

# The State of Garden Moths in Great Britain and Ireland

Results from the Garden Moth Scheme  
2008-2023



# The State of Garden Moths in Great Britain and Ireland: Results from the Garden Moth Scheme 2008-2023

## Authors

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## Contributors

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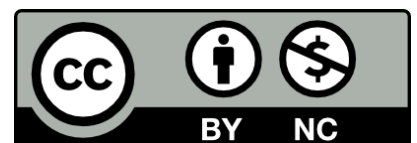
- **All the 1084 GMS recorders who provided the data.**
- All the Regional co-ordinators past and present.
- Steve Roberts: analysed the data and drafted this report.
- Audrey Turner: Data co-coordinator for the GMS.
- Norman Lowe: GMS committee chair.
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## Summary

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The Garden Moth Scheme (GMS) is a citizen science project that systematically monitors the numbers of common, readily identified moths in gardens across Great Britain and Ireland using light traps. The scheme has been running nationally since 2008 and here, and in the accompanying individual species accounts, we present the first rigorous analysis of trends in species abundance over the lifetime of the scheme.

Over 1300 recorders have contributed to the scheme with an average of 335 traps being run each year.

National 16-year trends in 178 species of moth are estimated (167 larger and 9 micro-moths). Overall, we find 93 (52%) species are increasing in abundance, with 64 (36%) showing a statistically significant increase. 85 (48%) species show a decline in abundance with 54 (30%) reaching significance.

There is only a weak correlation between these 16-year trends and the previously reported 1968-2023 trends based on the Rothamsted Insect Survey (RIS). This can be attributed to changes in the fortunes of many species over the time period with a number showing stabilisation or recovery in the last two decades compared to the 4 decades previously.

In contrast there is a good correlation between the GMS and the RIS abundances and trends when assessed over the same 2008-23 period, despite differences in methodology and geographical coverage.

We can detect significant North-South differences in the fates of species, with many species faring better in the North than the South: of those species with sufficient data to analyse, 49/119 (39%) show significantly more positive (or less negative) trends in the North whilst just 4 (3%) are faring significantly better in the South. These changes reflect the expected northwards shift due to climate change.

The GMS has proved itself a robust scheme for the monitoring of trends in common moth species over time and now provides useful data on moth trends for a good number of species. Providing the enthusiasm of the recorders can be maintained, the scheme should make a valuable contribution to the national monitoring of insect species as they respond to environmental and climate change.

### Feedback

Comments and feedback welcome to [steve.roberts@manchester.ac.uk](mailto:steve.roberts@manchester.ac.uk) or [SteveRoberts@live.co.uk](mailto:SteveRoberts@live.co.uk)

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# 1 Background

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This report presents the first comprehensive formal analysis of moth abundance trends based on the citizen science Garden Moth Scheme (GMS). It covers the period for 2008-2023. This report summarises the overall results and a companion set of reports are available giving the results for each individual moth species.

Previous studies have utilised data from the Rothamsted Insect Survey (RIS) (Harrower et al., 2025; Storkey et al., 2016) along with distribution data from the UK National Moth Recording Scheme (Butterfly Conservation, 2025) and have been published as the 2019 “Atlas of Britain and Ireland’s Larger Moths” (Randle et al., 2019, referred to as “the Atlas”), and “The State of Britain’s Larger Moths” reports (Fox et al., 2021; Fox et al., 2013) referred to as “the State of Larger Moth reports”.

## 1.1 About the Garden Moth Scheme

*“The purpose of the Garden Moth Scheme is to try to find out what is happening to our common garden moths. This is particularly relevant following a series of reports on “The State of Britain’s Larger Moths”, published by Butterfly Conservation over the years. The most recent of these reports, dated 2021, concludes that the number of species that are declining is more than four times the number that are increasing.”*

<https://gardenmothscheme.org.uk>

The Garden Moth Scheme is a citizen-led citizen science project which systematically records the moths present in UK gardens. It began as a pilot in the West Midlands in 2003 and achieved national coverage in 2008, with Ireland joining in 2009.

Recording uses light traps that are run once a week – nominally Fridays – regardless (in as far as is practicable) of the weather conditions, although records are accepted  $\pm 3$  days of the nominal date.

The main scheme runs for 36 weeks from March-October each year. A supplementary Winter scheme runs from November-February (16/17 weeks). The scheme is organised regionally with 12 regional co-ordinators collating the volunteer data and sending it on to a central data co-ordinator.

Recording is limited to the commoner species and moths that are readily visually identified. Historically the species lists have been regional and have expanded over time, but for the 2025 main season onwards a single national list of 455 species has replaced all the regional lists. A separate, national, list of species is used for the Winter scheme, which has expanded to 80 species by 2025. Both macro- and micro-moth species are included on the lists but species that are difficult to identify are either excluded or recorded as aggregates.

Recorders use their own light traps, which can be of any design, but use the same trap in the same location each week. Some recorders with large gardens run multiple traps, carefully sited to avoid interfering with each other.

As this is a volunteer scheme using their own traps, there is an inevitable turnover of gardens and traps as people join and leave the scheme, move house or replace their traps (or in some cases use a different trap for the Main and Winter schemes). Therefore, there are few long series where the same trap has been used in the same place for a long period. Whilst with care we can extract longer-term trend data from the series of shorter runs, we cannot readily extract quantitative distribution data.

## 2 Methods

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### 2.1 Datasets

The GMS scheme became national in 2007, but full UK coverage was not achieved until 2008 (Ireland joined in 2009).

This analysis includes all mainland UK and Ireland, but could not include the Channel Islands data as there was insufficient coverage and the Channel Islands are rather different ecologically.

The full data is available from the data co-ordinator and the analysis here utilises the full yearly records for the 2008-23 period. This report refers to 4 derived datasets:

- All the Main (summer) scheme data after cleaning.
- A subset of the main scheme data for traps with at least 3 seasons of data which we use for the formal estimation of trends.
- All the Winter scheme data, with the addition of any Main scheme data from the same trap.
- A subset of the Winter scheme data for traps with at least 3 seasons of data which we use for the formal estimation of trends.



*The raw data: Large Yellow Underwings in a trap.*

### 2.2 Trend Analysis methods

Full details of the data preparation and statistical analysis are documented in a series of technical reports available on the GMS website with four reports describing:

- The background to the data available for the main scheme and the winter scheme,
- The background to GMS and Data Setup for these analyses
- The details of the statistical methodology .

The analysis uses a two-stage approach, similar to that used in the UKBMS for transect data (Dennis et al., 2013; Dennis et al., 2016) and the published analyses of the Rothamsted Insect Survey (RIS) data (Conrad et al., 2004; Harrower et al., 2025).

The unit of analysis here is the Trap - that is we assume that gardens remain essentially constant from year-to-year but if the type of trap changes, we assume the recorded abundances will change.

In the first stage we fit the flight period for each species and each year with a spline function and use this to compute an abundance for each trap and year from the area under this curve. As the data is very heterogeneous, we use a Negative Binomial model (over-dispersed Poisson). This fills in any missing data, but does assume a common flight period for all sites (but different each year) - as do the UKBMS and RIS analyses. For this stage we utilise all the traps except those only recording for a few nights in the year. The species reports show the flight periods (phenology) for each year as estimated by the spline model.

In the second stage we fit models to these abundances to estimate:

1. A linear trend over time
2. Overall relative abundances for each year (normalised to 2008)

As we need multiple years of data from a trap to obtain a trend estimate for that trap, the second stage of the analysis excludes those traps with less than 3 years of records. These models adjust for Trap - that is we estimate trends within each trap and pool these to get the national averages. Again, as the data are heterogeneous, we fit Negative Binomial models.

A final step uses bootstrapping to quantify the uncertainty in the estimates (expressed as 95% confidence intervals (CI) - these can be loosely interpreted as the range of values consistent with the data we have).

The primary result is a percentage change in abundance per year - the same measure that is reported from the RIS data in the Moth Atlas and State of Larger Moth reports. The species reports show the relative abundances for each year (with CI) along with the fitted trend line and the trend estimate (with its 95%CI).

We include all species in this primary analysis where at least 2000 moths were recorded. The 2000 threshold was selected pragmatically to provide sufficient data to allow the models to be fitted and to enable estimates of trends with reasonable precision. A post-hoc review confirms that with 2000 moths we can typically estimate trends with an absolute precision of  $\pm 2.5\%$ /year (see Appendix B for details). In addition we compute a total abundance based on the total moths recorded each night from the 74 species recorded in all regions over the full 2008-23 time period.



***A Light Emerald in a light trap***

## 2.3 North-South differences

The 2021 State of Britain's Larger Moths report (Fox et al., 2021) suggested there were differences in trends between Northern and Southern Britain for a number of species, therefore we conducted a secondary analysis estimating trends in the two halves of the country separately. We follow this earlier work and divide the country into North and South defined by the 450km N line of the Ordnance Survey National Grid (which runs from Fleetwood on the west coast of Lancashire, through York to Hornsea on the east coast).

We used the same two-stage methodology as the primary analyses. The annual abundances were estimated allowing different flight periods in the North and South and the trends then estimated in the two halves of the country with bootstrapping used to estimate the confidence intervals and the statistical significance of the difference in trends. We focus on those species with a demonstrably different trend between the North and South - as defined by the bootstrapped P-value < 0.05 (i.e. classical statistical significance).

We include all species in this secondary analysis where at least 1000 moths were recorded in both the North and South subsets.



*Elephant Hawk-moth*

## 2.4 Species Distributions

Although the GMS scheme does not lend itself to a formal analysis of moth distributions, in the individual species accounts we do plot the species distributions for each species over 3 time periods. These maps indicate which traps had an average of at least one moth per year recorded for that trap over the period.

## 3 About the GMS data

### 3.1 Species Included

In this analysis we included all 178 species (9 of which were micro-moths) that were on the recording lists for all regions from 2010 onwards where at least 2000 moths were recorded, 166 using data from the Main (summer) scheme (Appendix A [Table 11](#)) and 12 using data from both the Main and Winter scheme (Appendix A [Table 12](#)). 6 species with nominally sufficient records were excluded as the data were deemed unreliable (Appendix A [Table 13](#)). Ireland joined the scheme in 2009 and therefore has no 2008 data. Otherwise nearly all these species were recorded in most regions where they were present in 2008/9.

### 3.2 Numbers of moths

The numbers in the Main (summer) scheme and the Winter scheme (after exclusions) along with the numbers in the subsets used for the trend analysis are summarised in [Table 1](#) below. Trap-Years is the number of traps multiplied by the number of years each was contributing to the scheme.

