Briefing note: Effectiveness of UK Protected Areas

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Summary

What did we do?

- We compared patterns of occurrence, species richness and average trends between sites with protected areas (PAs) and those without.
- We used data from a range of volunteer-gathered datasets spanning the UK. We used biological records data for 5,254 species of invertebrates, bryophytes and lichens, Atlas data for 180 bird species and abundance data for 133 bird and 37 butterfly species. For 1,568 invertebrate species, we also assessed whether their trends in occupancy differed between protected and unprotected sites.
- For birds, we also quantified variation in reproductive rates in relation to the extent of PA, which may be a key potential mechanism to explain any positive effects of PA.
- We also explored the role of bird and butterfly traits (including population status and habitat associations) in explaining the effectiveness of PAs and, for birds, consequent effects on metrics of community structure.

What did we find?

- We found that sites with protected areas support a larger number of species than sites without protected areas.
- The effect of PAs on ecological rates appeared to be quite variable, with rates affected (or not) to different degrees between the groups, but areas with PA were generally more likely to be colonised, suggesting they may act as 'landing pads', for groups like pollinators, or refuges for more cold-adapted bird species.
- For some groups, there is evidence that PAs support more abundant populations, have higher fecundity and support movement.
- We only found a positive effect of PAs on population trend for butterflies (in SSSI and SAC) and birds in SPA.

What does it mean?

- Protected sites harbour more species and have more abundant populations than non-protected sites. Most likely this reflects the way that designated sites were selected (i.e. choosing to protect the "best" sites), rather than direct effects of protection.
- The effectiveness of UK protected sites is often thought of in terms of designated features. There have been few attempts to assess the degree to which protected sites deliver benefits for wider biodiversity. Whilst we did find some benefits of protection, our results provide evidence that, for some groups, the current PA network can be effective in mitigating the effect of anthropogenic pressures that are driving widespread biodiversity declines.
- The current studies were unable to address whether the biodiversity benefits of protection are concentrated in sites that are particularly large, well-connected, or in good condition. Exploring these issues should be a priority for future research.

Background

- Approaching 15% of the world's terrestrial ecosystems are designated as protected in some form and there is a large body of literature aimed at assessing their effectiveness. However, because of the diversity of management measures and outcomes encompassed by these PAs, evidence for their effectiveness is mixed.
- Sites that have been designated for the protection of wildlife are the backbone of nature conservation in the UK.
- The UK has signed up to the global goal of protecting 30% of the land and sea area by 2030, known as 30x30.
- Most sites were designated for the protection of specific species or habitats features. Official statistics report on the condition of PAs in protecting these designated features. There is relatively little evidence on the effectiveness of terrestrial PAs for wider biodiversity.
- UKCEH and BTO have conducted separate analyses to address this question, using the large volunteer datasets collated under TEPoP schemes.
- We define effectiveness in terms of ecological parameters of organisms on PAs compared with unprotected sites. PAs could be considered effective if they support larger numbers of species, if the populations exist at higher abundance, have higher demographic rates, or if the average trends in occupancy or abundance are high (all relative to unprotected sites).
- This document is a high-level summary of the results from both pieces of work.

