The changing habitats of Buckinghamshire and Milton Keynes: A historic perspective over 90 years

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March 2024

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Introduction

Land-use and habitats in the UK have changed drastically since the Second World War. During this time period the countryside underwent a period of major intensification and industrialisation, with a rapid rise in the use of artificial fertilizers, pesticides, and machinery, as well as increases in field sizes, drainage of wetlands, reduction in rotations, simplification and homogenization of farm types, and altered cropping patterns from spring sown to autumn sown crops. At the same time there has been a rapid expansion of urban areas and an increase in plantation forestry. These factors taken together have led to the loss of many of the semi-natural habitats of lowland UK, and the fragmentation of remaining patches, resulting in major declines in biodiversity. It has also resulted in changes to the ecosystem services delivered by the land, with a primary focus on agricultural and timber production, but a decline in other ecosystem services.

Here, the land-use and habitats of Buckinghamshire and Milton Keynes have been mapped using data from the 1930s and compared to 1990 and the current situation (2023). The primary aims have been to establish how land-use has changed, and the magnitude of change across different habitats and in different parts of Buckinghamshire and Milton Keynes.

Approach

Although historic maps are available dating back several centuries and with newer editions appearing at regular intervals in more recent times, these do not provide any information on habitats, apart from identifying woodlands. Indeed, only one source of habitat information is available prior to 1990 and that is The Land Utilisation Survey of Great Britain, 1933-49. These resulting maps are known as the "Dudley Stamp Maps" after the organiser and instigator of the survey. A scanned and digitised version of the survey was obtained, to represent habitats from the 1930s.

It was not until 1990 that regular habitat mapping became available, through the use of satellite derived data. To map habitats from this time period, Land Cover Map (LCM) 1990 from UKCEH was used[1]. This is based on satellite images from 1989 and 1990 which are classified into 21 habitat-based classes.

To create a map of present day (2023) habitats, a natural capital basemap was created as part of the main Local Nature Recovery Strategy (LNRS) work for Buckinghamshire and Milton Keynes. This was based on the OS Mastermap Topography GIS layer (the most detailed mapping available across GB), but then used a series of additional data sets to classify each polygon within OS Mastermap to an appropriate habitat type.

The digital version of the Land Utilisation Survey classifies habitats into eight different categories, whereas the UKCEH landcover Map 1990 used 21, and the modern basemap uses a large number of different habitat types. A key challenge when comparing maps from very different sources is the difficulty of matching land cover types between the different surveys. The original definitions of the Dudley Stamp categories were used and compared to the habitat types produced in the modern basemap, and matched as closely as possible, and this process

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[1] Rowland, C. S., Marston, C. G., Morton, R. D., & O'Neil, A. W. (2020). Land Cover Map 1990 (vector, GB) [Data set]. NERC EDS Environmental Information Data Centre. https://doi.org/10.5285/304A7A40-1388-49F5-B3AC-709129406399

was repeated for UKCEH Landcover Map 1990. Nine final categories were chosen, and Table 1 describes how the habitats from all three time-periods fit into these categories.

Table 1: *Final habitat categories chosen, and the corresponding categories from the Dudley Stamp maps (1930s), UKCEH LCM 1990 and the natural capital basemap (2023).*

Final categories	Dudley Stamp categories	UK CEH Landcover Map 1990 categories	Basemap habitats 2023
Woodland	Forest and woodland	Broadleaved woodland Coniferous woodland	Broadleaved woodland Coniferous woodland Mixed woodland Scrub Parkland
Arable	Arable land	Arable and horticulture	Cultivated / disturbed land (excluding allotments)
Semi-natural grassland	Meadowland and permanent grass	Acid grassland Calcareous grassland Neutral grassland	Semi-natural grassland (includes neutral, acid, calcareous and rough grasslands), Floodplain grazing marsh
Improved grassland	-	Improved grassland	Improved grassland (excluding floodplain grazing marsh), Amenity grassland > 1 ha
Heath and marsh	Heaths and moorlands	Fen marsh and swamp Heather Heather grassland	Marshy grassland, Heathland, Mire Swamp
Built-up areas and gardens	Land agriculturally unproductive (includes buildings, roads, industry) Gardens (includes allotments)	Suburban Urban	Built-up areas Infrastructure Gardens & brownfield Allotments Amenity grassland < 1 ha Railway and road verges
Orchards	Orchards		Orchards
Water	Water	Freshwater	Water
Other / unclassified	-	Inland rock	Other Rock, quarry and waste Uncertain Unclassified (currently under development)

All "meadowland and permanent grass" identified in the Dudley Stamp map was classified as "semi-natural grassland" and no areas were classified in the "improved grassland" category. This is based on the assumption that no agricultural grasslands were improved at that time as they were not receiving inorganic fertilizers. This has been shown to be true in areas with detailed botanical data from the 1930s.

Urban areas presented a particular difficulty as these areas were not mapped in any detail in the Dudley Stamp survey. In the Dudley Stamp maps, dense urban areas were classified as "land agriculturally unproductive", with suburban areas classified as "gardens", and only large greenspaces within urban areas were marked separately. As there was no obvious way to match this with the categories on the modern map, a new category was created of "built-up areas and gardens" containing both the Dudley Stamp categories. For the present-day map, all urban and garden categories were combined, along with amenity grassland (e.g. road verges) that were less than 1 ha in size. Note that ditches between fields were not recorded on the Dudley Stamp maps and the width of larger rivers and drainage channels was not recorded accurately, hence any change in the amount of water between the time periods should be interpreted with caution.