**Table 1: Summary of the GMS datasets**

	All Main Summer scheme	All Winter Scheme	Main Season trend analysis	Winter trend analysis
Records	2,192,675	33,580	1,864,894	132,935
Gardens	1,013	378	611	157
Traps	1,347	538	671	175
Moths	7,791,219	41,083	6,742,085	499,312
Species	455	79	439	79
Trap-Years	5,354	2,139	4,439	1,311
Nights	181,323	22,151	151,121	45,137
Empty Traps	14,846 (8.2%)	13,373 (60.4%)	11,646 (7.7%)	14,465 (32%)
Missed Weeks	11,421 (5.9%)	54,853 (71.2%)	8,683 (5.4%)	2,059 (4.4%)

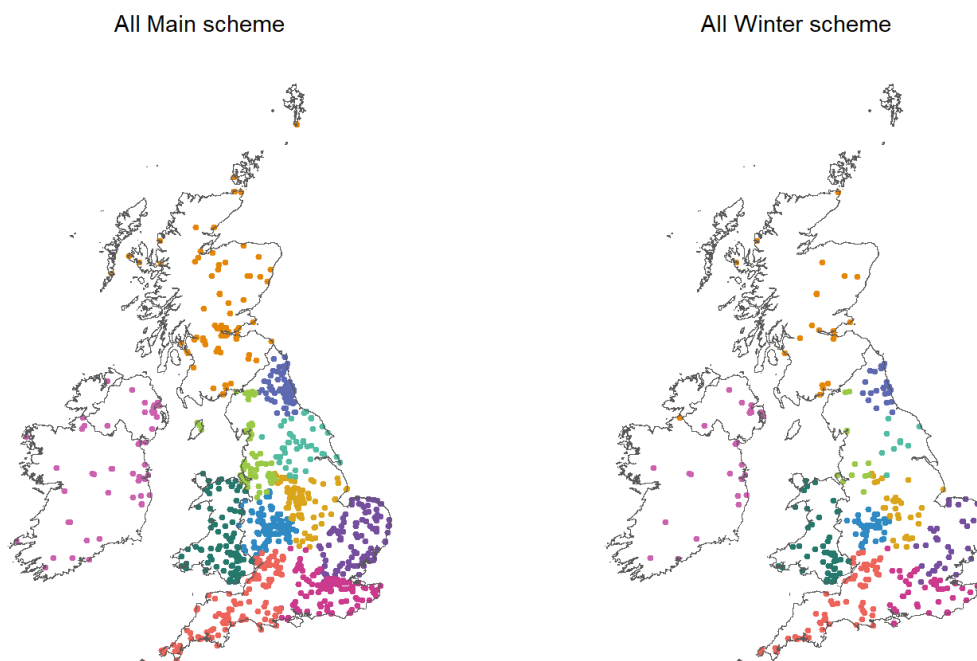


**More data:** A night's collection of Heart & Darts

### 3.3 GMS Coverage

Figure 1 shows the locations of the GMS gardens contributing to the Main summer scheme (LH plot) and the Winter scheme (RH plot).

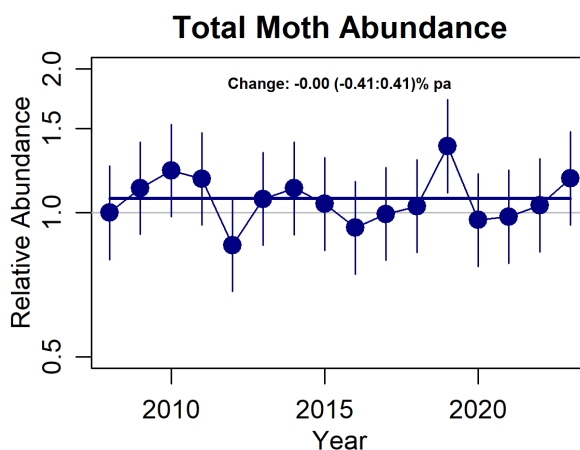
Figure 1: Trap locations. Colours represent the GMS regions.



## 4 Overall Moth Abundance

Although varying from year to year, the overall numbers of moths seen has been remarkably stable over the GMS period. Figure 2 shows the number of moths seen, relative to the 2008 baseline, where we count only the 74 species that have been consistently recorded over all regions and all years.

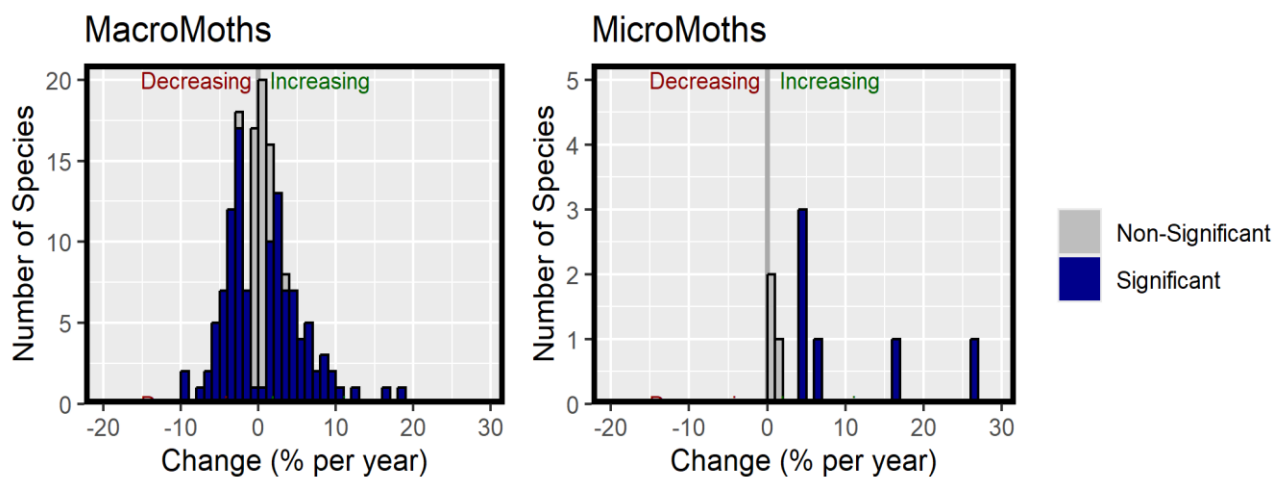
Figure 2: Total moth abundance (74 species) relative to 2008 and estimate of the trend as percentage change per year.



## 5 Increasing and Decreasing species

Figure 3 below shows the abundance trends across all included species, expressed as a % change in abundance per year. In order to focus on those trends most likely to be real we use the arbitrary threshold of statistical “significance” at the usual 5% level, with no adjustment for the number of species tested. Thus we expect by chance about 5% false positives (9 species) where species are included as “significant” but represent chance fluctuations.

Figure 3: Species abundance changes from GMS data 2008-23



Overall, 93/178 (52%) species showed an increase in abundance, with 64/178 (36%) reaching the statistical significance threshold. 85/178 (48%) species showed a decrease in abundance, with 54/178 (30%) reaching statistical significance.

It is noteworthy that all the micro-moth species show an increasing abundance. This may be due to the selection of species, but the possibility of recorder bias cannot be excluded here, as it is plausible that, as recorders become more confident, they are able to recognise and identify a wider range of small moths overlooked in earlier years of recording.

We note that this contrasts somewhat with the Atlas and State of Larger Moths reports which look at a longer time period (typically from 1970) and reports a much larger proportion of declining macro species – see §6 below.

### 5.1 Species Increasing in Abundance

Table 2 below lists the 64/178 (36%) species that showed a “significant” increase in abundance over the 2008-23 period, expressed as a percentage change per year with a 95% confidence interval. The total number of moths available for the trend analysis is included for information.

