The Natural Capital of Hedges: Briefing note

Appropriately managed hedgerows and their associated trees, banks, ditches and margins provide a wide range of valuable services which benefit people as well as wildlife. They include regulating services such as pest control and flood control, cultural services such as landscape aesthetics and historical heritage, and provisioning services such as firewood and food, as well as biodiversity.

This briefing summarises the ecosystem services, or public goods, delivered by hedges. Important facts are given, and where possible services quantified. The key evidence base is also presented.

The services are divided up into four categories:

1. Biodiversity
2. Those that benefit farm businesses directly
3. Those that are mainly of benefit to wider society
4. Those that benefit farmers and society equally. Tangible products, like firewood, are included in this last category.

A review of the services provided by Environmental Stewardship in England revealed that hedgerow options provide a greater number of services, 21 in all, that any other group of options. For comparison, other high ranking option groups include woodland and moorland ones (19 services each), and species-rich grassland (16 services) (Land Use Consultants 2009).

Much of the information below has been extracted from Wolton, R.J., Pollard, K.A., Goodwin, A. & Norton, L. 2014. *Regulatory services delivered by hedges: the evidence base*. Report of Defra project LM0106. 99pp.

The services delivered by hedges, and their value, depend heavily on their structure (e.g. whether they are continuous or not, or whether they have emergent trees or margins) and on how well they are managed.

N.B. This note currently only addresses rural hedges. It does not cover urban hedges (where the role hedges have in improving air quality is of particular importance).

Robert Wolton
robertwolton@devonhedges.com
8 May 2018

Ecosystem service or Public good	Key facts	Key evidence base
Biodiversity	• Priority habitat (S41, NERC Act). • Important for conservation of numerous rare and/or threatened species. • Hedges are vital for much farmland wildlife. • Value for nature is much higher that the proportion of land they occupy. • Important both as habitat in their own right and for landscape connectivity. • Hedgerow trees comprise the majority of trees outside woodlands and are of high biodiversity value (e.g. for hairstreak butterflies, hole-nesting birds, and feeding and breeding bats).	Important habitat for 107 S41 species and Biodiversity2020 Farmland Indicators (Wolton *et al.* 2013). 2,070 species identified from a single hedge, all big enough to see with naked eye. True total likely to be close to 3,000 (Wolton 2015). Mature hedgerow habitats had the highest number of plant species in a Somerset farm network, despite covering <3% of the land area. Moreover these habitats also tended to have highest numbers of species regarded as bio indicators (e.g. butterflies and rodents) and ecosystem services providers (pollinating insects and hymenopteran parasitoid wasps; a natural form of pest control) (Evans *et al*. 2013). Good evidence for importance of hedges and hedgerow trees in facilitating movement through the landscape for birds (Bellamy & Hinsley 2005, Broughton & Hinsley 2015), bats (Boughey *et al.* 2011), dormice (Bright 1998), moths (Slade *et al.* 2013) and bumblebees (Cranmer *et al.* 2011). Over half (60%) of the S41 species associated with hedgerows are dependent on, or partially dependent on, hedgerow trees (Wolton *et a*l. 2013). The presence of hedgerow trees in areas targeted by agri-environment schemes increased the numbers of larger moth present by 60% and the diversity of such moths by 38% (Merckx *et al*. 2009).
BENEFITS TO FARM BUSINESS		
Soil conservation	• Hedges along contours or beside water courses capture sediment and prevent loss to the sea. • The effect of this can often be	Hedges act as physical barriers to reduce the movement and distribution of soil particles carried down slope by water run-off or mechanical erosion (Follain *et al.* 2009, Mutegi *et al.* 2008).