LCM 1990 has more categories than Dudley Stamp, and these generally fit well into the categories created for this analysis. However, the LCM 1990 documentation[2] notes that the map is not particularly accurate at distinguishing between improved grassland and semi-natural grassland types (neutral, acid or calcareous grasslands), and also that the fen, marsh and swamp category will be underestimated due to the small size and mosaic nature of many of these patches. The 1990s map also does not include a category for orchards, so it is not possible to see a change in this habitat between 1930 and 1990, or 1990 and 2023.

Using the new categories, three maps were created representing the 1930s, 1990s and 2023 and clipped to the study area boundary. Data were then extracted on the cover of each habitat in each time period and the change in habitat area was calculated.

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[2] Land Cover Map 1990 Dataset documentation. Version 1.1, 8/10/2020. UK Centre for Ecology and Hydrology.

Results

A map of habitats in the 1930s is shown as Figure 1, with the corresponding map from 1990 as Figure 2 and the present basemap as Figure 3.

Semi-natural grassland was the dominant habitat type in the 1930s, occupying 63.3% of the area of Buckinghamshire. This was prevalent across most of the county but was concentrated particularly in Aylesbury Vale, where little other habitat was present. The next largest habitat type was arable land (15.3%), more common in the south and north of the county. Built-up areas and gardens occupied 9.9%, concentrated mostly in the south, and woodland occupied 8.5%. Small areas of heath and marsh, water, and orchards were also present.

In contrast, by 1990, improved grassland covered 42% of the county, and arable also increased greatly to 36.7%. Built-up areas and gardens stayed relatively constant at 9.6%, but are more concentrated in urban centres, particularly in the south of the county. Note that this is likely an inaccurate figure due to classification differences in the 1930s and 1990 maps. More details are presented in the discussion. Woodland has increased slightly to 9.5% and is again mostly concentrated in the south of the county. Semi-natural grassland has fallen dramatically, down to 1.5% of the total area, with only remnant patches remaining.
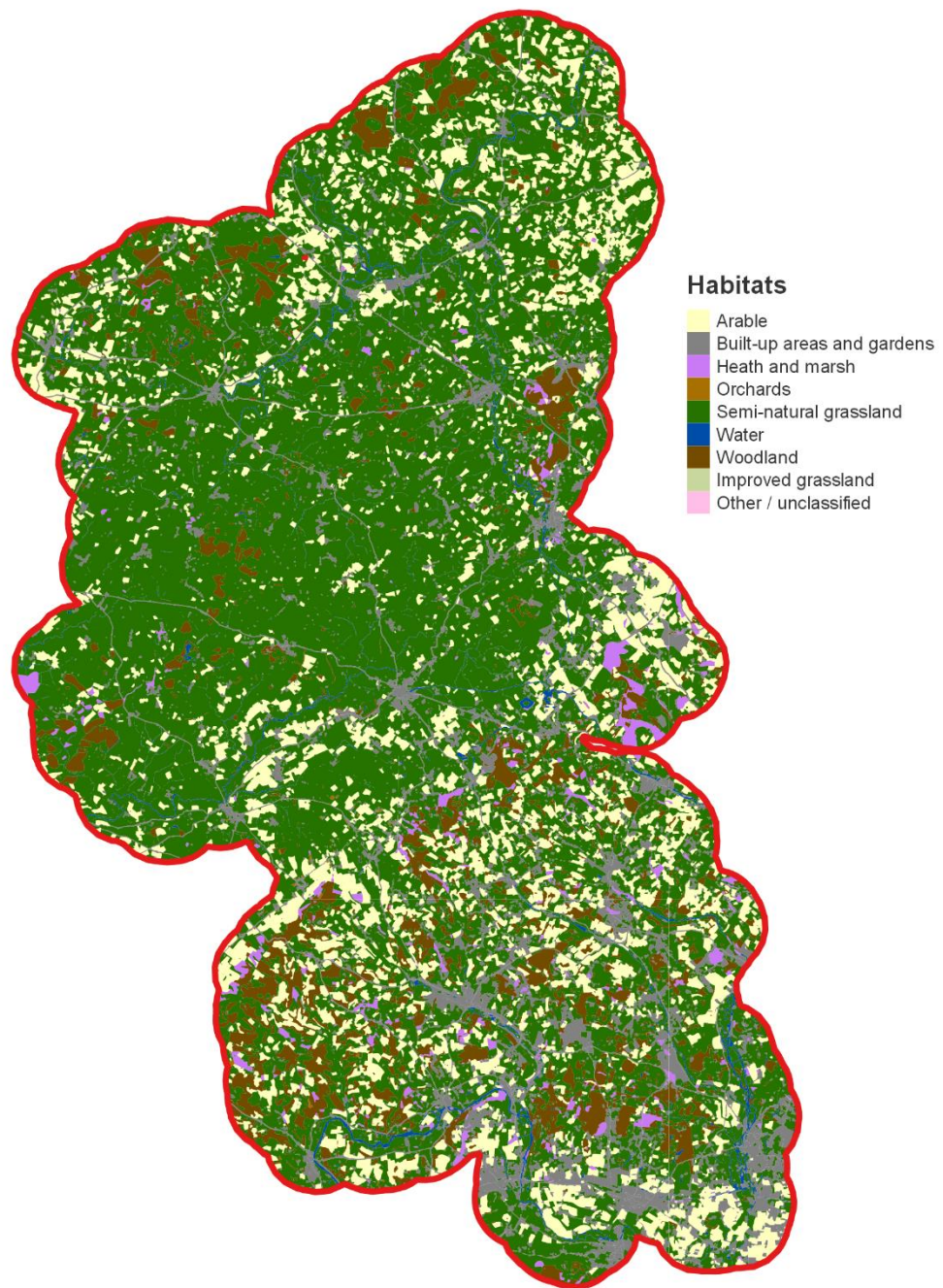
The present-day habitat composition remains relatively similar to the 1990 composition. Improved grassland and arable land have decreased since 1990, and most other habitats have increased slightly, including semi-natural grassland and woodland.