**Table 2: Species increasing in abundance in GMS traps between 2008 and 2023**

ABHno	Scientific Name	Common Name	Total moths recorded	Change per year
28.024	Tachystola acroxantha	Ruddy Streak	15,207	26.6 (18.8:35.1)%
70.004	Idaea rusticata	Least Carpet	8,446	18.6 (13.9:22.9)%
49.059	Tortrix viridana	Green Oak Tortrix	5,568	16.7 (10.9:21.9)%
73.099	Hoplodrina ambigua	Vine's Rustic	59,914	16.1 (12.7:19.6)%
63.080	Chrysoteuchia culmella	Garden Grass-veneer	176,982	12.2 (9.6:14.6)%
73.193	Anchoscelis lunosa	Lunar Underwing	70,379	10.6 (9.1:12.2)%
70.248	Lycia hirtaria	Brindled Beauty	8,482	10.0 (7.8:12.2)%
70.008	Idaea seriata	Small Dusty Wave	5,887	9.4 (7.4:11.3)%
69.016	Deilephila elpenor	Elephant Hawk-moth	32,716	8.7 (7.4:9.9)%
66.001	Poecilocampa populi	December Moth	5,778	8.4 (5.1:11.6)%
73.301	Leucania comma	Shoulder-striped Wainscot	11,581	8.1 (5.3:10.8)%
73.186	Agrochola lychnidis	Beaded Chestnut	23,548	7.7 (5.7:9.8)%
72.044	Eilema griseola	Dingy Footman	42,322	7.0 (4.3:9.6)%
73.291	Mythimna pallens	Common Wainscot	48,443	6.9 (5.0:8.6)%
63.018	Anania coronata	Elder Pearl	6,772	6.4 (4.2:8.7)%
70.024	Scopula imitaria	Small Blood-vein	2,972	6.2 (4.1:8.2)%
73.219	Atethmia centrago	Centre-barred Sallow	7,881	6.2 (4.3:8.2)%
31.001	Carcina quercana	Long-horned Flat-body	4,889	6.1 (4.1:8.3)%
73.233	Aporophyla nigra	Black Rustic	20,239	6.1 (4.4:7.8)%
70.256	Erannis defoliaria	Mottled Umber	2,607	5.9 (1.2:9.8)%
70.141	Gymnoscelis rufasciata	Double-striped Pug	25,053	5.9 (4.6:7.2)%
62.001	Aphomia sociella	Bee Moth	16,038	5.9 (4.5:7.2)%
71.025	Phalera bucephala	Buff-tip	13,216	5.7 (4.5:6.9)%
73.290	Mythimna conigera	Brown-line Bright-eye	4,864	5.0 (1.7:8.3)%
28.010	Hofmannophila pseudospretella	Brown House-moth	19,389	4.8 (3.3:6.4)%
70.173	Eupithecia centaureata	Lime-speck Pug	6,758	4.8 (2.7:6.8)%
73.095	Caradrina clavipalpis	Pale Mottled Willow	16,289	4.6 (3.0:6.4)%
73.180	Tiliacea aurago	Barred Sallow	5,537	4.4 (2.4:6.6)%
70.029	Timandra comae	Blood-Vein	8,691	4.4 (2.7:6.0)%
18.001	Plutella xylostella	Diamond-back Moth	38,471	4.3 (1.8:6.7)%
73.131	Luperina testacea	Flounced Rustic	39,841	4.2 (2.9:5.5)%
49.039	Epiphyas postvittana	Light Brown Apple Moth	138,758	4.1 (2.4:5.6)%
70.095	Chloroclysta siterata	Red-Green Carpet	4,419	4.0 (1.1:7.0)%
70.234	Ennomos alniaria	Canary-shouldered Thorn	7,738	4.0 (2.2:5.8)%
63.093	Agriphila straminella	Straw Grass-moth	60,812	3.7 (1.5:6.0)%
73.357	Xestia xanthographa	Square-spot Rustic	126,963	3.6 (2.2:4.9)%
62.075	Hypsopygia costalis	Gold Triangle	3,387	3.5 (1.1:6.2)%
65.007	Cilix glaucata	Chinese Character	5,733	3.5 (1.9:5.1)%
72.015	Calliteara pudibunda	Pale Tussock	9,076	3.3 (1.9:4.6)%
70.011	Idaea dimidiata	Single-dotted Wave	14,877	3.3 (2.3:4.5)%
70.059	Campptogramma bilineata	Yellow Shell	6,503	3.0 (1.7:4.3)%
70.283	Campaea margaritaria	Light Emerald	22,845	2.8 (1.5:4.1)%
70.207	Lomaspilis marginata	Clouded Border	17,498	2.8 (1.6:4.1)%
72.022	Diaphora mendica	Muslin Moth	10,190	2.7 (1.3:4.3)%
73.092	Caradrina morpheus	Mottled Rustic	19,501	2.6 (0.7:4.6)%
63.089	Agriphila tristella	Common Grass-moth	69,453	2.6 (0.4:4.6)%
3.001	Triodia sylvina	Orange Swift	6,674	2.5 (0.5:4.5)%
70.013	Idaea biselata	Small Fan-footed Wave	20,997	2.4 (1.0:3.8)%
73.045	Acronicta rumicis	Knot Grass	6,710	2.4 (0.6:4.2)%
73.343	Noctua fimbriata	Broad-bordered Yellow Underwing	13,472	2.3 (0.9:3.7)%
70.277	Cabera pusaria	Common White Wave	6,693	2.3 (0.9:3.7)%
73.319	Agrotis segetum	Turnip Moth	20,912	2.2 (0.6:4.2)%
63.025	Anania hortulata	Small Magpie	30,155	2.1 (0.9:3.3)%
73.338	Lycophotia porphyrea	True Lover's Knot	15,504	2.0 (0.0:4.0)%
70.226	Opisthograptis luteolata	Brimstone Moth	96,162	2.0 (1.2:2.8)%
70.222	Petrophora chlorosata	Brown Silver-line	8,322	1.9 (0.1:3.5)%
72.045	Eilema lurideola	Common Footman	113,668	1.9 (0.6:3.1)%
63.038	Patania ruralis	Mother of Pearl	61,084	1.8 (0.6:3.0)%
70.258	Peribatodes rhomboidaria	Willow Beauty	72,738	1.8 (0.8:2.7)%
73.359	Xestia c-nigrum	Setaceous Hebrew Character	203,146	1.8 (0.3:3.3)%
70.061	Epirrhoe alternata	Common Carpet	22,092	1.6 (0.4:2.7)%
71.020	Pterostoma palpina	Pale Prominent	4,326	1.6 (0.2:3.1)%
73.325	Agrotis puta	Shuttle-shaped Dart	69,567	1.5 (0.0:2.7)%
70.016	Idaea aversata	Riband Wave	122,194	0.9 (0.1:1.7)%

## 5.2 Species Decreasing in Abundance

Table 3 below lists the 54/178 (30%) species that showed a “significant” decrease in abundance over the 2008-23 period.

**Table 3: Species decreasing in abundance in GMS traps between 2008 and 2023**

ABHno	Scientific Name	Common Name	Total moths recorded	Change per year
73.206	Lithophane leautieri	Blair's Shoulder-knot	10,734	-9.9 (-11.4:-8.5)%
73.270	Melanchra persicariae	Dot Moth	13,045	-9.5 (-11.2:-7.6)%
73.156	Apamea crenata	Clouded-bordered Brindle	11,448	-7.7 (-9.2:-6.2)%
73.016	Autographa pulchrina	Beautiful Golden Y	10,885	-6.6 (-8.2:-5.0)%
73.271	Ceramica pisi	Broom Moth	3,118	-6.4 (-8.7:-3.8)%
73.250	Anorthoa munda	Twin-spotted Quaker	10,446	-5.6 (-7.2:-3.9)%
73.154	Apamea remissa	Dusky Brocade	6,529	-5.3 (-7.3:-3.1)%
73.274	Mamestra brassicae	Cabbage Moth	6,412	-5.3 (-6.8:-3.8)%
73.084	Bryophila domestica	Marbled Beauty	21,173	-5.3 (-6.6:-3.9)%
73.190	Leptologia macilenta	Yellow-line Quaker	4,815	-5.2 (-8.0:-1.9)%
70.054	Xanthorhoe montanata	Silver-ground Carpet	15,677	-4.8 (-6.0:-3.7)%
65.009	Habrosyne pyritoides	Buff Arches	14,555	-4.6 (-5.8:-3.3)%
73.353	Xestia baja	Dotted Clay	12,913	-4.5 (-6.5:-2.2)%
72.026	Arctia caja	Garden Tiger	4,425	-4.5 (-6.7:-2.3)%
73.247	Orthosia gracilis	Powdered Quaker	5,289	-4.5 (-6.3:-2.7)%
73.163	Apamea lithoxyloae	Light Arches	8,570	-4.2 (-6.1:-2.5)%
73.361	Xestia triangulum	Double Square-spot	35,560	-4.0 (-5.6:-2.6)%
73.121	Gortyna flavago	Frosted Orange	4,031	-3.9 (-5.7:-2.0)%
73.242	Orthosia incerta	Clouded Drab	52,668	-3.7 (-4.7:-2.9)%
70.241	Crocallis elinguarua	Scalloped Oak	20,102	-3.7 (-4.7:-2.7)%
73.244	Orthosia cerasi	Common Quaker	129,575	-3.6 (-4.5:-2.6)%
70.079	Thera britannica	Spruce Carpet	4,640	-3.5 (-6.4:-0.5)%
73.158	Apamea sordens	Rustic Shoulder-knot	12,041	-3.3 (-5.2:-1.3)%
71.021	Ptilodon capucina	Coxcomb Prominent	3,099	-3.1 (-4.9:-1.3)%
70.066	Earophila badiata	Shoulder Stripe	2,564	-3.1 (-4.9:-1.4)%
70.237	Selenia dentaria	Early Thorn	18,618	-3.1 (-4.0:-2.1)%
73.328	Axylia putris	Flame	48,849	-3.1 (-4.2:-1.9)%
70.081	Thera obeliscata	Grey Pine Carpet	7,284	-3.1 (-4.8:-1.1)%
73.017	Autographa jota	Plain Golden Y	6,344	-3.0 (-4.8:-1.1)%
73.114	Euplexia lucipara	Small Angle Shades	6,770	-3.0 (-4.4:-1.7)%
70.133	Perizoma alchemillata	Small Rivulet	6,203	-2.9 (-4.4:-1.4)%
73.012	Diachrysis chrysis	Burnished Brass	20,728	-2.9 (-4.0:-1.8)%
73.182	Cirrhia icteritia	Sallow	6,174	-2.9 (-4.7:-1.1)%
70.097	Dysstroma truncata	Common Marbled Carpet	66,294	-2.8 (-3.6:-2.0)%
73.181	Xanthia togata	Pink-barred Sallow	5,091	-2.8 (-4.4:-1.1)%
70.240	Odontopera bidentata	Scalloped Hazel	8,674	-2.7 (-4.0:-1.5)%
73.329	Ochropleura plecta	Flame Shoulder	105,250	-2.6 (-3.5:-1.7)%
73.245	Orthosia cruda	Small Quaker	58,223	-2.6 (-4.0:-1.1)%
73.189	Leptologia lota	Red-line Quaker	8,629	-2.5 (-3.9:-1.3)%
73.249	Orthosia gothica	Hebrew Character	159,111	-2.5 (-3.2:-1.8)%
72.020	Spilosoma lubricipeda	White Ermine	28,664	-2.4 (-3.5:-1.2)%
70.265	Alcis repandata	Mottled Beauty	19,040	-2.4 (-3.8:-0.9)%
70.239	Selenia tetralunaria	Purple Thorn	2,106	-2.3 (-4.5:-0.3)%
73.216	Cosmia trapezina	Dun-bar	22,784	-2.2 (-3.4:-0.8)%
72.053	Herminia tarsipennalis	Fan-foot	16,411	-2.1 (-3.4:-0.8)%
63.057	Evergestis forficalis	Garden Pebble	6,356	-2.1 (-3.6:-0.7)%
72.019	Spilosoma lutea	Buff Ermine	52,102	-2.0 (-3.0:-0.9)%
73.333	Diarsia mendica	Ingrailed Clay	16,774	-1.9 (-3.6:-0.2)%
70.074	Hydriomena furcata	July Highflyer	13,068	-1.7 (-2.9:-0.4)%
73.348	Noctua janthe	Lesser Broad-bordered Yellow Underwing	143,249	-1.5 (-2.5:-0.6)%
70.049	Xanthorhoe fluctuata	Garden Carpet	30,869	-1.3 (-2.2:-0.3)%
73.345	Noctua comes	Lesser Yellow Underwing	102,333	-1.2 (-2.0:-0.5)%
73.162	Apamea monoglypha	Dark Arches	205,983	-1.2 (-2.0:-0.4)%
73.342	Noctua pronuba	Large Yellow Underwing	783,438	-0.9 (-1.6:-0.2)%

### 5.3 Species with no significant change

Table 4 below lists the 60/178 (34%) species that failed to show any “significant” change in abundance over the 2008-23 period. In many cases this will be because there were too few moths recorded, the confidence intervals show the range of change that are compatible with the data we have - in many cases these are rather wide.