	observed as terrace formation	Simulation in Brittany suggests that after 1,200 years soil thickness across the landscape would increase by 62% if hedges present but decrease by 74% if absent (Follain *et al.* 2006).
Pest and disease control	• Hedges reduce pest levels in crops, and pesticide use, by increasing numbers of predators and parasitoids. • Hedges reduce the risk of bovine TB in cattle.	In California new hedge paid for itself in terms of insecticide savings in 16 years (7 years if benefits of pollinators included) (Morandin *et al*. 2016). Crop pests levels reduced over distances of at least 60m (Thomas 1990). An increase of 1km of hedges per 100 ha decreases risk of bTB herd breakdown by 12.5% - equivalent to 251 fewer infected herds in the West Country each year (2004 figures) (Mathews *et al*. 2006).
Crop pollination	• Hedges and other uncropped areas important in farmland for healthy and diverse populations of pollinators. • Hedges attract pollinators into intensive farmland and export those pollinators into crops, increasing yield. • Hedges can influence crop pollination 750+m away (based largely on bumblebees).	There is much evidence that in areas of intensive farming hedges, together with other patches of non-cropped land such as headlands, are important to the survival of many pollinators (Nicholls & Altieri 2013). Indeed, appropriate management of non-cropped areas to encourage wild pollinators is considered likely to be a cost effective means of maximising crop yield. Hedges, with their shrubs and trees, basal and marginal herbaceous flora, can provide essential resources for pollinators that are otherwise lacking in the landscape (Hannon & Sick 2009).
Shelter and shade: crops	• By reducing wind speed, hedges reduce water stress, physical damage (e.g. crop lodging), soil loss, daytime temperatures and salt spray. • So hedges managed as windbreaks or shelterbelts can improve crop yields, especially for vegetables, fruit and broad-leaved crops (potatoes, sugar beet, beans). • Yield increases range from a few	A considerable body of evidence exists both confirming and quantifying the benefits of shelter provided by hedges, to both livestock and crops (Baldwin 1988, Biber 1988, Bird 1998, Forman & Baudry 1984, Kort 1988, Van Laer *et al.* 2014).

	% to 25% for cereals, perhaps as high as 75% for vegetables. • Reduce wind speed significantly over a distance 12 x their height downwind, and 4 x upwind. (6.25m high hedges will provide shelter over 100m).	
Shelter and shade: livestock	• Hedges provide protection from sun, high winds, driving rain and drifting snow (and sand). • Valuable to lambs in bad spring weather. • Access to summer shade of particular importance to cattle. • Hedges reduce mortality and heat stress, and increase growth rates, milk yield, disease resistance and fertility.	See above.
Stock Control	• Hedges traditionally valued as livestock fences. • Now this function often delivered by wire fencing. • But hedges still provide shelter and a source of nutrients.	
Field sports	• Hedges provide cover and breeding sites for quarry species like pheasants and partridges. • Facilitate rough shooting.	
BENEFITS TO SOCIETY		
Carbon storage and capture	• Hedges store more carbon than cropped land. • Hedges and tree lines are able to sequester large amounts of carbon both in above-ground biomass and in soil organic carbon (SOC) as organic matter. • Can be used as a source of renewable (green) energy	Trimmed hedges can accumulate at least 0.9t/ha/yr. Data for triennial incremental trimming averaged over 7 years – at the 7 year mark the figure rose to 1.4t/ha/yr (Axe *et al*. 2012, 2017). Models suggest tree lines will accumulate c. 3t/ha/yr (Robertson *et al.* 2012).

	(biomass) – see below.	N.B. Accumulation only continues until plants mature, and carbon is released when hedges are trimmed, laid or coppiced. Below ground, modelling suggests both shrubby hedges and tree lines accumulate c. 0.5t/ha/yr. This may continue for more than 700 years (Falloon *et al*. 2004, Robertson *et al.* 2012). In Brittany, estimated that 13% of carbon in landscape in hedges (farmland with 50m hedge/ha - typical of lowland Britain) (Follain *et al.* 2007)
Cleaner water	• Appropriately sited mature hedges can remove nearly all N and P from run-off, and up to 90% of herbicides. • Increase effectiveness of grass buffer strips.	Caubel *et al.* (2001) compared concentrations of nitrate in soils between two sites, one with and the other without a hedge. They showed that nitrate concentrations were strongly affected by the presence of the hedge, up to distances of 10 m from the hedge. Nitrate in groundwater was three times lower with the hedge, with removal rates around 90% compared to 53% for the site without hedge. Borin *et al.* (2010) in Italy found that even a newly established 4 m wide buffer strip containing a line of trees and a grass strip reduced total run-off by 33%, losses of nitrogen (N) by 44% and phosphorus (P) by 50% compared to sites without buffer strips. A mature buffer strip was able to abate both nitrates (NO3–N) and dissolved P concentrations by almost 100%. In most cases it also proved a useful barrier for herbicides, with concentrations abated by 60% and 90%, depending on the chemical and the time elapsed since application.
Flood risk reduction	• Contouring or marginal hedges can reduce volumes and rates of water in streams, etc, following storms. • At landscape scale, a banked hedge network in Brittany reduced peak and total flow	Following a typical storm, run-off volume and peak flow were 1.5 to 2 times lower in streams draining a hedged landscape in Brittany, than in the catchment where there were no hedges (Merot 1999). At Pontbren (Wales), strips of native