Methods

- Biological records data came from national recording schemes for 1,083 species of bryophytes, centipedes, dragonflies and hoverflies.
- For these data we calculate the proportion of each species' predicted suitable habitat that overlaps with PAs. We compare representation between levels of specialism and taxonomic groups.
- We used occupancy-detection models to compare trends inside vs outside PAs for 1,568 terrestrial invertebrate species.
- Data for birds came from two comprehensive atlases (1988-91, Gibbons *et al*.[1] and 2007-11, Balmer *et al*.[2]) to measure occurrence (and changes in that), and the stratified random sample of the Breeding Bird Survey (1994-2019) to measure abundance and trends over time. Uniquely, we also quantified reproductive success on (self-selected) Constant Effort ringing sites (1994-2019) as a key demographic mechanism underlying population change.
- For bird occurrence we looked at 180 (80%) of ~220 regular breeding bird species, for abundance we quantified trends for 133 (60%) species. Measures of productivity were limited to 22 species that were regularly caught.
- Butterfly abundance data came from the Butterfly Monitoring Scheme and and the longer-running Wider Countryside Butterfly Survey and there were sufficient data to examine 37 species.
- For birds and butterflies (sampled at a 1- or 2km square level) we compared demographic metrics to the extent of statutorily designated PA (SSSI, SPA and SAC) in the sample square. For biological records data we compared two groups of 1km grid cells: "protected cells" were defined as those with at least 10% of the area was covered by sites designated for nature conservation (including statutory sites, but also NNR, Ramsar Sites, and Local Nature Reserves); "unprotected" sites were defined as those with <1% of area falling in these designations.
- Where possible, we controlled for differences between sites by incorporating confounding variables such as land-use and elevation in our models.
- Trends were analysed at the national (UK) level, with patterns of distribution from biological records data analysed separately for the four countries of the UK. Unfortunately, the data for Northern Ireland were not sufficient to allow separate estimates for every analysis.

[1]Gibbons, Reid and Chapman (1993). The New Atlas of Breeding Birds in Britain and Ireland: 1988-1991

[2] Balmer, Gillings, Caffrey, Swann, Downie and Fuller (2013). Bird Atlas 2007-11: the breeding and wintering birds of Britain and Ireland

Occupancy patterns & representation

- Both species richness and average occupancy among terrestrial invertebrates are higher in cells classified as protected than in unprotected cells.
- Representation of species in protected areas is highest for bryophytes, intermediate for dragonflies and hoverflies, and lowest for centipedes.
- Species found in few habitat types (i.e. specialists) are better-represented in PAs than generalists.

Occupancy Trends

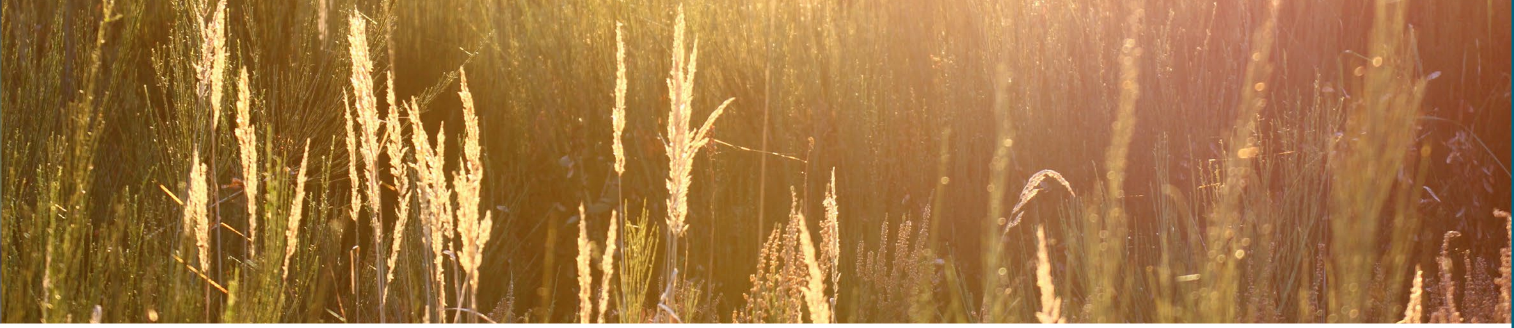
- Trends in occupancy overall were very similar between protected and unprotected sites. For pollinators, there is some evidence that trends within protected areas are better (less severe declines) but this result is subject to substantial uncertainty.
- Patterns of total compositional change were very similar in protected and unprotected sites. Across all invertebrates, there were more losses (local extinction events) in protected versus non-protected sites (perhaps reflecting that they have more to lose). By contrast, within pollinators there were more colonization events in protected sites than non-protected.

