

Title: Biodiversity: more than just how many species

Author(s): Alistair J. McGowan ^{*1}

Published Date: 01/07/2011

PermaLink: <http://www.palaeontologyonline.com/articles/2011/biodiversity-more-than-just-how-many-species/>

IMPORTANT

Your use of the Palaeontology [online] archive indicates your acceptance of Palaeontology [online]'s Terms and Conditions of Use, available at <http://www.palaeontologyonline.com/site-information/terms-and-conditions/>.

Palaeontology [online] (www.palaeontologyonline.com) asserts copyright on all articles and images in its electronic and print publications; except where third party copyright material is reproduced with permission from the copyright owners or otherwise stated.

Articles or figures from our publications may be reproduced in print or electronic medium for teaching, and for non-profit educational and research purposes, without fees or further permissions, providing that acknowledgements to 'Palaeontology [online] (www.palaeontologyonline.com)' is given, and that the source of the reproduced material is quoted in full. **Any third party copyright material will need permission from the copyright holders concerned.** Palaeontology [online] reserves the right to withdraw this permission without notice. Written permission is required by Palaeontology [online] for all other forms of capture, reproduction and/or distribution of any of its publications or items in its publications.

Please contact the publisher regarding any further use of this work. Publisher contact information may be obtained at <http://www.palaeontologyonline.com/contact-us/>.

Each copy of any part of a Palaeontology [online] article must contain the same copyright notice that appears on the screen or printed page of such transmission.



<http://www.palaeontologyonline.com/articles/2011/biodiversity-more-than-just-how-many-species/>

Biodiversity: more than just how many species

by Alistair J. McGowan*¹

Introduction:

Biological diversity, or biodiversity, shot to prominence among non-specialists in 1992, after the Rio Earth Summit (Fig. 1). Media coverage of the summit did a tremendous amount to raise awareness of the need to gather baseline data on species, and of the spectre of extinction hanging over some of them. The international [Convention on Biodiversity](#) declared 2010 the International Year of Biodiversity, and 2011–20 the Decade of Biodiversity. The use of the term biodiversity in the media has increased greatly, and the word is now in general use. Many countries now have biodiversity action plans that start locally and move through various levels and habitat types to the national level (for example, see the United Kingdom's [Biodiversity Action Plan](#)).

What is Biodiversity?

At a number of talks at conferences and at

academic meetings last year, I asked audiences how they would define biodiversity. The answer usually contained some reference to the number of species. I barred any ecologists in the audience from answering first, but they would invoke the other numerical parameter that ecologists routinely measure: abundance. Usually, ecologists measure the number of species in an area (often referred to as diversity, but richness is a more exact term) and the abundance (how many individuals of each species are present), and will use this pair of measurements to perform a series of calculations and draw sets of graphs.

Abundance is crucial for understanding biodiversity change. Tracking the abundance of a single species over time gives the change in population size. The International Union for Conservation of Nature (IUCN) publishes [Red Lists](#) of plants and animals considered to be