These changes are presented in Figures 7 and 8.

Table 2: *Habitat % changes between decades mapped.*

Habitat	% change		
	1930s-1990	**1990-2023**	*Total (1930s-2023)*
Improved grassland		-9.7 ⬇	
Arable	139.8 ⬆	-20.9 ⬇	*89.5* ⬆
Built-up areas and gardens	-3.6 ⬇	57.7 ⬆	*52.1* ⬆
Woodland	12.1 ⬆	33.2 ⬆	*48.9* ⬆
Semi-natural grassland	-97.6 ⬇	76.7 ⬆	*-95.7* ⬇
Water	-66.0 ⬇	104.1 ⬆	*-30.6* ⬇
Orchards			*233.3* ⬆
Heath and marsh	-94.6 ⬇	50.0 ⬆	*-93.2* ⬇

Note that gaps are present where one or both maps had no cover of the habitat type due to classification differences.
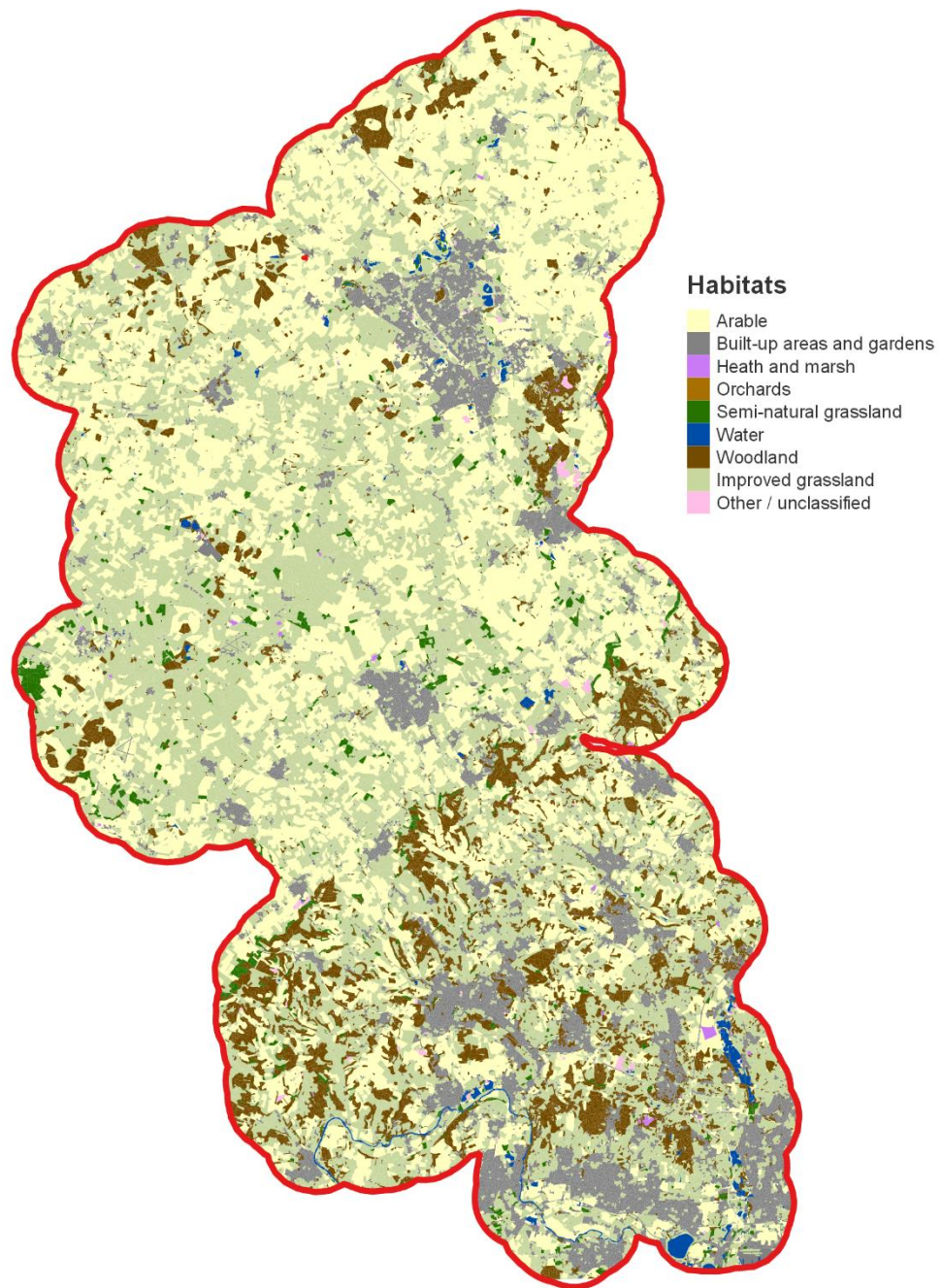
Habitats

- Arable
- Built-up areas and gardens
- Heath and marsh
- Orchards
- Semi-natural grassland
- Water
- Woodland
- Improved grassland
- Other / unclassified