	within streams by 25-50%. • Particularly effective where soils compacted or prone to rapid water runoff.	trees (mainly birch and alder but with some blackthorn, oak and ash) increased water infiltration compared to adjacent sheep grazed upland pasture by 60 times, when the trees are only six or seven years old (Carroll *et al.* 2004).
BENEFITS TO BOTH FARMERS AND SOCIETY		
Landscape attractiveness	• Hedges define and characterise most lowland farmed landscapes. • They are a selling point for farm produce. • They screen unsightly buildings or development (e.g. solar farms) • They increase the sale value of farms.	Aesthetically, hedgerows provide pattern, local grain and texture in the landscape (Countryside Agency 2000).
Cultural and historic heritage	• Often ancient. • Reveal landscape history. • May have a strong place in local folklore. • Traditional hedge laying styles.	Two thirds of England has had a continuously hedged landscape for six hundred years or more. Some hedgerow systems date back to prehistoric times, and most were well established by 1400 AD. It is only in the Midlands and part of the North-East that the majority of hedgerows were planted under the Enclosure Acts between 1750 and 1850 (Rackham 1994). Consequently, many hedgerows are as old as, if not older than, historic buildings like parish churches that society values highly. Farmers, experts and members of the public consider that hedges are a key component of the English landscape, are part of our cultural heritage, and contribute to sense of place and national identity (Oreszczyn and Lane 2000).
Recreation	• Increase visitor enjoyment of the countryside. • Make farms more attractive as B&Bs, for glamping, etc. • Increase opportunities for	

	diversification.	
Health and wellbeing	• Nature is an effective stress reducer. • Hedges provide healthy opportunities for physical activity and community engagement. • Regeneration of hedges can go hand in hand in regeneration of communities.	There is a lack of studies of health benefits specifically from hedges in a rural location, but there are studies of the health benefits of green corridors in the urban environment. Regular users of a canal towpath corridor in Berlin had significantly lower cortisol levels, combined with higher life satisfaction, than less frequent users (Honold *et al.* 2016). The presence of walkable green spaces in Japanese urban areas increased the longevity of senior citizens, independent of their socio-economic status (Takano *et al.* 2002). Pretty *et al.* (2007) have shown psychological benefits to health from recreational exercise in UK green spaces.

Source of renewable fuel	• Managing hedges for woodfuel gives:
	  • Cheap heat
	  • Green energy
	  • Healthier hedges
		Hedges can be managed to produce a woodfuel crop (chips or logs) cheaply and efficiently (Chambers *et al.* 2015, Wolton *et al.* 2016).

Other products	• Hedgerow fruits • Walking sticks, bows, etc, • Biochar • Compost	Evidence base from the importance or value of these, either economically or for hobbies, is as yet lacking.

References

AXE, M. S., GRANGE, I. D., BAINES, R.N. & CONWAY, J. S. 2012. Annual production and destination of shoots from a flailed hedge. In Dover, J. (Ed.) *Hedgerow Futures: Proceedings of the first International Hedgelink conference, Staffordshire University, Stoke-on-Trent, UK.* Tree Council, 147-156.

AXE, M. S., GRANGE, I. D. & CONWAY, J. S. 2017. Carbon storage in hedge biomass - A case study of actively managed hedges in England. *Agriculture, Ecosystems & Environment*, 250, 81-88.

BALDWIN, C. S. 1988. 10. The influence of field windbreaks on vegetable and specialty crops. *Agriculture, Ecosystems & Environment,* 22–23**,** 191-203.