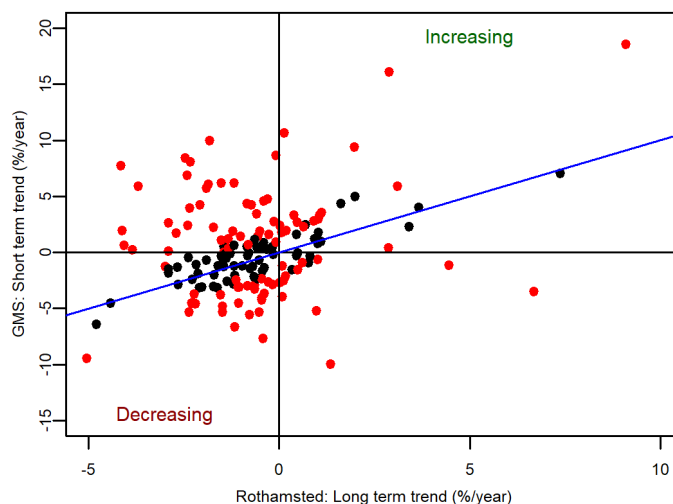
**Table 4: Species with no change detectable in GMS traps between 2008 and 2023**

ABHno	Scientific Name	Common Name	Total moths recorded	Change per year
70.109x	Epirrita dilutata agg.	November Moth agg.	6,370	3.3 (-0.3:6.9)%
73.187	Anchoscelis litura	Brown-spot Pinion	6,394	1.7 (-1.0:4.3)%
28.009	Endrosis sarcitrella	White-shouldered House-moth	7,367	1.7 (-0.6:3.9)%
70.305	Hemithea aestivaria	Common Emerald	5,804	1.5 (-0.2:3.2)%
70.278	Cabera exanthemata	Common Wave	6,214	1.2 (-0.4:2.8)%
70.251	Biston strataria	Oak Beauty	6,107	1.2 (-0.4:2.7)%
73.293	Mythimna impura	Smoky Wainscot	39,751	1.1 (-0.7:3.2)%
73.267	Lacanobia oleracea	Bright-line Brown-eye	45,677	1.1 (-0.0:2.2)%
72.024	Phragmatobia fuliginosa	Ruby Tiger	13,396	1.0 (-0.4:2.4)%
73.173x	Oligia strigilis agg.	Marbled Minor agg.	55,834	0.9 (-0.2:2.0)%
70.045	Scotopteryx chenopodiata	Shaded Broad-bar	4,097	0.9 (-1.1:2.9)%
73.001	Abrostola tripartita	Spectacle	22,425	0.8 (-0.3:2.0)%
73.298	Mythimna ferrago	Clay	14,921	0.7 (-0.4:1.9)%
73.064	Amphipyra tragopoginis	Mouse Moth	5,349	0.7 (-1.6:2.8)%
73.176	Oligia fasciuncula	Middle-barred Minor	16,228	0.7 (-1.2:2.3)%
69.003	Laotioe populi	Poplar Hawk-moth	19,796	0.5 (-0.2:1.3)%
73.113	Phlogophora meticulosa	Angle Shades	18,044	0.5 (-0.5:1.7)%
70.085	Cidaria fulvata	Barred Yellow	2,049	0.5 (-1.9:3.2)%
73.264	Lacanobia thalassina	Pale-shouldered Brocade	4,332	0.5 (-1.8:3.1)%
3.002	Korscheltellus lupulina	Common Swift	12,239	0.4 (-1.5:2.6)%
70.100	Colostygia pectinataria	Green Carpet	20,757	0.4 (-1.0:2.0)%
65.008	Thyatira batis	Peach Blossom	2,746	0.4 (-1.2:2.1)%
73.015	Autographa gamma	Silver Y	49,539	0.3 (-0.4:1.2)%
73.069	Xylocampa areola	Early Grey	25,808	0.3 (-0.7:1.4)%
44.001	Alucita hexadactyla	Many-plumed Moth	6,716	0.3 (-1.7:2.2)%
73.317	Agrotis exclamationis	Heart and Dart	353,620	0.2 (-0.6:1.2)%
70.252	Biston betularia	Peppered Moth	20,641	0.1 (-0.9:1.1)%
49.077	Acleris variegana	Garden Rose Tortrix	11,734	0.0 (-1.5:1.7)%
70.093	Gandaritis pyraliata	Barred Straw	9,283	0.0 (-1.3:1.3)%
71.017	Pheosia tremula	Swallow Prominent	5,706	-0.0 (-1.6:1.6)%
70.243	Ourapteryx sambucaria	Swallow-tailed Moth	13,264	-0.0 (-1.0:1.0)%
72.013	Euproctis similis	Yellow-tail	9,126	-0.1 (-1.5:1.3)%
71.012	Notodonta dromedarius	Iron Prominent	4,758	-0.1 (-1.6:1.2)%
73.346	Noctua interjecta	Least Yellow Underwing	5,052	-0.2 (-2.6:2.4)%
70.053	Xanthorhoe designata	Flame Carpet	15,697	-0.3 (-1.7:1.0)%
73.358	Xestia sexstrigata	Six-striped Rustic	13,592	-0.3 (-2.5:2.0)%
63.114	Elophila nymphaeata	Brown China-mark	2,093	-0.3 (-3.1:2.6)%
70.244	Colotois pennaria	Feathered Thorn	3,193	-0.4 (-2.7:1.8)%
72.003	Hypena proboscidalis	Snout	41,941	-0.4 (-1.1:0.5)%
70.245	Alsophila aescularia	March Moth	1,911	-0.5 (-4.7:3.6)%
71.013	Notodonta ziczac	Pebble Prominent	7,002	-0.5 (-1.8:0.9)%
70.144	Pasiphila rectangularata	Green Pug	8,605	-0.6 (-1.9:0.7)%
73.169x	Mesapamea secalis agg.	Common Rustic agg.	157,200	-0.7 (-1.6:0.3)%
73.068	Allophyes oxyacanthae	Green-brindled Crescent	10,097	-0.7 (-1.9:0.6)%
73.194	Conistra vaccinii	Chestnut	6,402	-0.9 (-3.1:1.4)%
73.102	Rusina ferruginea	Brown Rustic	4,781	-1.1 (-3.4:1.6)%
70.106	Operophtera brumata	Winter Moth	4,140	-1.1 (-3.9:1.8)%
72.002	Rivula sericealis	Straw Dot	51,159	-1.1 (-2.3:0.0)%
63.037	Udea olivalis	Garden Pearl	9,515	-1.2 (-3.6:1.3)%
71.018	Pheosia gnoma	Lesser Swallow Prominent	6,836	-1.2 (-2.5:0.1)%
70.094	Ecliptopera silaceata	Small Phoenix	14,670	-1.2 (-2.6:0.2)%
70.132	Perizoma affinitata	Rivulet	2,109	-1.3 (-3.9:1.3)%
70.255	Agriopis marginaria	Dotted Border	1,753	-1.3 (-4.0:1.3)%
73.123	Hydraecia micacea	Rosy Rustic	24,953	-1.3 (-2.7:0.0)%
72.055	Herminia grisealis	Small Fan-foot	4,531	-1.3 (-3.3:0.6)%
70.280	Lomographa temerata	Clouded Silver	13,781	-1.4 (-2.8:0.0)%
73.334	Diarsia rubi	Small Square-spot	48,233	-1.5 (-3.0:0.2)%
70.205	Abraxas grossulariata	Magpie Moth	7,606	-1.5 (-3.4:0.3)%
70.247	Phigalia pilosaria	Pale Brindled Beauty	1,854	-1.8 (-5.4:2.0)%
3.005	Hepialus humuli	Ghost Moth	2,029	-2.0 (-4.5:0.3)%

## 6 Comparing GMS trends to previously reported long-term trends

[Figure 5](#) compares the recent (2008-23) GMS trends with the long-term trend (1968-2023) from the Rothamsted Insect Survey (RIS) data (Harrower et al., 2025) for the 157 species with trends estimated in both datasets.

**Figure 5: Species abundance trends: RIS long term 1968-2023 v GMS 2008-2023.** The diagonal blue line is numerical equality between the two trends. The species where the two estimates are formally different (z-test based on the CI of the two estimates) are shown in red.



The correlation here is not very strong and most species show formally significant differences in the trends. In most cases this is due to the long-term trends not being representative of more recent trends, with declines in abundances from the 70s and 80s being reversed in the 2000s or increases in abundance plateauing. There is clearly an analysis to be done here comparing recent and historical trends within the RIS series, but that is beyond the scope of a GMS data analysis. *What we do note here is that the GMS data tells us what is happening to moths now, whilst the RIS data (Atlas and State of Larger Moth reports), as currently analysed, tells us about what has happened over 55 years.*

[Table 10](#) lists those species that are significantly increasing in the GMS (and usually also in RIS over the same period) whilst suffering a significant long-term decline over the 55 years of RIS. This will be a subset of the moths that are undergoing recovery in recent years as the RIS estimates include the recent period and we are only looking at “recent” as defined by the 16 years of GMS. Interestingly we do not detect any species that are showing a significant decline in GMS while having a significant long-term RIS increase: this is unsurprising as most species are declining in the long-term RIS series.

In Appendix C we compare the two series showing that when assessed over the same time period the GMS and RIS data are remarkably consistent, despite the differences in geographical coverage and methodology.

**Table 10: Species where GMS shows recovery from the long term decline estimated from the RIS**

ABHno	Scientific Name	Common Name
66.001	Poecilocampa populi	December Moth
70.024	Scopula imitaria	Small Blood-vein
70.234	Ennomos alniaria	Canary-shouldered Thorn
70.256	Erannis defoliaria	Mottled Umber
71.025	Phalera bucephala	Buff-tip
73.045	Acronicta rumicis	Knot Grass
73.092	Caradrina morpheus	Mottled Rustic
73.131	Luperina testacea	Flounced Rustic
73.186	Agrochola lychnidis	Beaded Chestnut
73.291	Mythimna pallens	Common Wainscot
73.301	Leucania comma	Shoulder-striped Wainscot
73.319	Agrotis segetum	Turnip Moth
73.338	Lycophotia porphyrea	True Lover's Knot



**December Moth**



**Canary-shouldered Thorn**

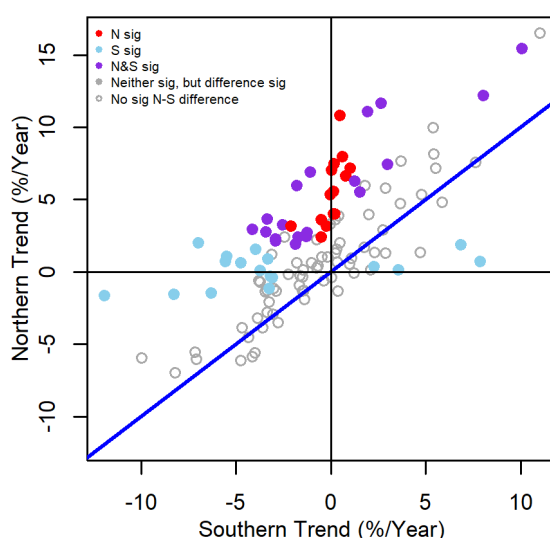
## North/South differences in abundance

Here we divide the country into North and South defined by the 450km N line of the Ordnance Survey National Grid (which runs from Fleetwood on the west coast of Lancashire, through York to Hornsea on the east coast), using the same split as the State of Larger Moths report (Fox et al., 2021). We estimate trends in abundance separately for the two halves of the country, and test whether these trends differ statistically.