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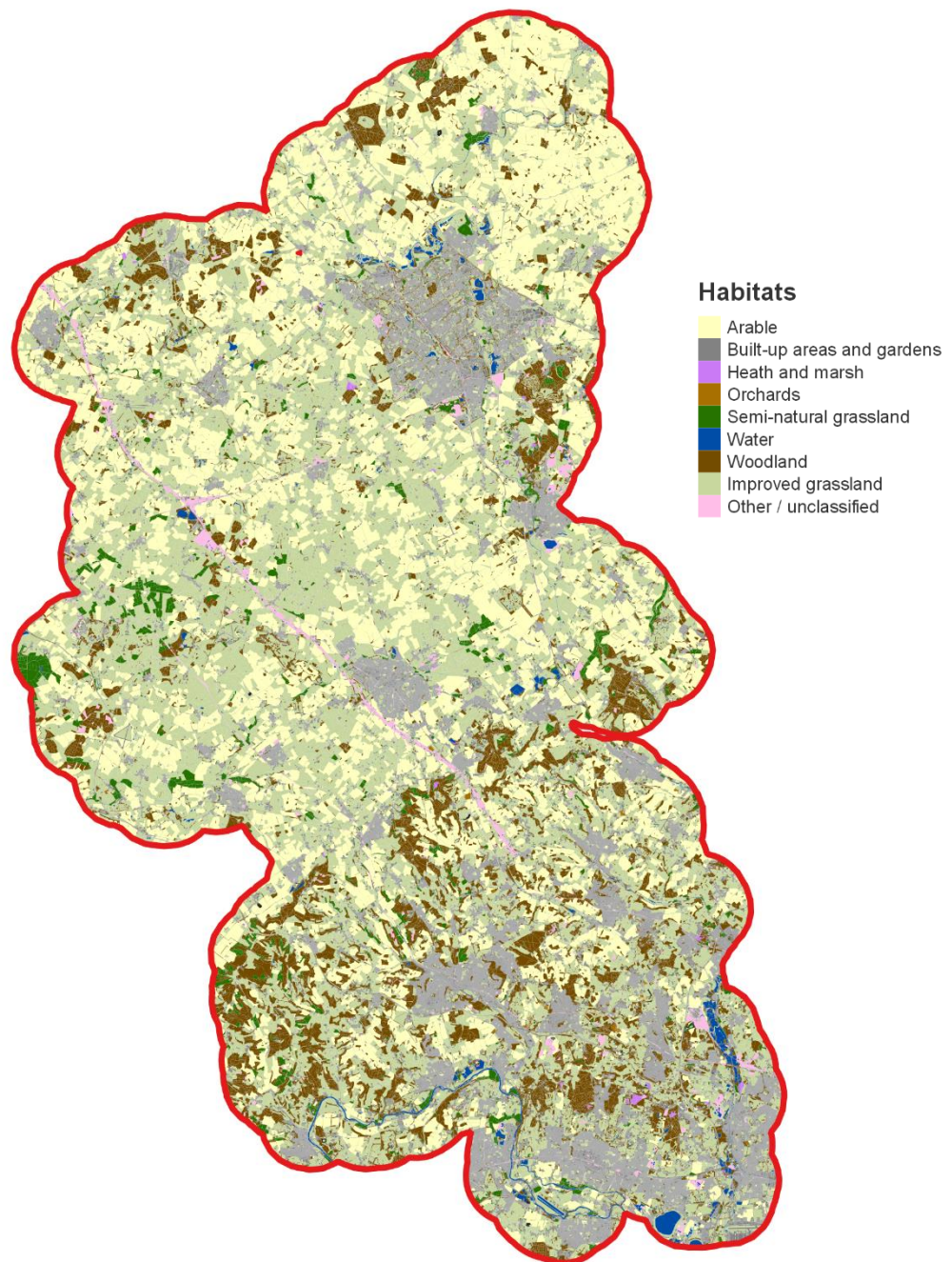
Figure 1: *Land-use and habitats in the 1930s, derived from the "Dudley Stamp" maps.*

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Figure 2: *Land-use and habitats in 1990, derived from LCM 1990 UKCEH maps, but with categories matched as closely as possible to the "Dudley Stamp" maps.*

Habitats
- Arable
- Built-up areas and gardens
- Heath and marsh
- Orchards
- Semi-natural grassland
- Water
- Woodland
- Improved grassland
- Other / unclassified

