<u>Biodiversity-Hotspot</u>

A biodiversity hotspot is a biogeographic region with significant reservoir of biodiversity that is threatened by human habitation. It exhibits high species richness as well as high species endemism. The idea was first developed by British ecologist **Norman Myers** 1988**.**

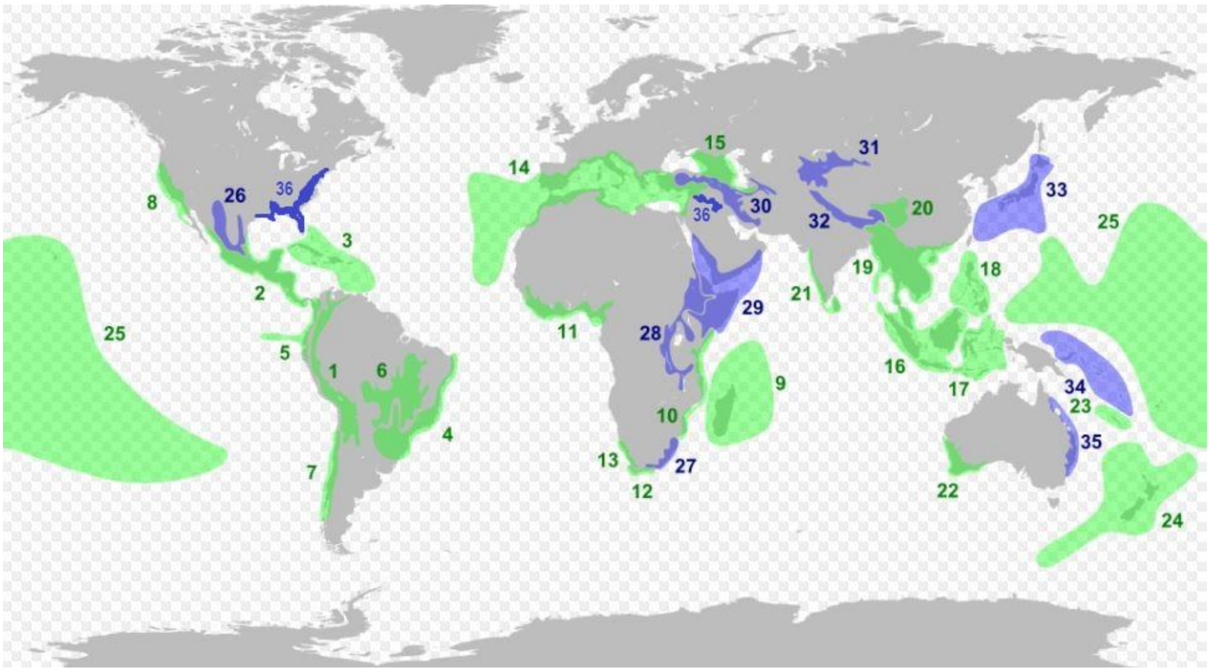
Criteria: Too qualify as a hotspot; a region must meet two strict criteria:

(I) It must contain at least 0.5% or 1,500 species of vascular plants as endemics, and

(II) It has to have lost at least 75% of its primary vegetation.

Biodiversity hotspots are a method to identify those regions of the world where attention is needed to address biodiversity loss and to guide investments in conservation.

At present, there are total **36** biodiversity hotspots around the world. These sites support nearly 60% of the world's **plant, bird, mammal, reptile**, and **amphibian species**, with a very high share of those species as endemics. Some of these hotspots support up to 15,000 endemic plant species and some have lost up to 95% of their natural habitat. Overall, the current hotspots cover more than 15.7% of the land surface area, but have lost around 85% of their habitat. This loss of habitat explains why approximately 60% of the world's terrestrial life lives on only 2.4% of the land surface area.



Biodiversity hotspots. Original proposal in green and added regions in blue.

Sl No.	Name of Biodiversity Hotspot	Sl No.	Name of Biodiversity Hotspot
1.	California Floristic Province **(8)**	19.	Succulent Karoo **(13)**
2.	Madrean pine-oak woodlands **(26)**	20.	Mountains of Central Asia **(31)**
3.	Mesoamerica **(2)**	21.	Eastern Himalaya **(32)**
4.	North American Coastal Plain **(36)**	22.	Indo-Burma, India and Myanmar **(19)**
5.	Caribbean Islands **(3)**	23.	Western Ghats and Sri Lanka **(21)**
6.	Atlantic Forest **(4)**	24.	East Melanesian Islands **(34)**
7.	Cerrado **(6)**	25.	New Caledonia **(23)**
8.	Chilean Winter Raldiviainfall-Van Forests **(7)**	26.	New Zealand **(24)**
9.	Tumbes-Chocó-Magdalena **(5)**	27.	Philippines **(18)**
10.	Tropical Andes **(1)**	28.	Polynesia-Micronesia **(25)**
11.	Mediterranean Basin **(14)**	29.	Eastern Australian temperate forests **(35)**
12.	Cape Floristic Region **(12)**	30.	Southwest Australia **(22)**
13.	Coastal Forests of Eastern Africa **(10)**	31.	Sundaland and Nicobar islands of India **(16)**
14.	Eastern Afromontane **(28)**	32.	Wallacea **(17)**
15.	Guinean Forests of West Africa **(11)**	33.	Japan **(33)**
16.	Horn of Africa **(29)**	34.	Mountains of Southwest China **(20)**
17.	Madagascar and the Indian Ocean Islands **(9)**	35.	Caucasus **(15)**
18.	Maputaland-Pondoland-Albany **(27)**	36.	Irano-Anatolian **(30)**