119 main season species have sufficient data for a N-S comparison (arbitrarily set at >1000 moths observed in each of the N and S areas). None of the Winter species have sufficient data to allow us to test for North/South differences.

[Figure 4](#) below shows the trend estimates in the North compared to the South, with those reaching statistical significance shown with filled symbols:

**Figure 4: Comparing the GMS species abundance trends between North and South Britain.** Coloured closed symbols indicate species which show a statistically significant difference between the North and South, open symbols indicate species that did not show a significant difference.



95/119 (80%) species are increasing more or decreasing less rapidly in the North than the South.

50/119 (42%) species show significant North-South abundance trend differences. Nearly all these are showing more positive trends in the North compared to the South.

- 46 species are doing significantly better in the North than the South:
  - 7 species are significantly increasing in both the North and the South but showing much stronger increases in the North (Right hand purple group in the plot above, listed in [Table 5](#))
  - 14 species are significantly increasing in the North but showing no significant change in the South (red in plot above, listed in [Table 6](#))
  - 12 species are significantly increasing in the North and significantly decreasing in the South (Left-hand purple group in plot above, listed in [Table 7](#))
  - 13 species are decreasing in the South but showing no significant change in the North (Left-hand blue group in plot above, listed in [Table 8](#))
- 4 species are doing significantly better in the South than the North:
  - All these 4 species are increasing in the South but showing no significant change in the North (Right-hand blue group in plot above, listed in [Table 9](#))

**Table 5: Species increasing nationally but more rapidly in the North**

Code	Scientific Name	Common Name	North trend (%/Y)	South trend (%/Y)	NvS P value
63.093	<i>Agriphila straminella</i>	Straw Grass-moth	11.07 (7.71:14.53)	1.94 (0.33:3.58)	<0.001
49.039	<i>Epiphyas postvittana</i>	Light Brown Apple Moth	11.66 (9.65:13.71)	2.66 (1.83:3.49)	<0.001
73.193	<i>Anchoscelis lunosa</i>	Lunar Underwing	15.43 (12.28:18.68)	10.08 (9.04:11.12)	0.038
72.045	<i>Eilema lurideola</i>	Common Footman	6.24 (4.34:8.17)	1.26 (0.49:2.03)	0.002
73.357	<i>Xestia xanthographa</i>	Square-spot Rustic	7.42 (5.67:9.20)	2.98 (2.20:3.76)	0.004
69.016	<i>Deilephila elpenor</i>	Elephant Hawk-moth	12.18 (9.80:14.62)	8.04 (7.08:9.02)	0.048
63.025	<i>Anania hortulata</i>	Small Magpie	5.49 (3.26:7.78)	1.54 (0.67:2.41)	0.014



**Lunar Underwing**

**Table 6: Species increasing in the North but no significant change in the South**

Code	Scientific Name	Common Name	North trend (%/Y)	South trend (%/Y)	NvS P value
73.359	<i>Xestia c-nigrum</i>	Setaceous Hebrew Character	10.78 (8.46:13.15)	0.48 (-0.38:1.34)	<0.001
73.325	<i>Agrotis puta</i>	Shuttle-shaped Dart	7.95 (5.38:10.57)	0.61 (-0.26:1.49)	<0.001
73.187	<i>Anchoscelis litura</i>	Brown-spot Pinion	7.48 (3.70:11.41)	0.18 (-1.89:2.28)	0.010
70.061	<i>Epirrhoe alternata</i>	Common Carpet	7.01 (5.26:8.79)	0.03 (-0.86:0.93)	<0.001
70.277	<i>Cabera pusaria</i>	Common White Wave	7.15 (4.48:9.89)	1.04 (-0.23:2.32)	0.004
63.038	<i>Patania ruralis</i>	Mother of Pearl	6.63 (4.53:8.77)	0.80 (-0.10:1.71)	<0.001
73.267	<i>Lacanobia oleracea</i>	Bright-line Brown-eye	5.57 (3.78:7.39)	0.15 (-0.64:0.95)	<0.001
73.338	<i>Lycophotia porphyrea</i>	True Lover's Knot	5.34 (2.40:8.37)	-0.04 (-2.23:2.19)	0.018
73.264	<i>Lacanobia thalassina</i>	Pale-shouldered Brocade	3.16 (0.63:5.76)	-2.10 (-4.41:0.26)	0.036
73.317	<i>Agrotis exclamationis</i>	Heart and Dart	3.61 (2.08:5.15)	-0.51 (-1.20:0.19)	<0.001
73.298	<i>Mythimna ferrago</i>	Clay	3.98 (1.48:6.53)	0.14 (-0.88:1.18)	0.018
70.016	<i>Idaea aversata</i>	Riband Wave	3.98 (2.75:5.21)	0.21 (-0.34:0.77)	<0.001
69.003	<i>Laothoe populi</i>	Poplar Hawk-moth	3.14 (1.82:4.48)	-0.24 (-0.93:0.45)	0.002
70.243	<i>Ourapteryx sambucaria</i>	Swallow-tailed Moth	2.39 (0.34:4.48)	-0.49 (-1.44:0.46)	0.022

**Table 7: Species increasing significantly in the North while decreasing significantly in the South**

Code	Scientific Name	Common Name	North trend (%/Y)	South trend (%/Y)	NvS P value
73.069	<i>Xylocampa areola</i>	Early Grey	6.89 (5.12:8.68)	-1.09 (-1.83:-0.35)	<0.001
73.064	<i>Amphipyra tragopoginis</i>	Mouse Moth	5.94 (3.40:8.54)	-1.80 (-3.47:-0.09)	<0.001
73.328	<i>Axylia putris</i>	Flame	2.94 (0.94:4.99)	-4.13 (-4.95:-3.30)	<0.001
73.216	<i>Cosmia trapezina</i>	Dun-bar	3.62 (1.33:5.95)	-3.36 (-4.32:-2.38)	<0.001
72.053	<i>Herminia tarsipennalis</i>	Fan-foot	2.74 (0.56:4.96)	-3.40 (-4.46:-2.32)	<0.001
70.094	<i>Ecliptopera silaceata</i>	Small Phoenix	3.22 (1.11:5.37)	-2.55 (-3.65:-1.44)	0.002
73.123	<i>Hydraecia micacea</i>	Rosy Rustic	2.27 (0.63:3.95)	-2.89 (-3.93:-1.84)	<0.001
72.019	<i>Spilosoma lutea</i>	Buff Ermine	2.14 (0.41:3.90)	-2.92 (-3.67:-2.17)	<0.001
72.002	<i>Rivula sericealis</i>	Straw Dot	2.39 (0.32:4.50)	-1.71 (-2.70:-0.71)	<0.001
71.013	<i>Notodonta ziczac</i>	Pebble Prominent	2.72 (0.20:5.30)	-1.24 (-2.44:-0.01)	0.018
73.342	<i>Noctua pronuba</i>	Large Yellow Underwing	1.88 (0.73:3.05)	-1.85 (-2.40:-1.30)	<0.001
70.053	<i>Xanthorhoe designata</i>	Flame Carpet	2.44 (0.77:4.13)	-1.27 (-2.31:-0.23)	0.020



**Early Grey**

**Table 8: Species decreasing in the South but no significant change in the North**

Code	Scientific Name	Common Name	North trend (%/Y)	South trend (%/Y)	NvS P value
73.206	<i>Lithophane leautieri</i>	Blair's Shoulder-knot	-1.65 (-4.19:0.95)	-11.93 (-13.07:-10.77)	<0.001
73.250	<i>Anorthoa munda</i>	Twin-spotted Quaker	1.99 (-1.62:5.74)	-6.97 (-8.46:-5.45)	<0.001
73.353	<i>Xestia baja</i>	Dotted Clay	-1.57 (-3.44:0.35)	-8.26 (-10.29:-6.18)	0.002
73.361	<i>Xestia triangulum</i>	Double Square-spot	1.06 (-0.92:3.07)	-5.47 (-6.50:-4.44)	<0.001
65.009	<i>Habrosyne pyritoides</i>	Buff Arches	0.70 (-2.07:3.54)	-5.54 (-6.74:-4.32)	<0.001
73.182	<i>Cirrhia icteritia</i>	Sallow	1.55 (-1.53:4.73)	-3.96 (-5.55:-2.34)	0.002
70.241	<i>Crocallis elinguaris</i>	Scalloped Oak	0.63 (-0.89:2.17)	-4.74 (-5.47:-4.00)	<0.001
73.084	<i>Bryophila domestica</i>	Marbled Beauty	-1.47 (-3.45:0.56)	-6.29 (-7.27:-5.30)	<0.001
72.020	<i>Spilosoma lubricipeda</i>	White Ermine	0.89 (-0.86:2.67)	-3.32 (-4.21:-2.42)	0.008
70.237	<i>Selenia dentaria</i>	Early Thorn	0.06 (-1.61:1.76)	-3.72 (-4.52:-2.91)	<0.001
73.329	<i>Ochrolepura plecta</i>	Flame Shoulder	-0.33 (-1.83:1.20)	-3.17 (-3.84:-2.48)	0.002
73.249	<i>Orthosia gothica</i>	Hebrew Character	-0.43 (-1.64:0.80)	-3.09 (-3.71:-2.46)	0.002
70.097	<i>Dysstroma truncata</i>	Common Marbled Carpet	-1.17 (-2.54:0.21)	-3.23 (-3.93:-2.52)	0.024



**Blair's Shoulder-knot**

**Table 9: Species doing better in the South: increasing in the South but no significant change in the North**

Code	Scientific Name	Common Name	North trend (%/Y)	South trend (%/Y)	NvS P value
70.226	<i>Opisthocraptis luteolata</i>	Brimstone Moth	0.36 (-0.84:1.57)	2.27 (1.72:2.83)	0.038
70.283	<i>Campaea margaritaria</i>	Light Emerald	0.14 (-1.65:1.97)	3.56 (2.68:4.45)	0.004
73.219	<i>Atethmia centrigo</i>	Centre-barred Sallow	1.86 (-1.00:4.81)	6.86 (5.36:8.38)	0.026
73.291	<i>Mythimna pallens</i>	Common Wainscot	0.72 (-1.97:3.49)	7.86 (6.66:9.08)	<0.001



**Brimstone Moth**

## 7 Discussion

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The analyses presented in this report demonstrate clearly that the GMS is now mature enough and has been running for sufficient time to allow us to draw reliable conclusions about the state of moths in our gardens. Overall the GMS reveals very similar trends to those seen in the RIS when similar time periods are considered, and the two series thus validate each other. The GMS runs around 300 traps run each year compared to the around 80 traps currently run by the RIS, albeit that the location of the GMS traps is inevitably biased towards areas of greater population. The GMS has better coverage in England and Wales, but less so in Scotland, but the RIS has the benefit of more stable locations over time. In contrast to the RIS, the GMS also includes Ireland.