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0.0   5.0   10.0   15.0 km

Figure 3: *Land-use and habitats in 2023, derived from the LNRS natural capital basemap, but with categories matched as closely as possible to the "Dudley Stamp" maps.*
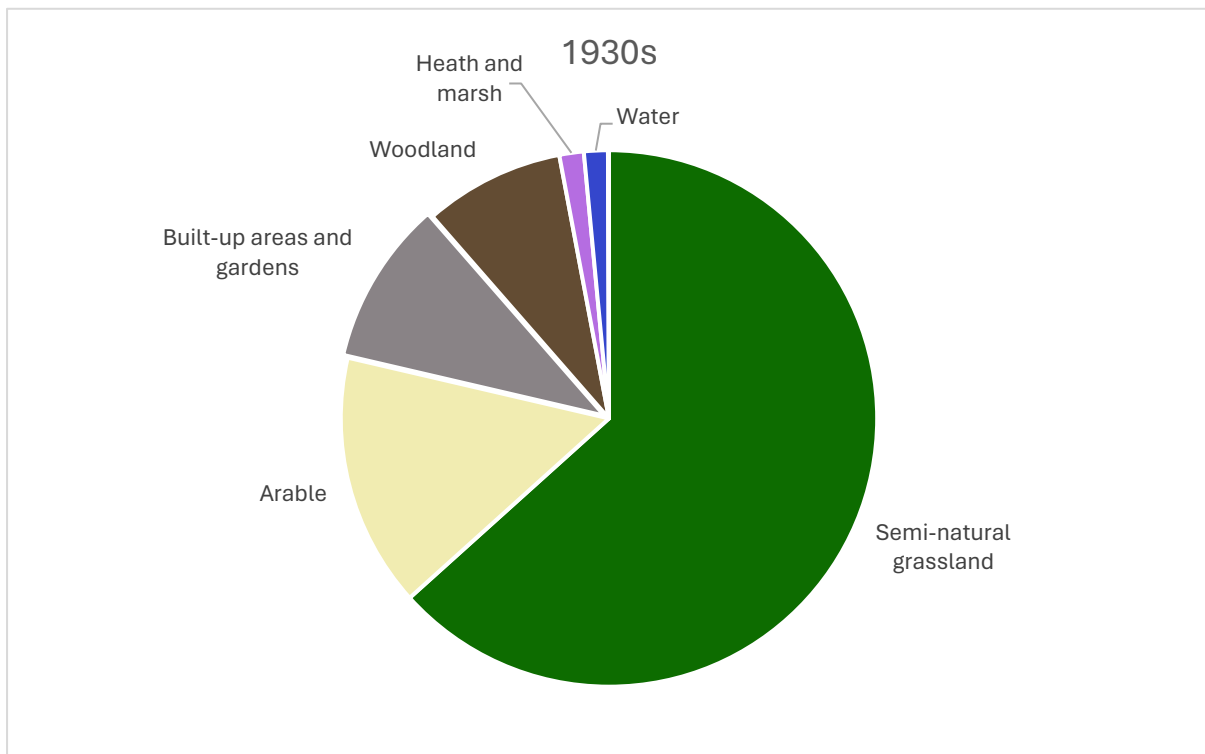
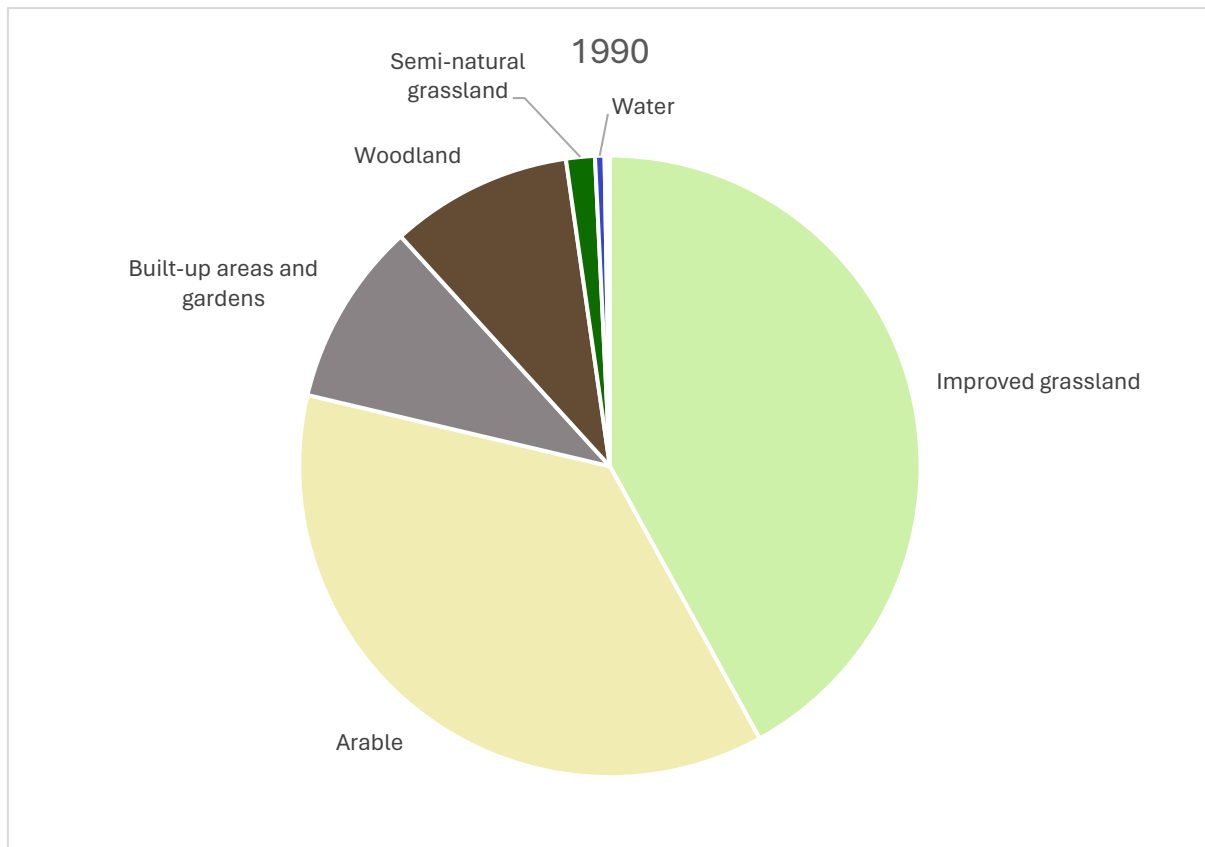**Figure 4:** *Percentage cover of habitat types in the 1930s.*

