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# A Short Review on Various Biodiversity Indices

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**Abstract:** *A multidimensional assessment of biodiversity can provide insights into the relationships between changes in biodiversity in ecosystem functioning and ecosystem services. The Biodiversity Index is widely used because it is a quick way to distinguish between different places, ecosystems or populations of organisms. This is a count of the total number of species at a given location. Different species have different ecological requirements that allow them to thrive in their ecological niches, which determine the patterns and extent of ecosystem community structure. Various indices were used to assess core community structure, species distribution and interactions to gain insight into overall ecosystem health. In this article, our main goal is to give a brief overview of various biodiversity indices and their applications in various areas related to the environment.*

**Keywords:** Diversity, Biodiversity, Biodiversity index

## I. INTRODUCTION

The term biological diversity refers to the diversity of life on Earth at all levels, from genes to ecosystems, and includes the evolutionary, ecological, and cultural processes that enable life to exist. The diversity of all life species on Earth, including the various plants, animals, and microbes, as well as the ecosystems in which they dwell, is referred to as biodiversity. The foundation of ecological services, which are intrinsically linked to human well-being, is biodiversity. According to [15], Harvard University's Edward O Wilson created the term biodiversity in his paper "Biological diversity crisis" in 1985, followed by a book titled Biodiversity in 1989 [17, 18]. Soon after, Michael Soule's book Conservation Biology included extensive chapters on biodiversity [14]. It gained popularity after the 1992 United Nations Earth Summit in Rio de Janeiro, Brazil.

It can be seen that the multidimensional nature of biodiversity presents enormous challenges to its measurement. There are various biodiversity measurements; species richness is one significant metric that is helpful as an indicator for biological diversity - but it must be combined with other measures to properly account for biodiversity.

Ecological indicators, according to [15], are scientific constructions that employ quantitative data to quantify elements of biodiversity and ecological state, services, or drivers of change, however no one ecological indicator encompasses all dimensions of biodiversity. Ecological indicators are an important part of monitoring, evaluation, and decision-making because they allow policymakers to disseminate information quickly and readily [10]. Economic statistics, such as GDP, are similarly powerful and readily understood by decision makers. Some environmental indicators, including as global mean temperature and CO2 concentrations in the atmosphere, are becoming commonly acknowledged as markers of anthropogenic influence on global climate. Ecological indicators are based on similar concepts and so have comparable advantages and disadvantages [11].

Supriatna [15] also indicated that the types of interest are mainly species, but they may be other categories such as genera, families, functional type or holotypes when diversity indices are used for ecological purposes. Individual plants or animals are considered as entities of interest and the measure of abundance can be, for example, number of individuals, biomass or coverage. In demography, the units of interest are people and the types of interest are different demographic groups. In information science, entities can be letters or different letters of the alphabet. The most commonly used diversity indices are simple transformations of the effective number of types (also known as "true diversity"), but each diversity index can also be interpreted as a stand-alone measure that corresponds to some real (but

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different for each diversity index) phenomenon [10]. It would be simpler to calculate the biodiversity index if the number of birds in a forest, wildflowers in a meadow, or insects in a log could be used as a proxy for biodiversity. Regretfully, biodiversity is not known for its simplicity [11].

The ecosystems are more complex than we can imagine. Common misconceptions about biodiversity are that it equals the diversity of species in an area and this means a higher level of biodiversity. Biodiversity's not a series of games; quality is much more important than quantity, it is not so much about the number of species as it is about its identity [4]. Biodiversity remains difficult to quantify, despite a large number of tools and data sources. It is therefore possible to gain an understanding of the relation between changes in biodiversity and changes in ecosystem function and service by means of a multidimensional assessment of biodiversity.

According to Soto-Navarro et al. [13], governments and the Secretariat of Multilateral Environmental Agreements (MEAs) use multiple biodiversity indicators to monitor global targets and many indicators. Furthermore, conservation NGOs use biodiversity indices to monitor their own performance or to monitor and raise awareness of the state of nature. For example, WWF and Zoological Society of London (ZSL) produce the Living Planet Report every two years. This report uses the Living Planet Index and the Ecological Footprint Index to assess global trends in the state of biodiversity and associated pressures. Furthermore, the Durrell Wildlife Conservation Trust was one of the first conservation organizations to develop a 'key performance indicator,' the Durrell Red List Index of Species Survival, which uses the IUCN Red List of Threatened Species to track progress toward the organization's mission of saving species from extinction. Recently, Kumar et al. [7] study identified the concentration of species among tree diversity in Mahavir Swami Wildlife Sanctuary, Bundelkhand, India using important ecological indicator.

Thus, in this paper, we provide a brief overview of numerous biodiversity indicators in diverse environmental sectors.

## II. VARIOUS BIODIVERSITY INDICES

Türkmen and Kazanci [16] explained that different diversity indices are used to determine distribution of benthic macro-invertebrates related to habitat quality. A diversity index is a statistical method designed to assess the diversity of a dataset consisting of different types of components. Diversity indices are based on population characteristics such as the number of species present (Richness), the even distribution of individuals (Evenness), and the total number of individuals present.

