

Getting more value from your data

Nick Isaac

Beyond maps: a review of the applications of biological records

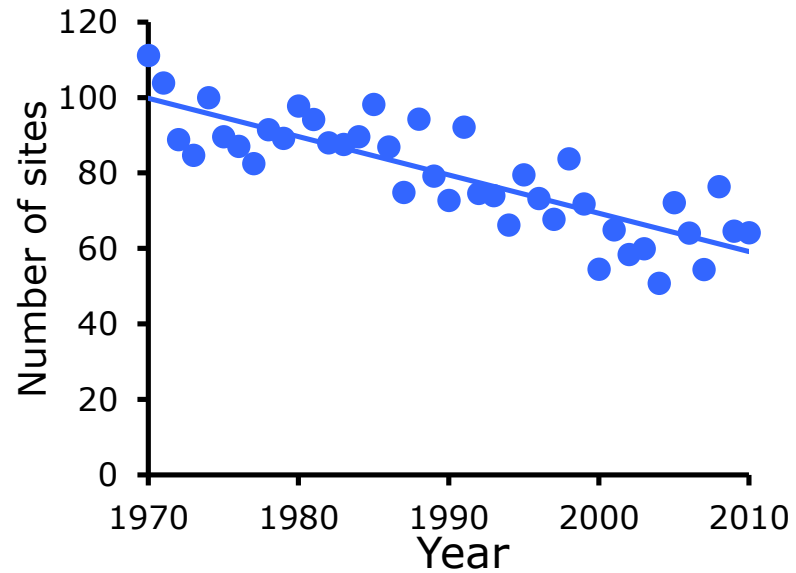
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Biological records are one of the most important sources of data for a large number of research areas. For example, their application has made valuable contributions to climate change ecology, where they are used to monitor species range shifts; to conservation ecology, where they are used to assess species' Red List status; and to biogeography, where they are used to highlight hotspots of biodiversity. A major benefit of biological records is the large spatial extent of the coverage combined with the fine spatial precision of the data: this combination is essential for any ecologist hoping to address large-scale questions about biodiversity and environmental change. Because most biological records are collected by a vast pool of volunteer recorders, studies utilizing biological records have the advantage of large-scale long-term data that it would otherwise be unfeasibly expensive to collect. We review the application of biological records by focussing on four key areas of biodiversity research: biogeography, trend assessments, climate change ecology, and conservation biology. We showcase the diversity of insights that biological records have delivered, which in turn illustrates the contribution of the voluntary recording community to our understanding of biodiversity science. © 2015 The Linnean Society of London, *Biological Journal of the Linnean Society*, 2015, **, ***–***.

ADDITIONAL KEYWORDS: biodiversity – citizen science – climate change – distribution change – range shift – richness – species trends.