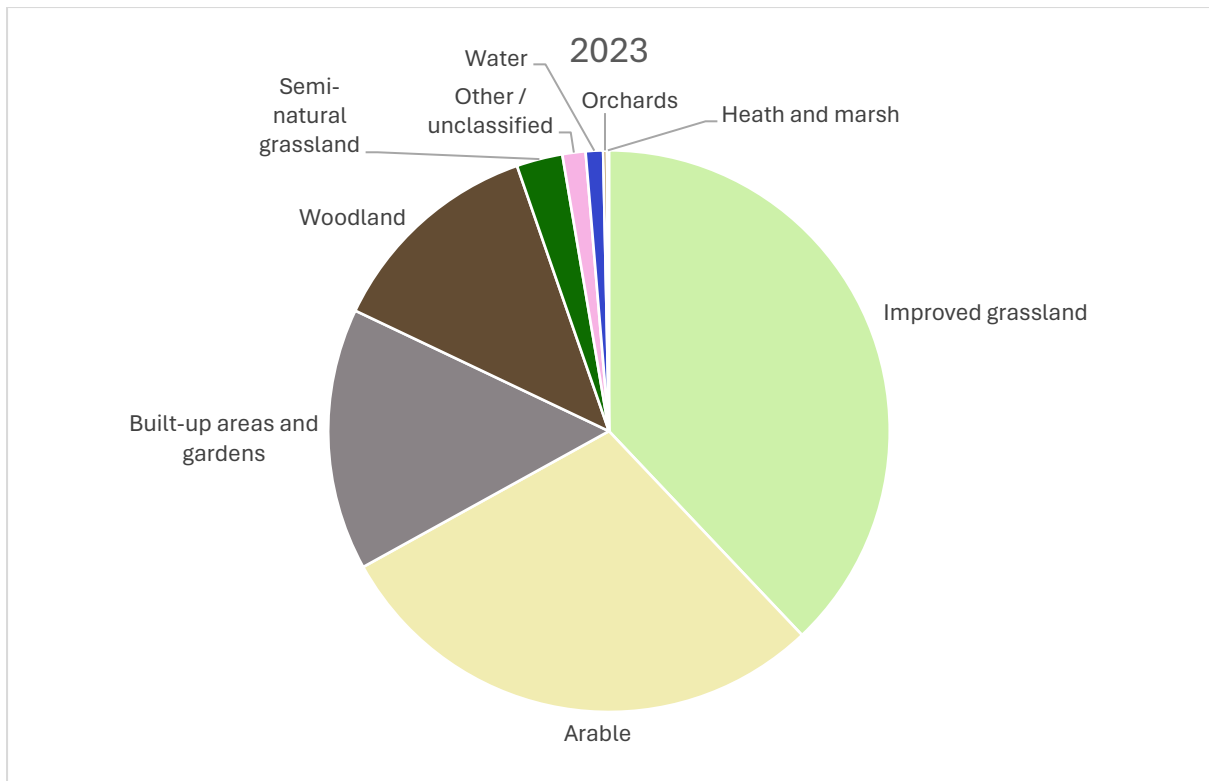**Figure 5:** *Percentage cover of habitat types in 1990.*

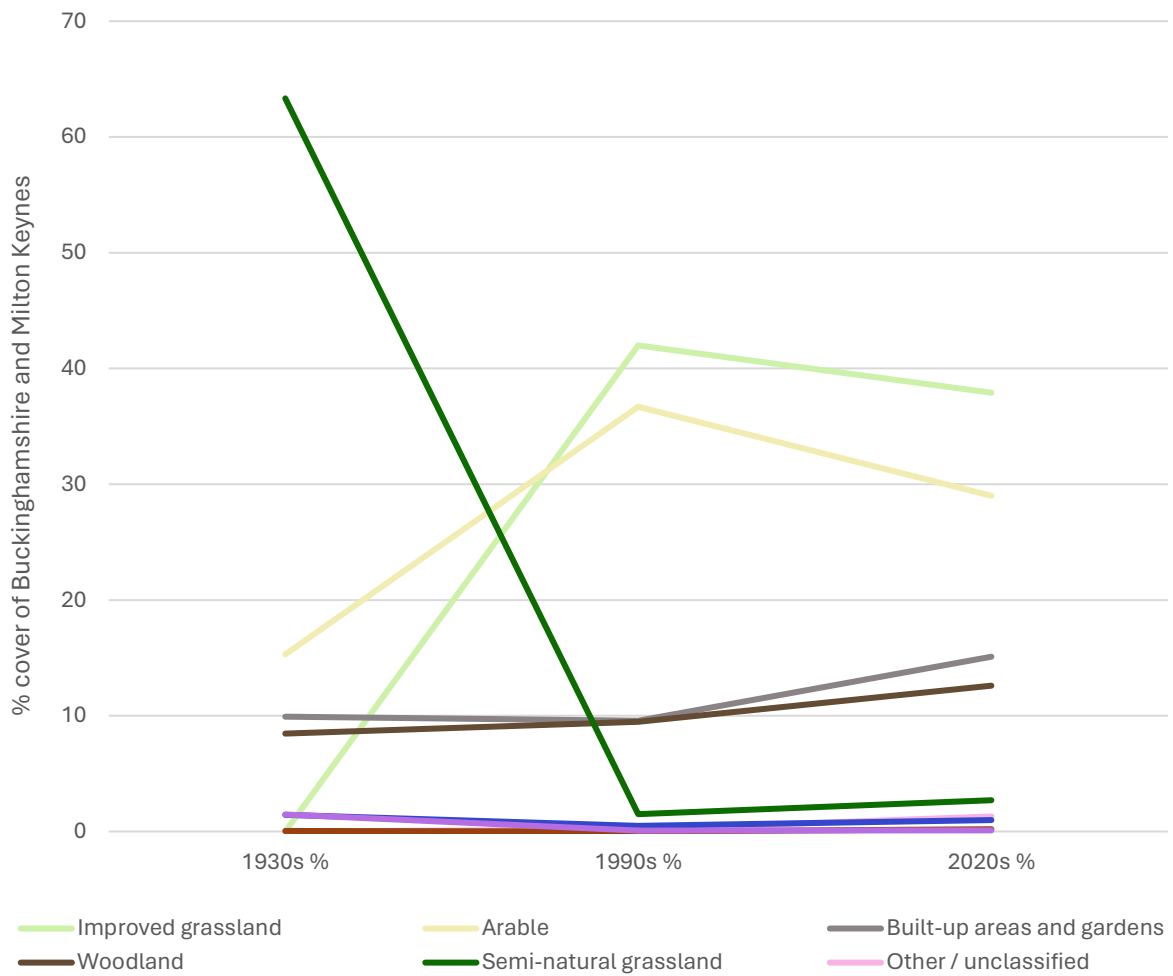***Figure 6:*** *Percentage cover of habitat types in 2023.*