BELLAMY, P. E. & HINSLEY, S. A. 2005. The role of hedgerows in linking woodland birds populations. Pp. 99−106 in: Planning, people and practice: the landscape ecology of sustainable landscapes. *Proceedings of the 13th Annual IALE(UK) Conference*.

BIBER, J-P. 1988. *Hedges*. Council of Europe. Planning and Management Series No.1. Strasbourg. 54pp.

BIRD, P. R. 1998. Tree windbreaks and shelter benefits to pasture in temperate grazing systems. *Agroforestry Systems*, 41, 35-54.

BORIN, M., PASSONI, M., THIENE, M. & TEMPESTA, T. 2010. Multiple functions of buffer strips in farming areas. *European Journal of Agronomy,* 32**,** 103-111.

BOUGHEY , K.L., LAKE, I.R., HAYSOM, K.A. & DOLMAN, P.M. 2011. Improving the biodiversity benefits of hedgerows: How physical characteristics and the proximity of foraging habitat affect the use of linear features by bats. *Biological Conservation*, 144: 1790–1798.

BRIGHT, P. W. 1998. Behaviour of specialist species in habitat corridors: Arboreal dormice avoid corridor gaps. *Animal Behaviour* 56: 1485−1490.

BROUGHTON, R.K. & HINSLEY, S.A. 2015. The ecology and conservation of the marsh tit in Britain. *British Birds* 108, 12-29.

CARROLL, Z. L., BIRD, S. B., EMMETT, B. A., REYNOLDS, B. & SINCLAIR, F. L. 2004. Can tree shelterbelts on agricultural land reduce flood risk? *Soil Use and Management,* 20**,** 357-359.

CAUBEL-FORGET, V., GRIMALDI, C. & ROUAULT, F. 2001. Contrasted dynamics of nitrate and chloride in groundwater submitted to the influence of a hedge. *Comptes Rendus de l'Académie des Sciences - Series IIA - Earth and Planetary Science,* 332**,** 107-113.

CHAMBERS, M., CROSSLAND, M, WESTAWAY, S & SMITH, J. 2015. *A guide to Harvesting woodfuel from hedges.* Organic Research Centre.

CRANMER, L., MCCOLLIN, D., & OLLERTON, J. 2011. Landscape structure influences pollinator movements and directly affects plant reproductive success. *Oikos* 121: 562−568.

COUNTRYSIDE AGENCY. 2000. *Hedgerows of England*.

EVANS, D. M., POCOCK, M. J. O., BROOKS, J. & MEMMOTT, J. 2013. The robustness of a network of ecological networks to habitat loss. *Ecology Letters* 16: 844−852.

FALLOON, P., POWLSON, D. & SMITH, P. 2004. Managing field margins for biodiversity and carbon sequestration: a Great Britain case study. *Soil Use and Management,* 20**,** 240-247.

FOLLAIN, S., MINASNY, B., MCBRATNEY, A. B. & WALTER, C. 2006. Simulation of soil thickness evolution in a complex agricultural landscape at fine spatial and temporal scales. *Geoderma,* 133**,** 71-86.

FOLLAIN, S., WALTER, C., BONTÉ, P., MARGUERIE, D. & LEFEVRE, I. 2009. A-horizon dynamics in a historical hedged landscape. *Geoderma,* 150**,** 334-343.

FOLLAIN, S., WALTER, C., LEGOUT, A., LEMERCIER, B. & DUTIN, G. 2007. Induced effects of hedgerow networks on soil organic carbon storage within an agricultural landscape. *Geoderma,* 142**,** 80-95.

FORMAN, R. T. & BAUDRY, J. 1984. Hedgerows and hedgerow networks in landscape ecology. *Environmental Management,* 8**,** 495-510.

HANNON, L. E. & SISK, T. D. 2009. Hedgerows in an agri-natural landscape: Potential habitat value for native bees. *Biological Conservation,* 142**,** 2140-2154.

HONOLD, J., LAKES, T., BEYER, R. & VAN DER MEER, E. 2016. Restoration in Urban Spaces Nature Views From Home, Greenways, and Public Parks. *Environment and Behavior*, 48(6), 796-825.

KORT, J. 1988. 9. Benefits of windbreaks to field and forage crops. *Agriculture, Ecosystems & Environment,* 22–23**,** 165-190.