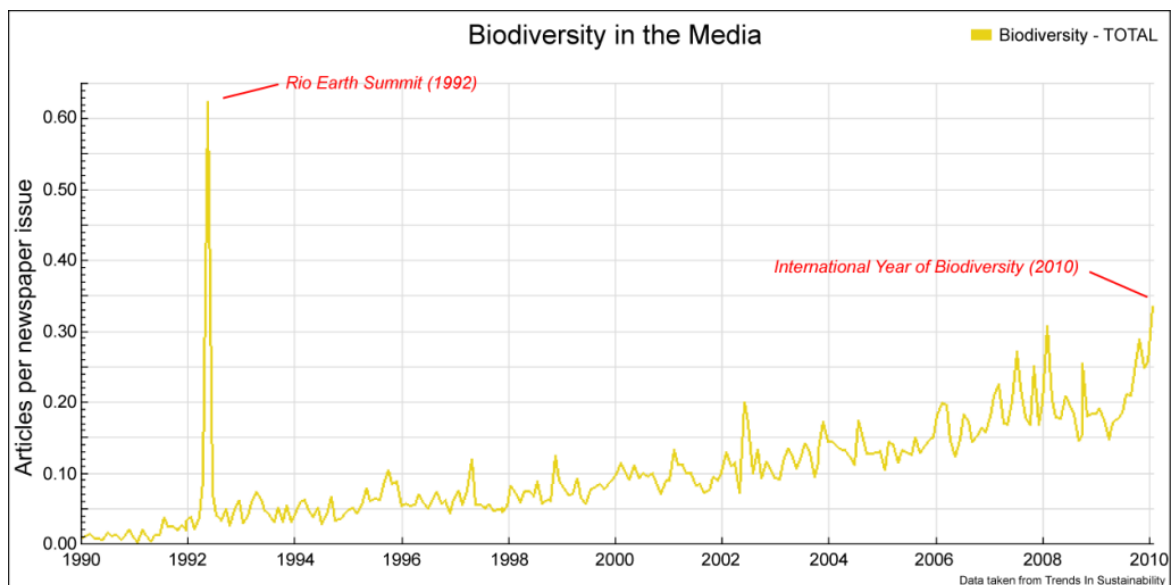


FIGURE 1 – BIODIVERSITY IN THE MEDIA

under threat of extinction. The original [IUCN criteria](#) were drawn up largely by ecologists and are based on measures such as population size, geographic range and how quickly individuals of a species grow from juveniles to adults able to reproduce. These criteria work best for species for which we have population data over decades, such as birds and mammals. Because the IUCN has a global remit, the criteria have been altered over time to help conserve species that are less well studied, and to reflect a growing shift in focus towards conserving whole landscapes or habitats rather than focusing on individual species. The IUCN has developed broader criteria to help in the assessment of less well-studied groups of organisms, and now includes information on the conservation actions that are already being taken. The organization also recognizes that there are social, economic and political dimensions to conservation biology, and the [website](#) discusses conservation in its wider context. The role of scientists in such work is to provide impartial evidence and encourage the other parts of society to take an evidence-based approach to actions.

But what does not get reported is the importance of population monitoring. I am particularly familiar with bird-surveying work in the British Isles. When I tell people that birds such as starlings, house sparrows and herring gulls are on the UK Red List, they are surprised and sceptical. They do not realize that a species may have UK Red Status because of population decline within the country, not just because it is globally threatened (IUCN red-listed). This seems to be down to a fundamental failure of communication by the scientists, or a failure of non-specialists to appreciate the nature of the UK's [Red, Amber, Green system](#) of rating conservation status.

When I have explained the UK criteria, the reaction from some people is that if the species is not threatened worldwide, why should they be conserved? The arguments for preserving threatened species are manifold and cover a number of dimensions, including political, legal, economic and moral arguments. These are covered on the [IUCN website](#). However, the scientific case for preserving small populations is that the more widely distributed a species is in space, the less likely it is that the whole species could be wiped out by a chance event. Even a large population in a single place cannot withstand an event such as a tsunami or massive volcanic eruption.

This leads neatly on to the other routine uses of abundance data. A common means of combining and displaying the joint information about richness and abundance is the rank-abundance plot (Fig. 2). This ranks species from the most abundant to the least abundant. A simple example is given in the figure. Species with high abundance are considered 'common', and the least abundant are 'rare'. Common species are also often said to be dominant. As well as representing it in graphs, ecologists have many, many ways of combining the information on richness and abundance to numerically express the distribution of individuals among species. This system of measurements is collectively referred to as evenness/dominance metrics. A perfectly even community would have an equal number of individuals in every species in the community. A totally uneven community would contain one [taxon](#) with many, many individuals: all other taxa would be represented by a single individual. These different numerical descriptions of communities can be compared with idealized mathematical models of different types of communities to define how the community is

structured. An excellent summary is given [here](#).

Measures of richness and evenness capture some aspects of the overall picture we need to understand the threats to species, but there are further facets. One particularly overlooked aspect is occupancy. Imagine laying a grid over a landscape and then checking whether particular species have

Another metric is the taxonomic distinctiveness of a community. This measures how closely related the species in a community are. A simple analogy would be a 'community' formed by your family (highly related, low taxonomic distinctiveness) versus the community of people in your class or workplace (probably less closely related, higher taxonomic distinctiveness).

