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# Quantifying links between birds, bats and insects in the UK

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## Introduction

**There is growing evidence that insect declines may be impacting higher trophic levels. Utilising the wealth of long-term monitoring data available within the UK, I conducted a broad assessment evaluating links between insect abundance and the population dynamics of five bird and five bat species.**

### Linking national monitoring schemes

We generated indices of insect abundance from the Rothamsted light trap survey, UK butterfly monitoring survey, Environment Agency freshwater insect monitoring, and ground beetle surveys from Environmental Change Network. These were then linked to population data from the Bird Breeding Survey and the National Bat Monitoring Programme. To pair timeseries we generated indices within different Ordnance Grid survey squares at three scales (100km, 50km, 10km).

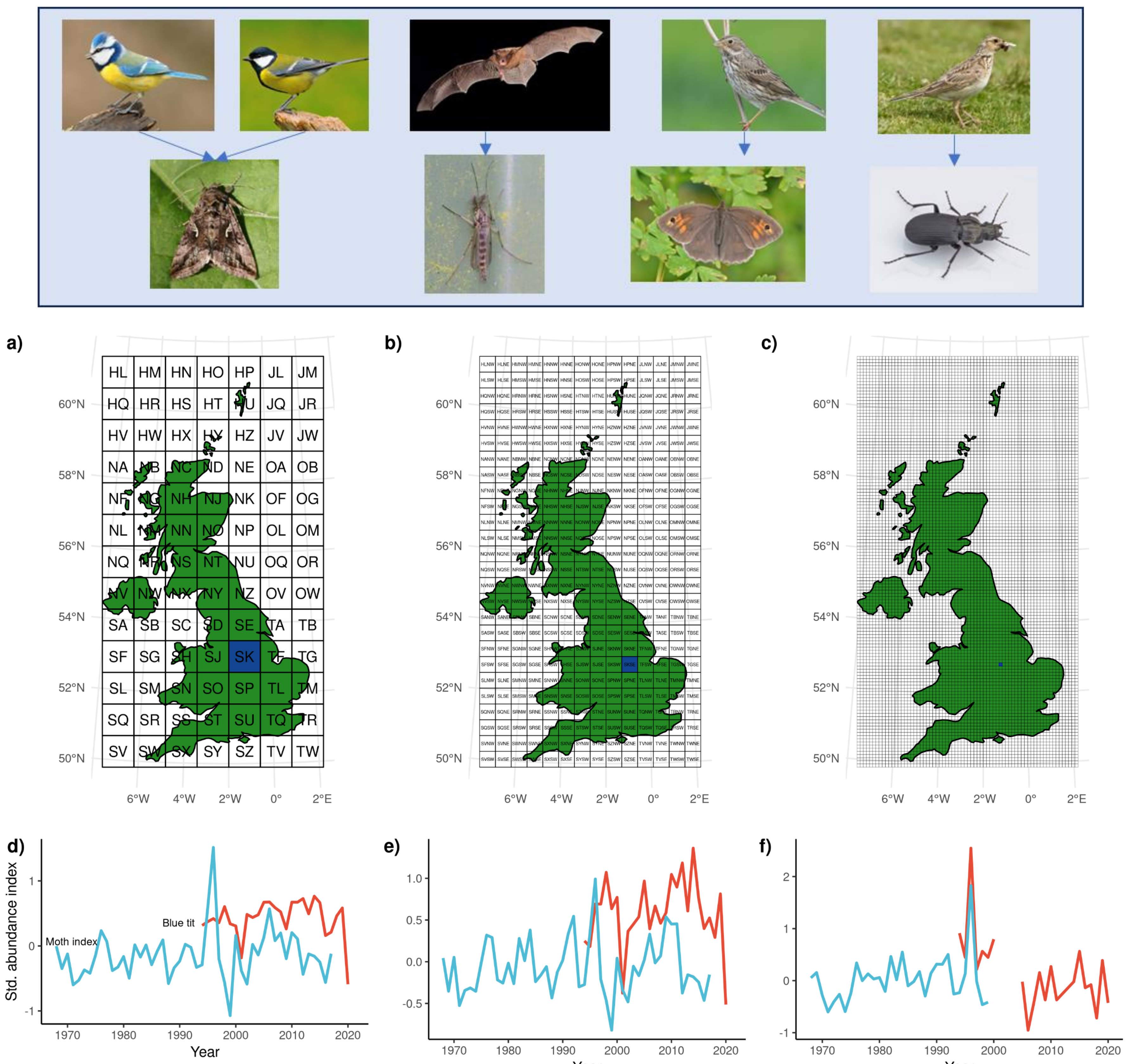


Figure 1. Top panel represents some parings between insects and insectivores. Bottom panel shows how indices were paired across different OS grid squares, the maps show a highlighted square with the resultant indices shown below for the blue tit (red) and the moth index (blue).

### Analysis

We used a 'causal ladder' approach, assessing: 1) correlation in population timeseries, 2) non-linear associations between timeseries through empirical dynamic modelling, and 3) linear causal links through fixed effects panel estimators. This approach allowed us to assess how robustly controlling for static and dynamic environmental factors influenced our inference about the role of insects and provided insight into the strengths and weaknesses of these different methodological approaches.