Biodiversity hotspot in India:

India has some of the world's most biodiverse regions. The political boundaries of India encompass a wide range of biomes–desert, high mountains, highlands, tropical and temperate forests, swamplands, plains, grasslands, areas surrounding rivers, as well as island archipelago. It hosts 4 biodiversity hotspots: the **Eastern Himalayas**, the **Western Ghats**, the **Indo-Burma region** and the **Sundaland** (Includes Nicobar group of Islands). These hotspots have numerous endemic species.

(1) **Western Ghats and Srilanka:** Western Ghats of south western and south eastern Srilanka are similar in geology, climate & evolutionary history. The Western Ghats, known locally as the Sahyadri hills run parallel to India's western coast, about 30-50 km inland. They cover an area about 1, 60,000 sq km & stretch for n16000 km from to south tip.

SPECIES DIVERSITY AND ENDEMISM

Taxonomic Group	Species	Endemic Species	Endemism (%)
Plants	5,916	3,049	51.5
Mammals	140	18	12.9
Birds	458	35	7.6
Reptiles	267	174	65.2
Amphibians	178	130	73.0
Freshwater fishes	191	139	72.8

(2) **Eastern Himalaya:** It includes the entire Indian Himalayan region (and the falling in Pakistan, Tibet, Nepal, Bhutan, China & Myanmar). The Himalayan hotspot is home to the world's highest mountains. It contains numerous number of diverse plant species along with several unique animals and birds, such as Vultures, Tigers, Elephants, Rhinos, Wild Water buffalo etc.

SPECIES DIVERSITY AND ENDEMISM

Taxonomic Group	Species	Endemic Species	Endemism (%)
Plants	10,000	3,160	31.6
Mammals	300	12	4.0
Birds	977	15	1.5
Reptiles	176	48	27.3
Amphibians	105	42	40.0
Freshwater fishes	269	33	12.3

(1) **Indo-Burma:** This region consists of numerous countries including North-Eastern India (to the south of the Brahmaputra River), Myanmar, and China's Yunnan provinces southern Lao People's Democratic Republic, Vietnam, Cambodia, and Thailand. It is spread over a distance of 2 parts, million square kilometres.

SPECIES DIVERSITY AND ENDEMISM

Taxonomic Group	Species	Endemic Species	Endemism (%)
Plants	13,500	7,000	51.9
Mammals	433	73	16.9
Birds	1,266	64	5.1
Reptiles	522	204	39.1
Amphibians	286	154	53.8
Freshwater Fishes	1,262	553	43.8

(2) **Sundaland:** This region lies in South-East Asia and includes Thailand, Singapore, Indonesia, Brunei, and Malaysia. The Nicobar Islands represent India. These islands have a rich terrestrial as well as marine ecosystem including mangroves, seagrass beds, and coral reefs.

SPECIES DIVERSITY AND ENDEMISM

Taxonomic Group	Species	Endemic Species	Endemism (%)
Plants	25,000	15,000	60.0
mammals	380	172	45.6
Birds	769	142	18.5
Reptiles	452	243	53.8
Amphibians	244	196	80.3
Freshwater Fishes	950	350	36.8

Measuring biodiversity

Biological diversity can be quantified in many different ways. The two main factors taken into account when measuring diversity are richness and evenness.

1. **Species richness-** Species richness is the total number of species present in the community
2. **Species Evenness-** Species evenness is the relative abundance among the individuals/ species present in a community.
   -Evenness contrast with **Dominance,** and is maximized when all species have the same number of individuals.

To give an example, we might have sampled two different fields for wildflowers. The sample from the first field consists of 300 daisies, 335 dandelions and 365 buttercups. The sample from the second field comprises 20 daisies, 49 dandelions and 931 buttercups (see the table below). Both samples have the same richness (3 species) and the same total number of individuals (1000). However, the first sample has more evenness than the second. This is because the total number of individuals in the sample is quite evenly distributed between the three species. In the second sample, most of the individuals are buttercups, with only a few daisies and dandelions present. Sample 2 is therefore considered to be less diverse than sample 1.

	Numbers of individuals	
Flower Species	**Sample 1**	**Sample 2**
Daisy	**300**	**20**
Dandelion	**335**	**49**
Buttercup	**365**	**931**
Total	**1000**	**1000**

As species richness and evenness increase, so diversity increases. Simpson's Diversity Index is a measure of diversity which takes into accounts both richness and evenness.

