural damage from smearing and compaction in wet conditions.[4] Because of the relatively late harvesting, most cropped maize fields are left uncultivated until the spring. If there is no undersown crop, the soil is likely to be exposed to further erosion risk.

A number of mitigating strategies have been developed to reduce some of the negative effects of the crop. Key among these is control of soil erosion and runoff. A number of techniques can be used to achieve this, two of which have particular potential to reduce biodiversity losses: a buffer strip around the crop can not only reduce soil and nutrient runoff, it can be a useful source of seeds and invertebrates throughout and beyond the growing period. Undersown crops, or late-sown cover crops can provide similar benefits, and provide better soil stability and retention of nutrients after harvest.

Maize is considered to be a 'lazy rooter', often developing a shallow root system, particularly where there are ready supplies of surface nutrients. Attention to potential soil compaction before sowing not only reduces erosion and run-off risk, it allows the maize crop to develop a strong root system which is better able to utilise existing soil nutrients, thereby reducing the requirements for heavy additional applications.

Use of such simple strategies can reduce costs to farmers and improve environmental performance. These measures are amongst those being advocated and adopted under the England Catchment Sensitive Farming Initiative.[5]

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[1] Defra, *Economics and statistics,* (June 2007), URL: **https://statistics.defra.gov.uk/esg/**. Accessed January 2009

[2] Wilkinson, J.M. and Toivonen, M.I., *World silage: a survey of forage conservation round the world* (London, Chalcombe Publications, 2003)

[3] Defra, *Economics and statistics, op.cit.*

[4] IGER, *Soil erosion control in maize*. Final Project Report SP0404 (Defra, 2001)

[5] Defra (2008), *ECSFDI: The first phase. A compendium of advice activity examples,* URL: **www.defra.gov.uk/FARM/environment/water/csf/pdf/ecsfdi-compendium.pdf**. Accessed January 2009