Bias and information in biological records

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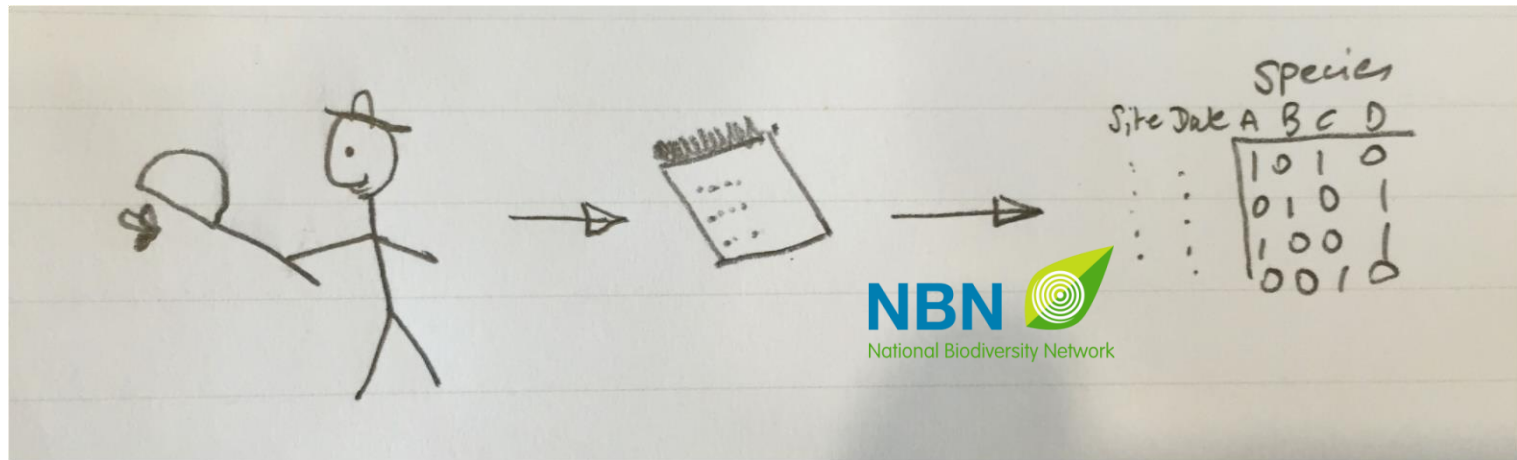
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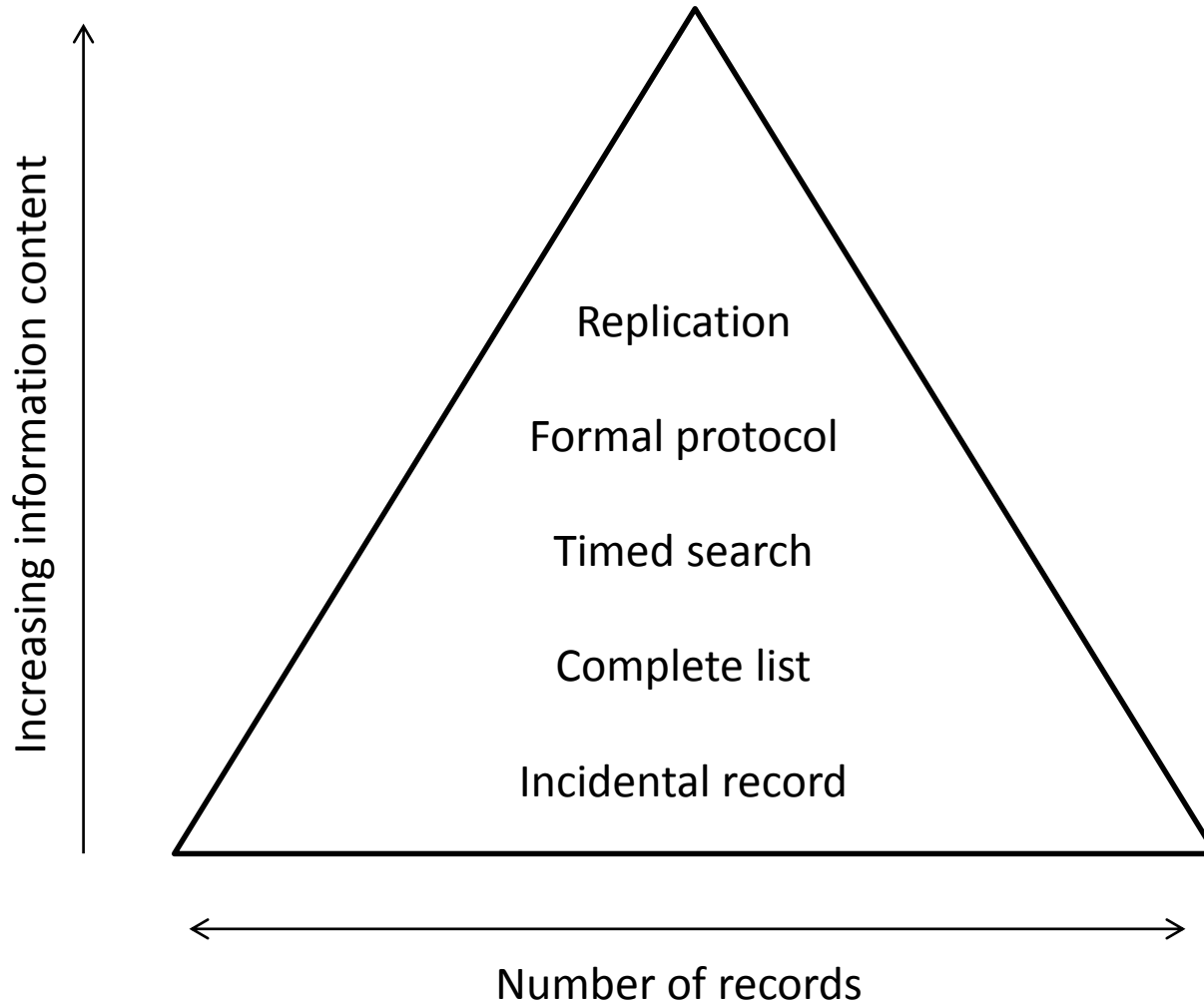
Biological recording is in essence a very simple concept in which a record is the report of a species at a physical location at a certain time. The collation of these records into a dataset is a powerful approach to addressing large-scale questions about biodiversity change. Records are collected by volunteers at times and places that suit them, leading to a variety of biases: uneven sampling over space and time, uneven sampling effort per visit and uneven detectability. These need to be controlled for in statistical analyses that use biological records. In particular, the data are 'presence-only', and lack information on the sampling protocol or intensity. Submitting 'complete lists' of all the species seen is one potential solution because the data can be treated as 'presence-absence' and detectability of each species can be statistically modelled. The corollary of bias is that records vary in their 'information content'. The information content is a measure of how much an individual record, or collection of records, contributes to reducing uncertainty in a parameter of interest. The information content of biological records varies, depending on the question to which the data are being applied. We consider a set of hypothetical 'syndromes' of recording behaviour, each of which is characterized by different information content. We demonstrate how these concepts can be used to support the growth of a particular type of recording behaviour. Approaches to recording are rapidly changing, especially with the growth of mass participation citizen science. We discuss how these developments present a range of challenges and opportunities for biological recording in the future. © 2015 The Linnean Society of London, *Biological Journal of the Linnean Society*, 2015, **••**, ••–••.

ADDITIONAL KEYWORDS: citizen science – GBIF – human behaviour – information content – recording behaviour.

The data collection process



Information in records



Syndromes of recording?

Table 1. Traits of recorders that could be influential in describing different recorder 'profiles' or 'syndromes'; a range of potential profiles have been identified

Trait	Relevance to information content	Hypothetical recorder profiles ('syndromes')				
		Taxon specialist	Patch/county specialist	General naturalist	Casual recorder	Pan-lister
Complete lists?	An indication of the typical effort per survey	Yes	Yes	Varies	No	No
Coverage of 'rare' species	Predilection for reporting unusual sightings	Varies	Varies	Low	Low	High
Coverage of difficult species	Taxonomic expertise	High	High	Low	Low	Varies
Length of activity of reporting	Temporal footprint	High	High	High	Varies	Varies
Frequency of recording	Productivity and consistency	High	High	Varies	Low	High
Spatial variation in recording	Spatial footprint of the data	High	Low	Varies	Varies	High
Variation in recording across taxa	Consistency of recording across taxa (taxonomic specialist versus jack-of-all-trades)	Low	Low	High	High	High

Data flow in academia