Simpson's Diversity Indices

The term 'Simpson's Diversity Index' can actually refer to any one of 3 closely related indices.

1. **Simpson's Index** (**D**) measures the probability that two individuals randomly selected from a sample will belong to the same species (or some category other than species). There are two versions of the formula for calculating **D**. either is acceptable, but be consistent.

$D = \sum (n/N)^2$	$D = \frac{\sum n(n-1)}{N(N-1)}$
n = the total number of organisms of a particular species **N = the total number of organisms of all species**	

The value of **D** ranges between 0 and 1

With this index, 0 represents **infinite diversity** and 1, **no diversity**.

2. **Simpson's Index of Diversity:** 1 – **D**
   The value of this index also ranges between 0 and 1, but now, the greater the value, the greater the sample diversity. This makes more sense. In this case, the index represents the probability that two individuals randomly selected from a sample will belong to different species.
3. **Simpson's Reciprocal Index:** 1 / **D**
   The value of this index starts with 1 as the lowest possible figure. This figure would represent a community containing only one species. The higher value indicates greater the diversity. The maximum value is the number of species (or other category being used) in the sample.

For example:-

Species	**Number (n)**	**n(n-1)**
A	2	2
B	8	56
C	1	0
D	1	0
E	3	6
Total (**N**)	**15**	**64**

Putting the figures into the formula for Simpson's Index

$$\mathbf{D}= \frac{\sum \boldsymbol{n(n-1)}}{\boldsymbol{N(N-1)}}$$

$$D= \frac{64}{210}$$

D = 0.3 (Simpson's Index)

Then,

Simpson's Index of Diversity 1 - D = 0.7

Simpson's Reciprocal Index 1 / D = 3.3

These 3 different values all represent the same biodiversity. It is therefore important to ascertain which index has actually been used in any comparative studies of diversity. A value of Simpson's Index of 0.7 is not the same as a value of 0.7 for Simpson's Index of Diversity.

Simpson's Index gives more weight to the more abundant species in a sample. The addition of rare species to a sample causes only small changes in the value of **D**.

[**Simpson’s biodiversity index** generally measure **Alpha diversity**]

The name 'Simson's biodiversity index' is often very loosely applied therefore it is important to find out which index has actually been used in any comparative studies of biodiversity.

The Shannon index originally developed for use information science, accounts for the order or abundance of a species within a simple plot. This is often used for identifying areas of high natural or human disturbance.

According to **Shannon diversity index,**

$$\mathbf{H = -\sum_{i=1}^{s} p_i \ln p_i}$$

Where,

H= the Shannon diversity index

p_i= pi (n/N) is the proportion of individuals of ith species (n) found, divided by total number of individuals found (N)

S= number of species of in sample/community/ecosystem etc.

Species	No. of individuals (n)	p_i (n/N)	ln p_i	p_i ln p_i
***Solanum* sp.**	6	6/27=0.222	-1.505	-0.334
***Datura* sp.**	5	5/27=0.185	-1.687	-0.312
***Nicotiana* sp.**	1	1/27=0.037	-3.297	-0.122
***Physallis* sp.**	3	3/27=0.111	-2.198	-0.244
***Atropa* sp.**	12	12/27=0.444	-0.812	-0.360

S (Number of species) = 5

N (Total No. of individuals) =27

H = - {(-0.334) + (-0.312) + (-0.122) + (-0.244) + (-0.360)}

= 1.372

The Sorensen index: The **Sorensen's similarity index/Sorensen index** is a statistic used for comparing the similarity of two samples. It was developed by the botanist Thorvald Sorensen and published in 1948.

The Sorensen index is a very simple measure of beta diversity, ranging from a value of 0 where no species overlaps between the communities, to a value of 1 when exactly the same species are found in both communities.

Where,

S_1= the total number of species in the first community

S_2= the total number of species in the second community

C= the number of species common in both communities

$$\beta = 2C/\ (2C+S_1+S_2)$$

Beta diversity index:

$$\text{Beta diversity index} = 2C/\ (S_1+S_2)$$

For an example,

Two communities have a total of 12 species: a, b, c, d, e, f, g, h, i, j, k, l

In community 1 there are 10 species: a-j

In community 2 there are 7 species: f-l

Both communities have 5 species in common i.e. f-j

Here,

C (common between both communities) = 5, so twice that is 10

S_1+S_2 = 17

So, **beta diversity index** = 10/17 = 0.59

Home works

Q.1 The following table shows the number of individuals of each species found in two Communities:

Community	Species			
	A	B	C	D
C1	25	25	25	25
C2	80	05	05	10

(Hint: in values for 0.05, 0.10, 0.25 and 0.80 are -3.0, -2.3, -1.4 and -0.2 respectively)

- **What are the Shannon diversity indexes (H) for C1 and C2?**

Q.2 Calculate Sampson's biodiversity index and Simpson's Reciprocal Index from the following table:-

Species	No. of individual species
M	12
N	8
O	6
P	9
Q	15