Figure 7: *Percentage change in habitat types between the 1930s, 1990 and 2023.*

Figure 7 shows that the largest habitat change is semi-natural grassland, which is vastly reduced from 1930 to 1990. It increases slightly in 2023 but is still less than 5% of the 1930s cover. Arable and improved grassland increase massively from 1930 to 1990 and then are slightly reduced from 1990 to 2023. Woodland increases slightly from 1930 to 1990 and again from 1990 to 2023, and water and heath decline from 1930 to 1990 and then increase again slightly from 1990 to 2023. Built-up areas stay approximately the same from 1930 to 1990 and then increase from 1990 to 2023. Note that a number of these smaller changes will be due to errors or changes in classifying and mapping habitats, particularly in LCM 1990, rather than real changes (see Discussion section).
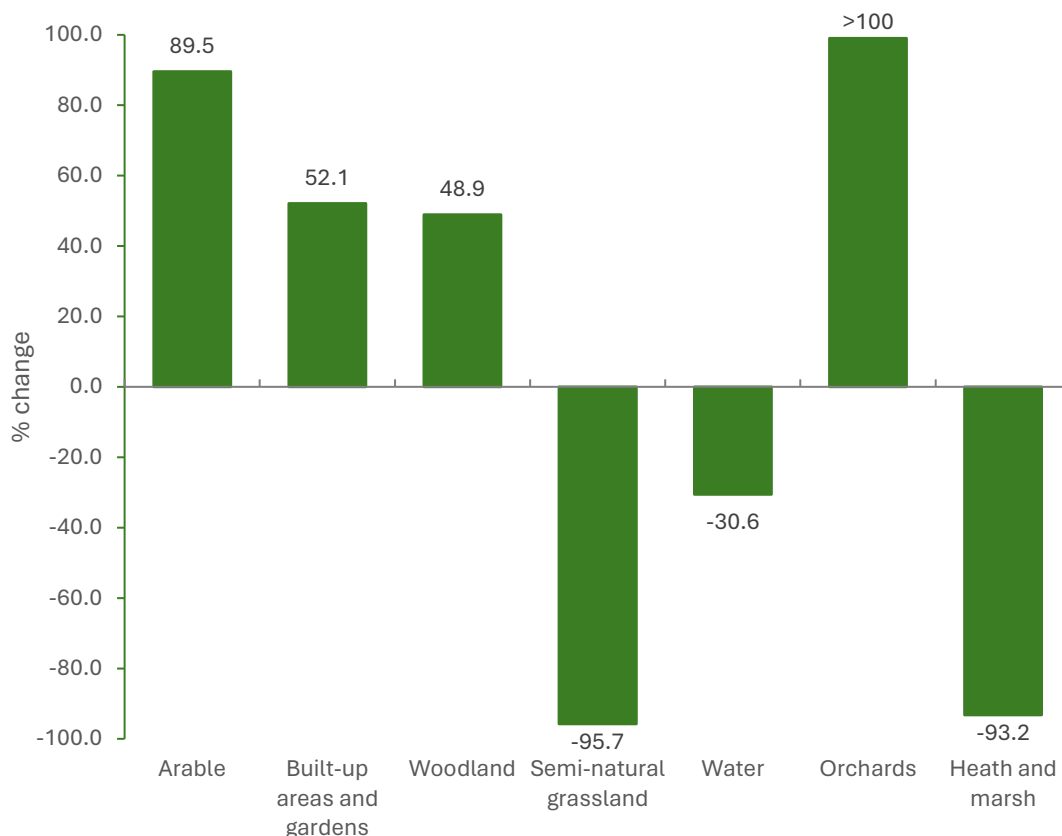
Figure 8: *Total change in habitat types from 1930s to 2023. Note that improved grassland and other / unclassified have not been reported as they were not classified in the 1930s basemap.*

Figure 8 shows the overall change from the 1930s to the present day. Semi-natural grassland and heathland have both decreased massively, by 96% and 93% respectively, built-up areas and woodland have increased by approximately half, and arable and orchards have almost doubled. Note that the orchards figure is likely inaccurate as many orchards are likely to have been classified as woodland or garden in the 1930s basemap.

Habitats by National Character Area zone

Table 3 shows the distribution of habitats in Buckinghamshire by National Character Area.

Milton Keynes and North Bucks

The 1930s basemap shows that the zone consisted of 71.8% semi-natural grassland. Most of the rest of the zone was covered by arable land (14.1%), and built-up areas and gardens (7.3%).

By 1990, arable land had increased to be the largest habitat type (48%), followed by improved grassland (36.5%). Semi-natural grassland had been reduced to only 0.9%, and built-up areas and gardens had increased slightly to 9.5%, as a result of the building of Milton Keynes.

The present day basemap shows a further increase in built-up area, again likely linked to the expansion of Milton Keynes. There has been a decline in arable and improved grassland and an increase of semi-natural habitats including semi-natural grassland, woodland and water.

Aylesbury Vale

In the 1930s basemap, this area was mostly semi-natural grassland (79.3%), with some arable land (9%) and built-up areas and gardens (6.7%).

In 1990, improved grassland had increased to be the largest habitat type (51.6%), followed by arable land (38.1%).

In the present day basemap, arable and improved grassland has decreased slightly, and built-up areas have also increased slightly. There has been a substantial increase in semi-natural grassland and woodland compared to 1990, although the change in grasslands is highly likely to be driven by a change in habitat classification between 1990 and 2023, rather than an increase in habitat area. Overall, there is still a huge decline in semi-natural grasslands from the 1930s to the present day.