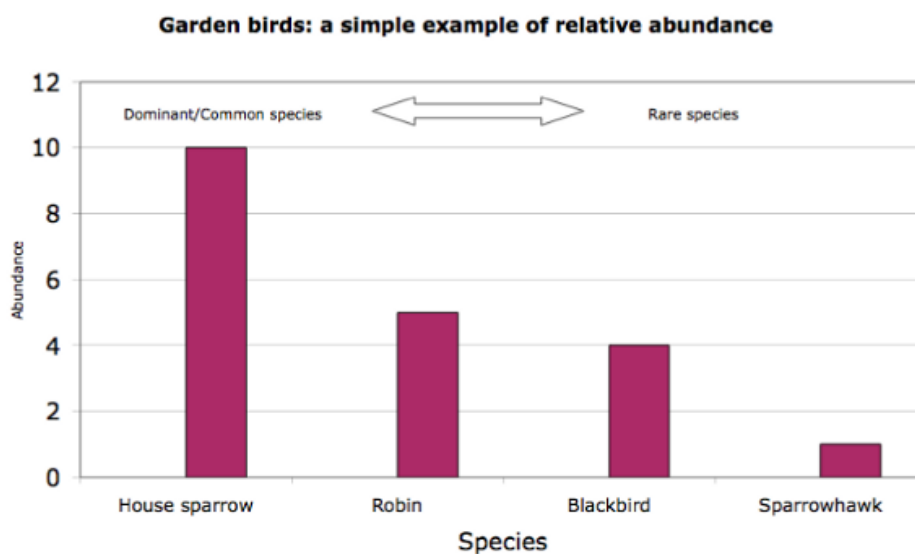


FIGURE 1 – EXAMPLE OF A RELATIVE RANK-ABUNDANCE PLOT

individuals in each grid square. Those species with high occupancy will have individuals in most of the grid cells. Those with low occupancy will occupy few squares. The resulting data table is called a presence/absence matrix. Measures of the spatial distribution of species are important in determining extinction risk; a species may have a large geographic range, as measured by the endpoints of its distribution, but if the populations at the endpoints are isolated from each other, they can be more vulnerable. [Work conducted this year](#) on the only poisonous snake in Great Britain, the adder, demonstrates an excellent example of this.

So far we have only considered counting individuals and taxa, but not considered the nature of the organisms themselves. During growth from juvenile to adult, an individual can occupy different levels of consumption in the food chain. The diversity of forms, or morphology, within a group of organisms can be measured in a variety of ways. This is routinely referred to as morphological diversity or disparity.

The currency of evolution is the number of offspring contributed to the next generation, but within an ecosystem, just as within an economy, there are many ways to exploit the environment and make a living, earning that currency. This is often described as [functional](#)

[diversity](#), and depicted as an idealized grid defined by characteristics such as whether a species is mobile, is a predator or scavenger, or burrows into the earth or flies in the air. The more boxes in the grid are filled, the more functionally diverse and complex the community is.

Biodiversity and the fossil record:

This may seem a strange essay to find on a website about palaeontology, but consider that all of these factors can be measured in the fossil record to a greater or less extent. The fossil record is the most significant documentation of extinctions available to us in our efforts to stem biodiversity loss. If it is to be useful to conservation biology,

conservationists and palaeontologists need to describe it using the same terms. The fossil record offers us the opportunity to test our understanding of what indicators are the early warning signs of extinction. Ecologists have proposed several characteristics that increase the likelihood of extinction for a species, including small geographic range, large body size and slow growth to maturity.

Palaeontologists have shown that these factors did indeed increase the extinction risk among now-fossilized species. It is important that we explain to non-specialists and policy-makers why we are collecting and analysing these data, whether from the fossil record or our front gardens, and what they can tell us that simply counting the number of species cannot.

Acknowledgements:

Alan Spencer was kind enough to invite me to contribute an article for the opening of Palaeontology [online]. The thoughts and ideas expressed in this article reflect conversations that I have had with colleagues over the past 15 years.

Suggestions for further reading:

Flanders Marine Institute. *Marine Biodiversity and Ecosystem Functioning*. EU Network of Excellence. <http://www.marbef.org/>

Magurran, A. E. 2004 *Measuring Biological Diversity*. Hoboken, New Jersey: Wiley-Blackwell. ISBN-10: [0632056339](#). — *A classic text that provides an accessible overview.*

Magurran, A. E. and McGill, B. J. 2010 *Biological Diversity: Frontiers in Measurement and Assessment*. Oxford: Oxford University Press. ISBN-10: [0199580669](#). — *The state of the art*

Royal Society of London. 2010. *Biological diversity in a changing world*. <http://royalsociety.org/biological-diversity/> — *Audio recordings of talks and a link to a volume of papers produced from this discussion meeting.*

Sohier, C. Measurements of biodiversity. *Encora Coastal Portal*.

http://www.coastalwiki.org/coastalwiki/Measurements_of_biodiversity

¹ School of Geographical and Earth Sciences, University of Glasgow, Glasgow, G12 8QQ, United Kingdom.