Previous large-scale UK studies of abundance trends, based on RIS data (the Atlas and State of Larger Moth reports) have focussed on the larger (macro) moths and have looked over a long timescale from the late '60s or early '70s. These reports generally present a depressing picture with long-term declines in two-thirds of recorded species. The more recent (2008-23) GMS data paints a somewhat brighter picture with overall moth abundance steady, with about half of species increasing, and half decreasing, in abundance. The GMS scheme is limited to common, widespread species so may miss habitat specialists that might be particularly at risk. However, it is clear that there are a large number of GMS-monitored species which have declined in the long-term studies, but which are now increasing, or at least reasonably stable. Similar recoveries are seen in the (as yet unpublished) RIS datasets which do suggest that for a number of species a nadir in abundance was reached in the late 2000's. It is tempting to attribute this partial recovery to changes in environmental and agricultural policies in the 1990's and 2000's.

Despite this, there are clearly many species that are still declining and reducing in range and are of concern (see Table 3). Some of the species showing the steepest decline (such as the Dot moth and Beautiful Golden Y), are continuing long-term trends, whilst the Clouded-bordered Brindle was stable in the long-term studies but has declined in gardens in the last few years - whether this is a statistical fluke or part of a greater pattern will be seen in future years of the GMS.



***Dot Moth***

There are two species which may be particularly associated with gardens and are showing major declines. Blair's Shoulder-knot is a moth that has increased in abundance and range over recent decades, an increase associated with the planting of cypress (particularly *leylandii*) species in gardens. Similarly, the Spruce Carpet has increased since the 1970's due to increased planting of conifers – including in gardens. In both cases this increase has now reversed and both species have

declined over the GMS period: Blair's Shoulder-knot by some 10%/year, and also showing a large decrease in GMS range, the Spruce Carpet by a more modest 3%/year.



***Spruce Carpet***

The Twin-spotted Quaker has shown a substantial decline (5.6%/year) over the GMS period, but this seems to be largely attributable to a few abnormally good years in the first few years of the GMS. It is possible that this, and some other, apparent trends may be exaggerated in this analysis due to exceptionally good or bad years at the start of the scheme, and we require longer periods to be certain of some of the trends (Fox et al., 2019), particularly in those species which show long-term periodicity in abundance (e.g. the Buff-tip).



***Buff-tip***

Species doing particularly well and showing increases in abundance of 10% per year or more include a number of micro-moths (see below), the Least Carpet and Vine's Rustic (which are also being seen more gardens), and Lunar Underwing and Brindled Beauty.

There are only a few micro-moth species that have been recorded in the GMS for the full period, although many more have been added subsequently. There is little monitoring of micro-moth species, and the GMS has potential to make a novel contribution in future years. However, we have to be cautious in interpreting trends in micro-moth species as these have until very recently been tricky to ID, and it is only since 2012 and the publication of the 1st edition of the Sterling & Parsons book (Sterling, Parsons and Lewington, 2012) that there has been an accessible field guide. It is plausible

that as recorders become more confident, they are able to recognise and identify a wider range of small moths overlooked in earlier years of recording. The species with currently available trends include the Ruddy Streak (*Tachystola acroxantha*) – now named the Australian Orange-tip; as its new name suggests this is an adventive species which has spread rapidly in recent years, and the range expansion can be seen in the GMS data as well as a 27%/year increase in abundance. Whilst this micro may be overlooked until recorders become more experienced, the rate of increase here is so dramatic as to be hard to ascribe to bias.



**Ruddy Streak or Australian Orange-tip (*Tachystola acroxantha*)**

The Green Oak Tortrix has shown a very large increase in abundance (17%/year), but the abundance has been very variable year-to-year and much of the trend is due to a few good recent years with 2023 being exceptional; it will be interesting to follow this species in future years. The large increase (12%/year) in the abundance of the Garden Grass Moth (*Chrysoteuchia culmella*) is interesting to a Garden Moth Scheme, but this species, along with the other “grass moths” that are also showing increases, would seem to be more susceptible to recording bias - these are readily ignored and require some determination and experience to sort through and identify.

80% of species where we can assess North-South differences are performing better in the North than the South with 46/119 (39%) of species showing statistically significantly more positive (or less negative) trends in the North and only 4/119 (3%) species doing better in the South (see tables 5-9). These changes are likely to be due to climate change and a northward shift in suitable climate for the species, although differential agricultural practices in the more intensively farmed South cannot be ruled out.



**Setaceous Hebrew Character**

Notable species doing particularly well in the North compared to the South are the Setaceous Hebrew Character and Shuttle-shaped Dart (see [Table 6](#)). 12 species are significantly increasing in abundance in the North whilst significantly decreasing in the South (see [Table 7](#)) which is strong evidence of a northerly range shift, the largest differences being seen in the Early Grey, Mouse Moth, Flame and Dun-Bar. Even the ubiquitous Large Yellow Underwing is showing a small increase (2%/year) in the North with a similar decrease in the South.

It is difficult to be certain of distribution changes with the GMS data as the location of traps is not consistent over time, but march of Dingy Footman through northern England is unmistakable as is the spread of the Shuttle-shaped Dart into Scotland. The loss of Burnished Brass and Light Arches on South coast is also quite apparent. On the negative side, the reduction in range of the Plain Golden Y and the Dot Moth is also relatively clear.



***Dingy Footman***

There are only 4 species that are demonstrably faring better in the South compared to the North (see [Table 9](#)), the Common Wainscot showing the most marked difference with the ubiquitous Brimstone Moth, the Light Emerald and the Centre-barred Sallow showing smaller differences. These are all species which are significantly increasing in the South but only showing non-significant increases in the North.

Other than the Northward movement of what we can assume are the suitable climatic conditions driven by global heating, it is difficult to find any large-scale patterns to specific species traits that might suggest a common cause of gain or loss. We have looked at the relationship between abundance trends and a published set of potential traits (Howell et al., 2023) but failed to find any meaningful associations. This is probably not surprising as the GMS focuses on common, widespread species, rather than those which have specific narrow habitat requirements. The ability to thrive in a wide range of common habitats – and therefore to be relatively common in gardens – was a prerequisite for inclusion in the scheme. In recent years the list of species monitored has increased substantially, the 2025 list has 455 species, however it remains to be seen how many of these species frequent garden moth traps and provide sufficient numbers to estimate trends.

## 8 Individual species accounts

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A series of individual reports are available showing the distributions, yearly abundances and trends for each of the 178 species evaluated. These are available in the results section of the GMS website <http://gardenmothscheme.org.uk/>.

## 9 Conclusions

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The GMS has proved to be a valuable tool for assessing trends in the abundance of moths. With careful analysis, this citizen led, citizen science project has been able to derive trend estimates of similar reliability and robustness to the professionally managed Rothamsted Insect Survey.

The results demonstrate a mixed picture with some evidence that the long-term decline noted in previous studies may have reversed or at least stabilised for many species. However, there are still concerning declines in many of these common moth species.

If the enthusiasm and dedication of the recorders can be maintained and new recorders added to replace those who can no longer participate, the GMS has the potential to continue to monitor trends over a longer time, and as the data with additional species matures, over a wider range of species.



*Shuttle-shaped Darts*

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# APPENDIX A: Moth species analysed