LAND USE CONSULTANTS 2009. *Provision of environmental services through the Environmental Stewardship scheme*. Final report to Defra (research contract NR0121). By Land Use Consultants in association with GHK Consulting Ltd. http://randd.defra.gov.uk/Document.aspx?Document=NR0121_8197_FRA.pdf

F. MATHEWS, F., L. LOVETT, L., RUSHTON, S. and MACDONALD, D. W. 2006. Bovine tuberculosis in cattle: reduced risk on wildlife-friendly farms. *Biology Lett*ers 2, 271–274.

MERCKX, T., FEBER, R., RIORDAN, P., TOWNSHEND, M., BOURN, N., PARSONS, M. & MACDONALD, D. 2009. Optimising the biodiversity gain from agri-environment schemes. *Agriculture, Ecosystems and the Environment* 130, 177-182.

MEROT, P. 1999. The influence of hedgerow systems on the hydrology of agricultural catchments in a temperate climate. *Agronomie,* 19**,** 655-669.

MORANDIN, L.A., LONG, R.F. & KREMEN, C. 2016. Pest Control and Pollination Cost–Benefit Analysis of Hedgerow Restoration in a Simplified Agricultural Landscape. *J. Economic Entomology* 109, 1020-1027.

MUTEGI , J ., MUGENDI , D., VERCHOT, L. & KUNG 'U, J. 2008. Combining napier grass with leguminous shrubs in contour hedgerows controls soil erosion without competing with crops. *Agroforestry Systems,* 74**,** 37-49.

NICHOLLS, C. & ALTIERI, M. 2013. Plant biodiversity enhances bees and other insect pollinators in agroecosystems. A review. *Agronomy for Sustainable Development,* 33**,** 257-274.

ORESZCZYN, S. & LANE, A. 2000. The meaning of hedgerows in the English landscape: different stakeholder perspectives and the implications for future hedge management. *Journal of Environmental Management*, 60(1), 101-118.

PRETTY, J., PEACOCK, J., HINE, R., SELLENS, M., SOUTH, N. & GRIFFIN, M. 2007. Green exercise in the UK countryside: effects on health and psychological well-being, and implications for policy and planning. *Journal of Environmental Planning and Management*, 50(2), 211-231.

RACKHAM, O. 1994. *The illustrated history of the Countryside*. George Weidenfeld and Nicholson Ltd.

ROBERTSON, H., MARSHALL, D., SLINGSBY, E. & NEWMAN, G. 2012. *Economic, biodiversity, resource protection and social values of orchards: a study of six orchards by the Herefordshire Orchards Community Evaluation Project*. Natural England Commissioned Report, Number 90.

SLADE, E. M., MERCKX, T., RIUTTA, T., BEBBER, D. P., REDHEAD, D., RIORDAN, P. & MACDONALD, D. W. 2013. Life-history traits and landscape characteristics predict macro-moth responses to forest fragmentation. *Ecology* 94: 1519−1530.

TAKANO, T., NAKAMURA, K. & WATANABE, M. 2002. Urban residential environments and senior citizens' longevity in megacity areas: the importance of walkable green spaces. *Journal of Epidemiology & Community Health,* 56(12), 913-918.

THOMAS, M.B. 1990. The role of man-made grassy habitats in enhancing carabid populations in arable land. In: *The Role of Ground Beetles in Ecological and Environmental Studies*. Ed. Stork, N.E. Intercept Ltd, Andover, pp. 77-85.

VAN LAER, E., MOONS, C. P. H., SONCK, B. & TUYTTENS, F. A. M. 2014. Importance of outdoor shelter for cattle in temperate climates. *Livestock Science,* 159**,** 87-101.

WOLTON, R, WESTAWAY, S., CHAMBERS, M. CROSSLAND, M. & SMITH, J. 2016. Harvesting fuel from Hedges. *Conservation Land Management* 14, 4-8.

WOLTON, R.J. 2015. Life in a hedge. *British Wildlife* 26, 306 – 316.

WOLTON, R.J., MORRIS, R.K.A., POLLARD, K. & DOVER J.W. 2013. Understanding the combined biodiversity benefits of the component features of hedges. Report of Defra project BD5214.