## Results

Table 1. Trends across scales for selected spp. Across different scales we found variation in trends, notably, for least one scale, all indices of insect food were declining

| Taxa | 100 | 50 | 10 |
|---|---|---|---|
| Blue tit | ↘ | ↘ | ↘ |
| Great tit | ↗ | → | ↘ |
| Corn bunting | → | → | → |
| Grey partridge | ↘ | → | → |
| Skylark | → | ↘ | ↘ |
| Serotine | → | → | → |
| Daubenton's bat | → | → | → |
| Moth index | → | → | ↘ |
| Butterfly index | ↘ | ↘ | ↘ |
| Diptera index | ↘ | ↘ | ↘ |
| Beetle index | ↘ | - | - |

Table 2. Correlations between trends for selected spp. There were few correlations in population trajectories with only positive correlations between moths and blue tits while aquatic insects and Daubenton's bats were negatively correlated

| | Trend | | | Remainder | | |
|---|---|---|---|---|---|---|
| Comparison | 100 | 50 | 10 | 100 | 50 | 10 |
| Blue tit (moths) | ● | ● | ● | ● | ● | ● |
| Great tit (moths) | ● | ● | ● | ● | ● | ● |
| Daubenton's (diptera) | ● | ● | ● | ● | ● | ● |

Controlling for shared responses to environmental variation had different effects across species. For the blue tit, controlling for shared responses to annual variation reduced the effect of moth abundance. For the Daubenton's bat the reverse was found, with effects of Diptera only detected after controlling for annual effects.

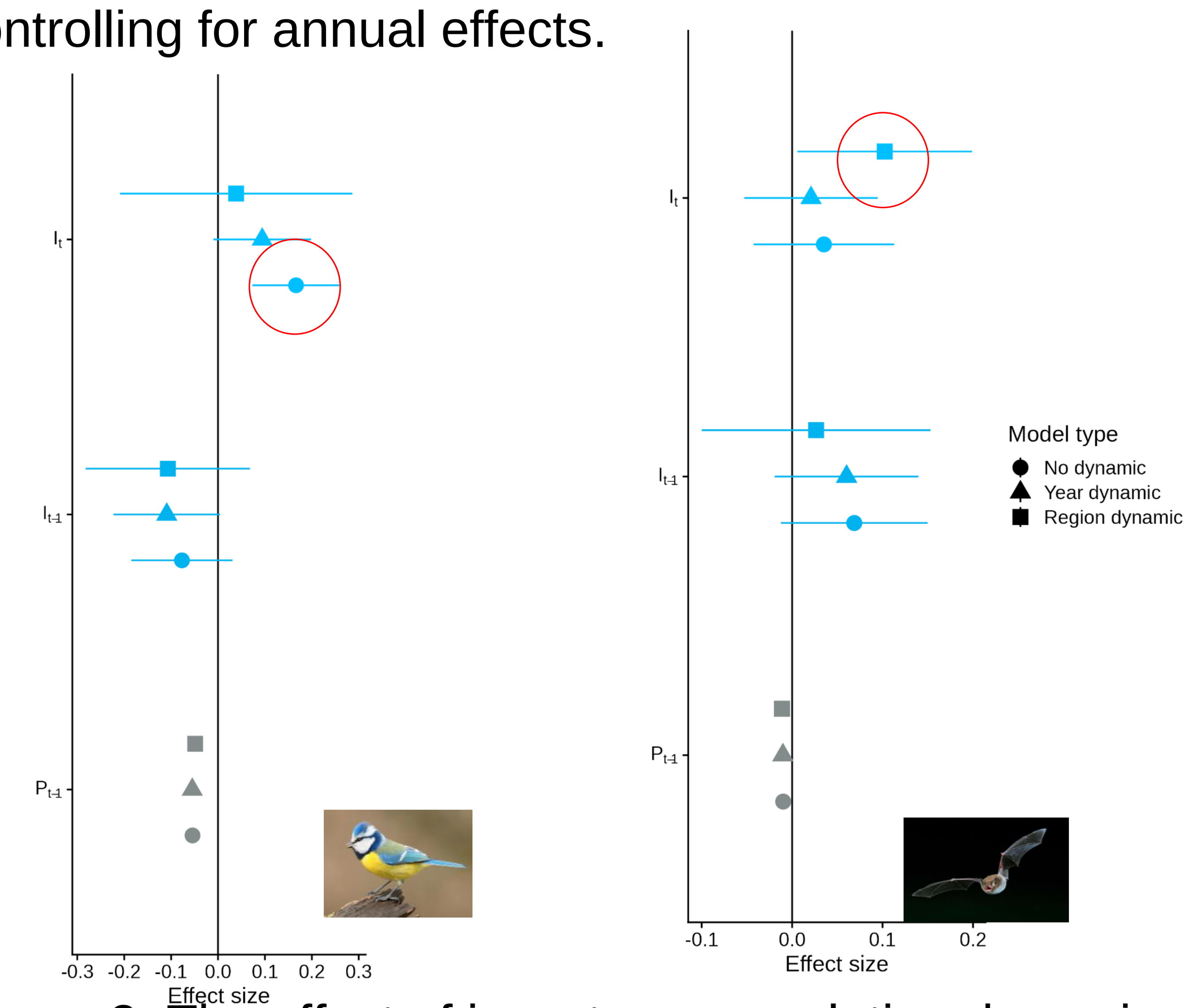


Figure 2. The effect of insects on population dynamics (annual population growth) given different controls on shared responses to environmental variation. Highlighted results are those described above.

### Conclusion

Across all comparisons we found evidence of links between great tit, blue it and moths, and the Daubenton's bat and Diptera (though evidence was mixed). Our work highlights the need to design robust identification strategies to understand the impacts of insects on higher trophic levels.