**Table 11: Species included in this report (Main summer scheme)**

ABHno	Scientific Name	Common Name	Total Moths Recorded
18.001	<i>Plutella xylostella</i>	Diamond-back Moth	44,292
28.009	<i>Endrosis sarcitrella</i>	White-shouldered House-moth	9,263
28.010	<i>Hofmannophila pseudospretella</i>	Brown House-moth	22,614
28.024	<i>Tachystola acroxantha</i>	Ruddy Streak	17,205
3.001	<i>Triodia sylvina</i>	Orange Swift	7,970
3.002	<i>Korscheltellus lupulina</i>	Common Swift	13,767
3.005	<i>Hepialus humuli</i>	Ghost Moth	2,412
31.001	<i>Carcina quercana</i>	Long-horned Flat-body	5,736
44.001	<i>Alucita hexadactyla</i>	Many-plumed Moth	7,739
49.039	<i>Epiphyas postvittana</i>	Light Brown Apple Moth	161,678
49.059	<i>Tortrix viridana</i>	Green Oak Tortrix	6,351
49.077	<i>Acleris variegana</i>	Garden Rose Tortrix	13,164
62.001	<i>Aphomia sociella</i>	Bee Moth	18,613
62.075	<i>Hypsopygia costalis</i>	Gold Triangle	3,793
63.018	<i>Anania coronata</i>	Elder Pearl	7,828
63.025	<i>Anania hortulata</i>	Small Magpie	34,246
63.031	<i>Udea ferrugalis</i>	Rusty-dot Pearl	12,288
63.037	<i>Udea olivalis</i>	Garden Pearl	10,694
63.038	<i>Patania ruralis</i>	Mother of Pearl	66,845
63.052	<i>Nomophila noctuella</i>	Rush Veneer	8,317
63.057	<i>Evergestis forficalis</i>	Garden Pebble	7,516
63.080	<i>Chrysoteuchia culmella</i>	Garden Grass-veneer	200,714
63.089	<i>Agriphila tristella</i>	Common Grass-moth	78,000
63.093	<i>Agriphila straminella</i>	Straw Grass-moth	66,209
63.114	<i>Elophila nymphaeata</i>	Brown China-mark	2,364
65.007	<i>Cilix glaucata</i>	Chinese Character	6,840
65.008	<i>Thyatira batis</i>	Peach Blossom	3,263
65.009	<i>Habrosyne pyritoides</i>	Buff Arches	16,919
69.003	<i>Laothoe populi</i>	Poplar Hawk-moth	23,335
69.016	<i>Deilephila elpenor</i>	Elephant Hawk-moth	36,352
70.004	<i>Idaea rusticata</i>	Least Carpet	10,831
70.008	<i>Idaea seriata</i>	Small Dusty Wave	7,216
70.011	<i>Idaea dimidiata</i>	Single-dotted Wave	16,805
70.013	<i>Idaea biselata</i>	Small Fan-footed Wave	24,106
70.016	<i>Idaea aversata</i>	Riband Wave	138,745
70.024	<i>Scopula imitaria</i>	Small Blood-vein	3,447
70.029	<i>Timandra comae</i>	Blood-Vein	9,597
70.045	<i>Scotopteryx chenopodiata</i>	Shaded Broad-bar	4,802
70.049	<i>Xanthorhoe fluctuata</i>	Garden Carpet	36,884
70.053	<i>Xanthorhoe designata</i>	Flame Carpet	17,449
70.054	<i>Xanthorhoe montanata</i>	Silver-ground Carpet	17,931
70.059	<i>Campogramma bilineata</i>	Yellow Shell	7,688
70.061	<i>Epirrhoe alternata</i>	Common Carpet	25,132
70.066	<i>Earophila badiata</i>	Shoulder Stripe	2,850
70.074	<i>Hydriomena furcata</i>	July Highflyer	16,021
70.081	<i>Thera obeliscata</i>	Grey Pine Carpet	8,367
70.085	<i>Cidaria fulvata</i>	Barred Yellow	2,373
70.093	<i>Gandaritis pyraliata</i>	Barred Straw	10,741
70.094	<i>Ecliptopera silaceata</i>	Small Phoenix	16,847
70.097	<i>Dysstroma truncata</i>	Common Marbled Carpet	76,667
70.100	<i>Colostygia pectinataria</i>	Green Carpet	24,065
70.132	<i>Perizoma affinitata</i>	Rivulet	2,354
70.133	<i>Perizoma alchemillata</i>	Small Rivulet	6,996
70.141	<i>Gymnoscelis ruffasciata</i>	Double-striped Pug	29,891
70.144	<i>Pasiphila rectangulata</i>	Green Pug	10,024
70.173	<i>Eupithecia centaureata</i>	Lime-speck Pug	8,353
70.205	<i>Abraxas grossulariata</i>	Magpie Moth	8,610
70.207	<i>Lomaspilis marginata</i>	Clouded Border	19,926
70.222	<i>Petrophora chlorosata</i>	Brown Silver-line	9,863
70.226	<i>Opisthopteryx luteolata</i>	Brimstone Moth	110,948

70.234	<i>Ennomos alniaria</i>	Canary-shouldered Thorn	8,968
70.237	<i>Selenia dentaria</i>	Early Thorn	21,838
70.239	<i>Selenia tetralunaria</i>	Purple Thorn	2,467
70.240	<i>Odontopera bidentata</i>	Scalloped Hazel	10,248
70.241	<i>Crocallis elinguaría</i>	Scalloped Oak	23,418
70.243	<i>Ourapteryx sambucaria</i>	Swallow-tailed Moth	15,169
70.248	<i>Lycia hirtaria</i>	Brindled Beauty	9,696
70.251	<i>Biston strataria</i>	Oak Beauty	7,216
70.252	<i>Biston betularia</i>	Peppered Moth	24,118
70.258	<i>Peribatodes rhomboidaria</i>	Willow Beauty	85,608
70.265	<i>Alcis repandata</i>	Mottled Beauty	22,412
70.277	<i>Cabera pusaria</i>	Common White Wave	7,826
70.278	<i>Cabera exanthemata</i>	Common Wave	7,246
70.280	<i>Lomographa temerata</i>	Clouded Silver	15,697
70.283	<i>Campaea margaritaria</i>	Light Emerald	27,131
70.305	<i>Hemithea aestivaria</i>	Common Emerald	6,767
71.012	<i>Notodonta dromedarius</i>	Iron Prominent	5,490
71.013	<i>Notodonta ziczac</i>	Pebble Prominent	8,171
71.017	<i>Pheosia tremula</i>	Swallow Prominent	6,819
71.018	<i>Pheosia gnoma</i>	Lesser Swallow Prominent	8,037
71.020	<i>Pterostoma palpina</i>	Pale Prominent	5,057
71.021	<i>Ptilodon capucina</i>	Coxcomb Prominent	3,665
71.025	<i>Phalera bucephala</i>	Buff-tip	15,387
72.002	<i>Rivula sericealis</i>	Straw Dot	56,501
72.003	<i>Hypena proboscidalis</i>	Snout	48,005
72.013	<i>Euproctis similis</i>	Yellow-tail	10,586
72.015	<i>Calliteara pudibunda</i>	Pale Tussock	10,935
72.019	<i>Spilosoma lutea</i>	Buff Ermine	61,466
72.020	<i>Spilosoma lubricipeda</i>	White Ermine	34,489
72.022	<i>Diaphora mendica</i>	Muslin Moth	12,149
72.024	<i>Phragmatobia fuliginosa</i>	Ruby Tiger	16,344
72.026	<i>Arctia caja</i>	Garden Tiger	5,203
72.044	<i>Eilema griseola</i>	Dingy Footman	47,882
72.045	<i>Eilema lurideola</i>	Common Footman	128,108
72.053	<i>Herminia tarsipennalis</i>	Fan-foot	18,534
72.055	<i>Herminia grisealis</i>	Small Fan-foot	5,210
73.001	<i>Abrostola tripartita</i>	Spectacle	25,713
73.012	<i>Diachrysis chrysis</i>	Burnished Brass	24,080
73.015	<i>Autographa gamma</i>	Silver Y	58,057
73.016	<i>Autographa pulchrina</i>	Beautiful Golden Y	12,597
73.017	<i>Autographa jota</i>	Plain Golden Y	7,232
73.045	<i>Acronicta rumicis</i>	Knot Grass	8,788
73.064	<i>Amphipyra tragopoginis</i>	Mouse Moth	6,508
73.068	<i>Allophyes oxyacanthae</i>	Green-brindled Crescent	11,538
73.069	<i>Xylocampa areola</i>	Early Grey	31,126
73.084	<i>Bryophila domestica</i>	Marbled Beauty	23,985
73.092	<i>Caradrina morpheus</i>	Mottled Rustic	21,785
73.095	<i>Caradrina clavipalpis</i>	Pale Mottled Willow	19,741
73.099	<i>Hoplodrina ambigua</i>	Vine's Rustic	70,689
73.102	<i>Rusina ferruginea</i>	Brown Rustic	5,713
73.113	<i>Phlogophora meticulosa</i>	Angle Shades	21,006
73.114	<i>Euplexia lucipara</i>	Small Angle Shades	8,165
73.121	<i>Gortyna flavago</i>	Frosted Orange	4,596
73.123	<i>Hydraecia micacea</i>	Rosy Rustic	29,067
73.131	<i>Luperina testacea</i>	Flounced Rustic	47,133
73.154	<i>Apamea remissa</i>	Dusky Brocade	7,592
73.156	<i>Apamea crenata</i>	Clouded-bordered Brindle	13,081
73.158	<i>Apamea sordens</i>	Rustic Shoulder-knot	13,314
73.162	<i>Apamea monoglypha</i>	Dark Arches	236,203
73.163	<i>Apamea lithoxylaea</i>	Light Arches	9,840
73.169x	<i>Mesapamea secalis</i> agg.	Common Rustic agg.	176,549
73.173x	<i>Oligia strigilis</i> agg.	Marbled Minor agg.	63,548
73.176	<i>Oligia fasciuncula</i>	Middle-barred Minor	18,282
73.180	<i>Tiliacea aurago</i>	Barred Sallow	6,276
73.181	<i>Xanthia togata</i>	Pink-barred Sallow	5,777
73.182	<i>Cirrhia icteritia</i>	Sallow	6,990
73.186	<i>Agrochola lychnidis</i>	Beaded Chestnut	26,579

73.187	Anchoscelis litura	Brown-spot Pinion	7,471
73.189	Leptologia lota	Red-line Quaker	9,956
73.192	Sunira circellaris	Brick	2,658
73.193	Anchoscelis lunosa	Lunar Underwing	81,884
73.195	Conistra ligula	Dark Chestnut	2,334
73.206	Lithophane leautieri	Blair's Shoulder-knot	12,254
73.210	Eupsilia transversa	Satellite	3,548
73.216	Cosmia trapezina	Dun-bar	26,934
73.219	Atethmia centrago	Centre-barred Sallow	8,941
73.233	Aporophyla nigra	Black Rustic	23,566
73.242	Orthosia incerta	Clouded Drab	60,973
73.244	Orthosia cerasi	Common Quaker	150,842
73.245	Orthosia cruda	Small Quaker	72,310
73.247	Orthosia gracilis	Powdered Quaker	6,146
73.249	Orthosia gothica	Hebrew Character	186,147
73.250	Anorthoa munda	Twin-spotted Quaker	12,528
73.264	Lacanobia thalassina	Pale-shouldered Brocade	5,009
73.267	Lacanobia oleracea	Bright-line Brown-eye	51,832
73.270	Melanchnra persicariae	Dot Moth	14,717
73.271	Ceramica pisi	Broom Moth	3,731
73.274	Mamestra brassicae	Cabbage Moth	7,562
73.290	Mythimna conigera	Brown-line Bright-eye	5,575
73.291	Mythimna pallens	Common Wainscot	55,015
73.293	Mythimna impura	Smoky Wainscot	44,380
73.298	Mythimna ferrago	Clay	17,403
73.301	Leucania comma	Shoulder-striped Wainscot	12,952
73.317	Agrotis exclamationis	Heart and Dart	401,460
73.319	Agrotis segetum	Turnip Moth	23,344
73.325	Agrotis puta	Shuttle-shaped Dart	83,896
73.327	Agrotis ipsilon	Dark Sword-grass	4,836
73.328	Axylia putris	Flame	55,418
73.329	Ochropleura plecta	Flame Shoulder	121,517
73.333	Diarsia mendica	Ingrailed Clay	19,572
73.334	Diarsia rubi	Small Square-spot	56,013
73.338	Lycophotia porphyrea	True Lover's Knot	17,284
73.342	Noctua pronuba	Large Yellow Underwing	911,008
73.343	Noctua fimbriata	Broad-bordered Yellow Underwing	15,758
73.345	Noctua comes	Lesser Yellow Underwing	117,199
73.346	Noctua interjecta	Least Yellow Underwing	6,258
73.348	Noctua janthe	Lesser Broad-bordered Yellow Underwing	165,667
73.353	Xestia baja	Dotted Clay	15,150
73.357	Xestia xanthographa	Square-spot Rustic	145,006
73.358	Xestia sexstrigata	Six-striped Rustic	15,411
73.359	Xestia c-nigrum	Setaceous Hebrew Character	231,697
73.361	Xestia triangulum	Double Square-spot	40,758