Chilterns

In the 1930s basemap, this was where the majority of the arable land in the county was found (covering 23.2% of the area). The largest habitat type was still semi-natural grassland (43.2%). Woodland also covered a fairly significant area (15.6%), as did built-up areas and gardens (13.8%). This zone had the highest heath and marsh percentage in the county (3.2%).

By 1990, improved grassland was the largest single habitat (38.7%), followed by arable land (27.9%). Woodland had increased slightly to 19%, and semi-natural grassland had dramatically decreased to only 1.7%.

The present day basemap shows a slight decrease in arable and improved grassland compared to 1990, an increase in built-up areas and garden and an increase in semi-natural grassland and woodland. Orchards have also increased to cover 0.4% of the area.

Thames Valley

In the 1930s basemap, this area had the highest percentage of built-up areas and gardens (18.7%). This includes suburbs from Slough, and Gerrards Cross. It also had the largest woodland percentage in the county (18.3%). Semi-natural grassland was again the largest single habitat type (44.2%).

In 1990, improved grassland had become the single largest habitat type (44.2%), and semi-natural grassland had been reduced to almost nothing (0.9%). Woodland had increased slightly to 21.3%.

The present day basemap shows a slight decrease in arable and improved grassland, an increase in built-up areas and an increase in semi-natural grassland and woodland compared to 1990. Orchards have also increased to cover 0.4% of the area. As is the case in the other areas, arable, improved grassland and built-up areas and gardens have increased and seminatural grassland has decreased hugely since the 1930s.

Table 3: *Habitat categories in NCA zones by year.*

Habitat	% cover											
	Milton Keynes and North Bucks			Aylesbury Vale			Chilterns			Thames Valley		
	1930s	1990	2023	1930s	1990	2023	1930s	1990	2023	1930s	1990	2023
Arable	14.1	48.0	37.0	9.0	38.1	31.5	23.2	27.9	23.4	14.3	14.8	7.2
Built-up areas and gardens	7.3	9.5	15.0	6.7	5.0	9.5	13.8	12.0	17.9	18.7	16.7	24.3
Heath and marsh	0.6	0.0	0.2	0.4	0.1	0.0	3.2	0.1	0.1	2.7	0.3	0.6
Improved grassland	0.0	36.5	33.2	0.0	51.6	41.7	0.0	38.7	30.7	0.0	44.4	37.0
Orchards	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.4	0.0	0.0	0.4
Other / unclassified	0.0	0.2	1.7	0.0	0.0	2.3	0.0	0.3	1.7	0.0	0.4	3.1
Semi-natural grassland	71.8	0.9	4.0	79.3	2.3	9.4	43.2	1.7	4.4	44.2	0.9	2.1
Water	1.8	0.7	1.3	1.4	0.2	0.7	0.9	0.4	0.6	2.0	1.2	2.1
Woodland	4.4	4.2	7.5	3.2	2.7	4.9	15.6	19.0	20.9	18.3	21.3	23.2

Discussion

The maps and data paint a picture of profound habitat change over the last 90 years. The vast majority of semi-natural habitats have been lost, replaced predominantly by arable and improved grassland. There has also been an expansion of woodland, particularly of plantation forestry in the 1950-60s, but also signs of more recent woodland planting. Similar changes have been seen throughout the UK. Nationally, it has been estimated that 97% of enclosed semi-natural grasslands in England and Wales were lost between 1930 and 1984, whereas woodland in the UK increased by almost 100% over similar periods[3], figures that are not dissimilar to the change seen here where semi-natural grassland has declined by 96% and woodland has increased by 49%. Heathland also decreased significantly across the UK from the 1930s, which is again reflected in Buckinghamshire's trend (93% decline).

The changes shown between 1990 and the present day broadly follow the same trend as the rest of the UK, where enclosed farmland has decreased by 5%, woodland has increased by 29%, and urban areas have increased by 30%[4].

When interpreting the results, it is important to bear in mind that some of the changes are due to methodological errors, particularly in the classification of habitats in the LCM 1990. Efforts were made to match the habitats recorded in the three periods, but there will inevitably be some discrepancies. Habitats were recorded at a much higher resolution in the present study, capturing very small habitat patches. This was not the case in the 1930s, particularly in urban areas, and water was also mapped with less accuracy. In addition, the digitization process led to some further loss of detail for small habitat patches. It is likely that both the built-up / garden and water categories will have been slightly over-simplified in the 1930s map compared to the present day, and some smaller habitats such as orchards will have been underrepresented.

The UKCEH LCM 1990 was the first of its type attempted in the UK and was created using lower resolution satellite data than is available today. There are known inaccuracies in the classification of semi-natural grassland, which will have been misclassified as improved grassland in some cases, and in categories such as fen, marsh and swamp (included in heath and marsh here). This means that some of the apparent increase in these habitats from 1990 to 2023 will be due to errors in the 1990 map, rather than real increases. It seems that built up areas and gardens are also seriously underrepresented in the 1990 map (and probably slightly overrepresented in the 1930s map), hence there appears to be little change in this category from the 1930s to 1990 and then a very large increase to 2023. On the other hand, changes in woodland cover and arable are likely to be more accurate and the increase in the former and decrease in the latter since 1990 are very likely real.

Overall, therefore, the changes from the 1930s to 2023 are likely to be more accurate than those involving the 1990 map, although all come with caveats. The exact habitat areas and percentage change reported here are therefore prone to some error. Nevertheless, the overall picture of change is accurate.

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[3] UK NEA (2011) The UK National Ecosystem Assessment. UNEP WCMC, Cambridge.
[4] https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/habitatextentandconditionnaturalcapitaluk/2022