Birds

- Species occurred more frequently and were more abundant in squares that had a greater extent of PA.
- Species were more likely to colonise, and persist, in squares that had a greater extent of PA, but there was no evidence they had a more positive trend in abundance.
- These patterns were more evident in areas designated as Special Protection Areas (SPA) than those designated as Special Areas of Conservation (SAC).
- Reproductive success was lower on sites that had a greater extent of PA (possibly due to density dependence), however, species for which productivity was higher in sites with greater PA extent also tended to show a greater uplift in abundance, occupancy, colonisations and persistence thereby suggesting a demographic mechanism for the observed PA effects.
- After accounting for body mass and phylogenetic relatedness, positive relationships were strongest for those with low population size and that were habitat specialists. Furthermore, species which were declining nationally had more positive (or less negative) trends in abundance. These effects were greatest on SPAs.
- After accounting for population size, there was limited evidence that designated species (Annex 1, Schedule 1) or those of conservation concern benefitted to a greater extent from an increased extent of PA.
- Sites with an increased extent of PA did not support greater species richness (but SPA supported greater species diversity). All types of PA, however, supported communities that had higher proportions of habitat specialists and species that were adapted to colder temperatures.
- There was no trend in either species richness or specialisation but, over time, areas with a greater PA extent supported more cold-adapted species.
- There is evidence that some of these positive effects may be due to increased production of young.

Butterflies

- There was no trend in either species richness or specialisation but, over time, areas with a greater PA extent supported more cold-adapted species.
- Most butterfly species had negative associations between population abundance and extent of PA. However, trends in abundance were more positive with greater PA, with the exception of SPA, particularly for priority and declining species.



Next steps

- Extend this research to other groups, e.g. bats, other invertebrates.
- Some of the patterns we observe are confounded by spatial autocorrelation. For example, the uplands are subject to less human pressure than the lowlands, contain more and better-connected habitat, as well as larger protected areas. Disentangling these effects requires more sophisticated modelling approaches than were employed here.
- Explore whether the results change using different ways to explore the impacts of protection. One option is to change between area protected to a binary distinction between protected and unprotected sites.
- Test whether ecological status or trends vary according to whether the site is in favourable conservation status.
- Biodiversity benefits of protection could include spillover effects into the surrounding landscape. To test for this, one could compare sites in close proximity to PAs to those that are far away.
- There are other ways to dig into these results in more detail. For example, in birds there are suggestions of demographic benefits from protection, and for pollinators there is evidence that PAs are more likely to be colonized than unprotected sites, yet neither of these patterns seems to translate into large-scale differences in population trends between protected and unprotected sites.

Full Papers

A. E. Barnes, J. G. Davies, B. Martay, S.J. Harris, D.G. Noble, J.W. Pearce-Higgins & R.A. Robinson 2023 Do conservation designations provide positive benefits for bird species and communities? *Nature Ecology & Evolution* 7:92-101

R. Cooke, F. Mancini, R. Boyd, K. Evans, A. Shaw, T. J. Webb & N. J. B. Isaac (2023) Protected areas support more species than unprotected areas in Great Britain, but lose them equally rapidly. *Biological Conservation* 278:109884

R. Boyd, E. Wright, O. Pescott, R. Morris, C. Preston, R. Hassall & N. J. B. Isaac (2022) Representation of specialist bryophytes, centipedes, dragonflies and hoverflies in the United Kingdom's protected area network. *JNCC report 722*.

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The Joint Nature Conservation Committee (JNCC) is the only statutory nature advisor to all four countries of the United Kingdom. We provide robust scientific evidence and advice to help decision makers turn science into action for nature to guide the UK on a sustainable path. We work across land and sea with partners throughout the UK, the UK Overseas Territories (UKOTs), the Crown Dependencies (CDs) and around the world. For over 30 years our trusted expertise, dedication and skills have underpinned nature conservation and recovery. We know that a thriving natural world is essential for humanity's prosperity and wellbeing. We use our convening power to bring stakeholders together to drive innovative action in the interests of local and global nature conservation and recovery.

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