Supriatna [15] stated that several indices have been used in relation to environmental challenges. These include the Environmental Sustainability Index (ESI), Environmental Performance Index (EPI), Environmental Vulnerability Index (EVI), Living Planet Index (LPI), Ecological Footprint (EF), City Development Index (CDI), Human Development Index (HDI), Index of Sustainable Economic Welfare/Genuine Progress Index (ISEW/GPI), Well-Being Index (WI), Genuine Savings Index (GS), Environmental Adjusted Domestic Product (EDP), and Biodiversity Index. Some biodiversity indices used to measure diversity in relation to the environment are listed below:

### (a) Shannon Diversity Index [15]

This is an indicator applied to natural systems by deduced from a fine formula used in communication area by Shannon in 1948 [9]. It's the most favoured indicator among the other diversity indicators. The indicator values are between 0.0 –5.0. Results are generally between1.5 –3.5, and it exceeds 4.5 veritably infrequently [6]. Values more than 3.0 indicate that the habitat structure is stable and balanced; values less than 1.0 indicate that the habitat structure is polluted and degraded.

$$H = \Sigma\, p_i \ln p_i \quad \text{or} \quad H' = -\Sigma(n_i/N) * \ln(n_i/N)$$

H': Shannon Diversity Index; $p_i$ : Proportion of characters belonging to the ith type of letter in the string of interest; $n_i$ : Number of individuals belonging to i species; N : Total number of individuals.

The Shannon Index is the most widely used index of diversity in ecological literature, where it also appears to be known by several names that are Shannon's diversity indicator, the Shannon – Wiener indicator, the Shannon – Weaver indicator and the Shannon entropy.

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**(b) Simpson Diversity Index [16]**

This is an index of diversity derived by Simpson in 1949 [9]. The index values of Simpson (Δ) vary from 0 to 1. When calculated, the final result is subtracted from 1 to correct for the inverse relationship.

$$1 - 1 - \Delta = [\Sigma n_i (n_i - 1)] / N (N - 1)$$

Δ : Simpson Diversity Index
$n_i$ : Number of individuals belonging to i species
N : Total number of individuals
In some cases, Simpson's diversity index values represent both species richness and species evenness across transects. Thus, it can be concluded that Simpson's diversity index has higher values for more species and evenness.

**(c) Margalef Diversity indicator (R) [16]**

It measures the evenness, but it is highly sensitive to the sample size [2]. It is not bound by a limit value and it shows variation depending on the number of species. Thus, it is used to compare sites [6]. The calculation shall be made in accordance with the rule:

$$d = (S - 1) / lnN$$

$d$ : Margalef Diversity Index
$S$ : Total number of species
$N$ : Total number of individuals
This parameter does not have threshold values, and its higher values prove higher biodiversity [8].

**(d) McIntosh Diversity Index[16]**

It was proposed by McIntosh in 1967. Values range from 0 to 1. If the value is closer to one, meaning that organisms are evenly distributed in the community (McIntosh 1967).

$$Mc = [N - \sqrt{(\Sigma n_i^2)}] / [N - \sqrt{N}]$$

Mc : McIntosh Diversity Index
$n_i$ : Number of individuals belonging to i species
N : Total number of individuals

**(e) Pielou Evenness Index [16]**

According to [16], Pielou [12] derived it from the Shannon index in 1966. Pielou Evenness Index results are based on a ratio between the observed value of the Shannon index and its maximum value. These values are in the range of 0 to 1. As the value gets close to 1, it means that each individuals are distributed equally.

$$J' = H' / H'_{max}$$

J' : Pielou evenness index
H' : The observed value of Shannon index
$H'_{max}$ : lnS;
S : Total number of species

**(f) McIntosh Evenness Index [16]**

It was derived from the McIntosh index. The values range from 0 to 1. When the value approaches 1, it means that the individuals are evenly distributed [3]. Applications of different biodiversity indices to benthic macro-invertebrates assemblages in streams of a Turkish national park.

$$Mc\,E = [N - \sqrt{(\Sigma n_i^2)}] / [N - (N\sqrt{S})]$$

Mc E : McIntosh evenness index

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$n_i$ : Number of individuals belonging to i species
S : Total number of species
N : Total number of individuals

**(g) Berger-Parker index (d) [1]**

According to Berger-Parker in 1970, this indicator assesses the dominance of the most numerous species and is thus largely connected to evenness. It is calculated as:

$$d = \frac{N_{max}}{N}$$

Here $N_{max}$is the number of individuals of the most abundant species. The values range from 0 to 1, with values closer to 0 indicating greater variety and values closer to 1 indicating monoculture.

**(h) Jaccard indicator(J) [5]**

Jaccard in 1901 described that this index is a measure of similarity between two sets of factors and that it is applied to a variety of problems, including those in environmental studies. This index is calculated as follows:

$$J(X,Y) = \frac{X \cap Y}{X \cup Y}$$

Where X and Y are some stands analysed. The intersection of two assemblages represents the number of species they share, while the union represents the number of species in common, the number of species found exclusively in forest X, and the number of species found exclusively in stand Y. In addition to this value 1-J is often calculated as a support index and is called the Jaccard distance.

## IV. CONCLUSION

In order to provide insight into overall ecosystem health, various biodiversity indices can be used to examine core community structure, species distribution and interactions. In this article, we provided a quick introduction of a number of biodiversity indices and their applications in diverse environmental fields.

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