**Table 12: Species included in this report (Winter scheme)**

ABHno	Scientific Name	Common Name	Total Moths Recorded
66.001	Poecilocampa populi	December Moth	7,404
70.079	Thera britannica	Spruce Carpet	5,187
70.095	Chloroclysta siterata	Red-Green Carpet	5,500
70.106	Operophtera brumata	Winter Moth	5,359
70.109x	Epirrita dilutata agg.	November Moth agg.	7,602
70.244	Colotois pennaria	Feathered Thorn	4,009
70.245	Alsophila aescularia	March Moth	2,555
70.247	Phigalia pilosaria	Pale Brindled Beauty	2,475
70.255	Agriopsis marginaria	Dotted Border	2,286
70.256	Erannis defoliaria	Mottled Umber	3,200
73.190	Leptologia macilenta	Yellow-line Quaker	5,574
73.194	Conistra vaccinii	Chestnut	7,599

**Table 13: Species excluded from this report**

ABHno	Scientific Name	Common Name	Reason
73.192	<i>Sunira circellaris</i>	Brick	Flight period outside GMS summer and insufficient winter data
73.195	<i>Conistra ligula</i>	Dark Chestnut	Flight period outside GMS summer and insufficient winter data
73.210	<i>Eupsilia transversa</i>	Satellite	Flight period outside GMS summer and insufficient winter data
63.052	<i>Nomophila noctuella</i>	Rush Veneer	Data unreliable *
73.327	<i>Agrotis ipsilon</i>	Dark Sword-grass	Data unreliable *
63.031	<i>Udea ferrugalis</i>	Rusty-dot Pearl	Data unreliable *

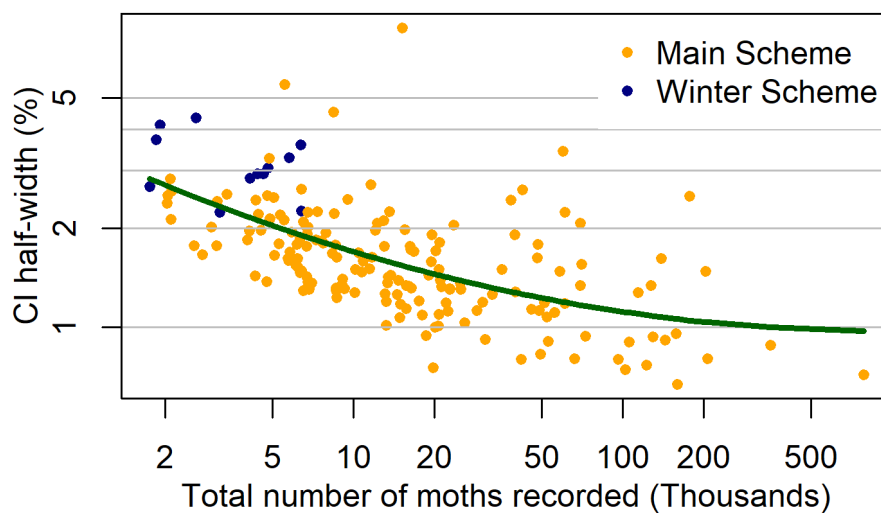
\* Unable to obtain reliable fits to the statistical models.

## APPENDIX B: What changes in abundance can we detect?

The ability of the dataset to detect changes in abundance and determine whether positive or negative trends are statistically significant depends on the number of moths recorded. More abundant species with more moths recorded have the potential to detect smaller changes in abundance. Here we provide an assessment of the magnitude of trends that we can detect with the GMS data as the number of moths recorded increases (this is what is called statistical power).

In [Figure 6](#) we plot the differences we can detect for each species (defined by the half-width of the 95% confidence interval) as a function of the number of moths in the analysis dataset. There is some noise here as the detectable difference depends on the distribution of these moths across traps and the variability between years; the line gives a smoothed average.

**Figure 6: Detectable change by number of moths recorded**



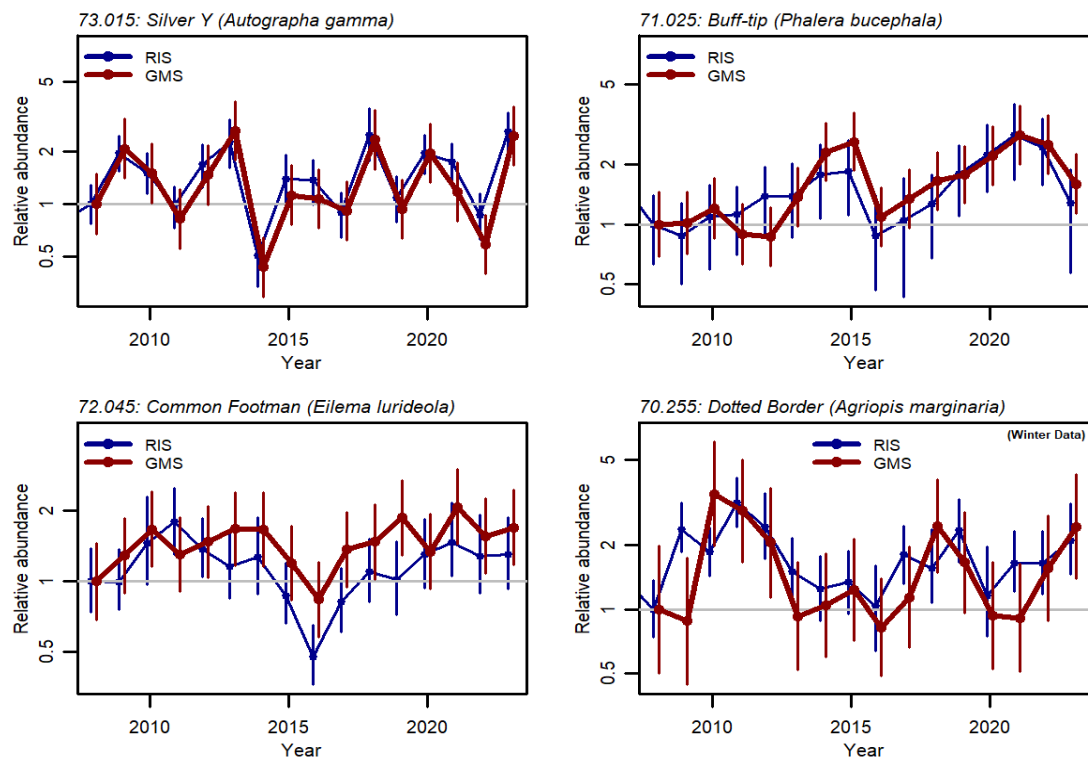
Thus, we can detect a change in abundance (trend) of around  $\pm 2.5\%$ /year with just 2000 moths recorded, whilst for the most abundant species we can detect a change in abundance of around  $\pm 1\%$ /year.

## APPENDIX C: Validation: Comparing GMS annual abundances to Rothamsted estimates

Here we compare the results obtained from the GMS data with those obtained previously from the Rothamsted Insect Survey (RIS) over a similar time frame. [Figure 7](#) shows the annual relative abundances for four illustrative species by year estimated from the two datasets. Abundances are normalised relative to 2008 and are shown with their associated 95%CI.

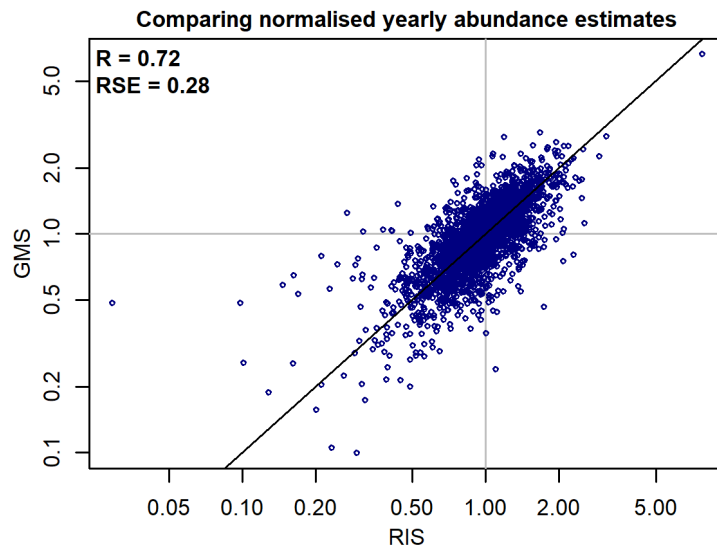
The Silver-Y is a ubiquitous, non-resident migratory species is widespread both geographically and in terms of habitat and would not be expected to show much difference in (relative) abundance between locations and monitoring schemes. As such it provides a reasonable test of the equivalence between the two schemes. The two series match astonishingly well. (Note the points in [Figure 7](#) are offset slightly for visibility.) Two further main GMS season and one Winter season species are also illustrated, selected as species which show rather wide fluctuations in abundance from year-to-year; again the trends are very similar, as they are for most species where we have data to compare.

**Figure 7: Abundance by year for Selected species**



[Figure 8](#) shows the association between the (log) annual abundances from the two series over 2008-2023 for all 157 species where we have both estimates.

**Figure 8: Normalised species abundance trend estimates: RIS 2008-23 v GMS 2008-23.** The abundances have been normalised by the mean abundances in each species and series so reflect relative changes between years and we analyse on the log scale and the diagonal line represents equivalence.



Despite the differences in methodology and geographical coverage, the two abundance estimates are well correlated ( $R=0.72$ ) and overall show a good level of agreement. The residual standard error from a linear fit is 0.28 suggesting a ~28% variation between the two measures. A better estimate is provided by the Bland-Altman limits of agreement (LoA); the 95% limits of agreement are (-0.54:0.54) suggesting the two series will estimate the abundance to within  $\pm 50\%$  95% of the time.