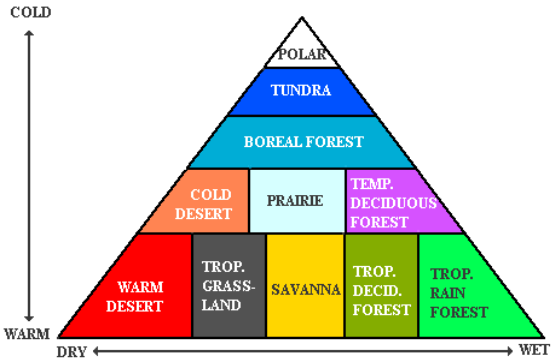
Contents

ECOLOGY

environment and niche

There are different environmental factors that regulates the ecosystem of a specific area, those factors can be divided into biotic and abiotic factors.



Biotic factors	Abiotic factors
1. Producers 2. Consumers 3. Decomposer	1. Light 2. Temperature 3. Water 4. Soil or edaphic factor 5. Altitude 6. Wind etc.

Rule	**Polar Region**	**Tropical Region**
Bergmen's rule	Size (↑)	Size (↓)
Allen's Rule	Appendages (↓)	Apendages (↑)
Glogger's rue	Pigmentation (↓)	Pigmentation(↑)
Richard Hess's rule	Heart Size(↑)	Heart size(↓)
Rensh's rule	Bird wing pointed(↑)	Bird wing pointed(↓)
Jorden's rule	Fish vertebrae and scales(↑)	Fish vertebrae and scales(↓)

- ***Gordu's Rule***: body changes according to temperature
- ***Rule of cope:*** body size increased during the course of evolution
- ***Leibig's Rule/ law of minimum*****:** plant growth will be affected due to the limitation of nutrient present in the soil that is why soil nutrition is a limiting factor for plants.
- **Blackmainn's law of limiting factor**: any factors that effect or limit the photosynthesis rate is a limiting factor for plants such as CO2, H2O, Chloroplast, Chlorophyll, Sunlight

ADAPTATION

Types of adaptation

- Morphological adaptation
- physiological adaptation
- behaviour adaptation

Types of adaptation (on the basis of condition)

- Xeric adaptation: adaptation for limitation of water availability.
- Saline adaptation: adaptation to the hypersalinity.
- Oligotrophic adaptation: where nutrition is limited or mostly been use the app organisms show oligotrophic adaptation, like in rainforest and man grooves.

Categories produced by ecological effect

- Ecophene/Ecades: when same species separated to different geographical location they are phenotype changes without effective does eno type, those are known as Ecophene/Ecades
- Ecotype/ Ecological Race/Ecological soecies: genetically irreversible changed population due to living in different ecosystem or geographical location, those are known as ecotype
- Coenospecies: When populations of two different Ecospecies sometimes overlap but do not produce viable offspring they are known as Coenospecies.
    a. ECOTONE: The transition zone between two ecosystem where biodiversity is different from both of the ecosystem
    b. Edge Effect: in **Ecotones** species is greater than both the nearby ecosystem this is known and edge Effect and ecotone also contain unique types of biodiversity.

Smallest hierarchy in ecology = **Organism**
Smallest living unit in ecology = **Organism/Individual**
Smallest functional/Basic unit in ecology = **Ecosystem**
Smallest unit in ecology= **Ecosystem**
Smallest functional unit in evolution = **Population**

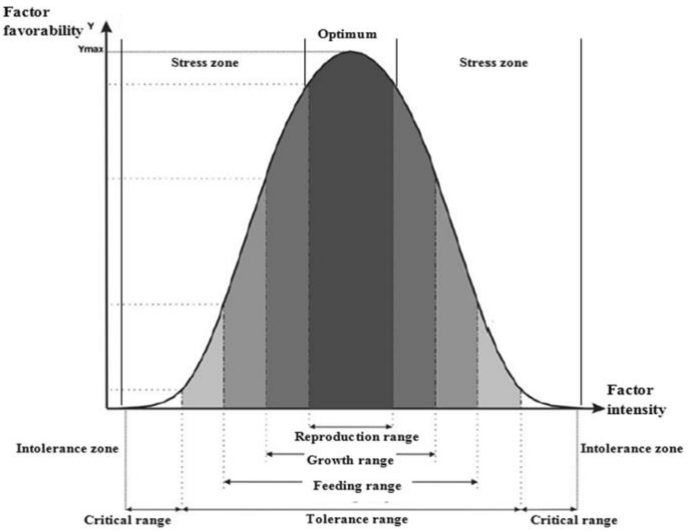
Organism<Population<Species< Community<Ecosystem<Landscapes<Biomes<Biosphere

Autecology = Study of individuals or populations of a single species with respect to its environment.
Synecology = Study of species with respect to their environment.
Ecological equivalence = when 2 different species have similar ecological role.

Guild = when two or more spaces exploit same or similar type of food resources.
Ecotone = transition zone between two ecosystem
Habitat = physical space occupied by a specific species or organism
Range = extended habitat
Territory = physical space occupied and being protected by a specific species or organism or individual
Cohort = Group of individuals having same age group

Range of tolerance

Factor	Narrow Tolerance	Wide Tolerance
1. Temperature 2. Water 3. Salinity 4. Food 5. Habitat	1. Stenothermal 2. Stenohydric 3. Stenohaline 4. Stenophagic 5. Stenoecious	1. Eurythermal 2. Euryhydric 3. Euryhaline 4. Euryphagic 5. Euryecious



Niche concept:

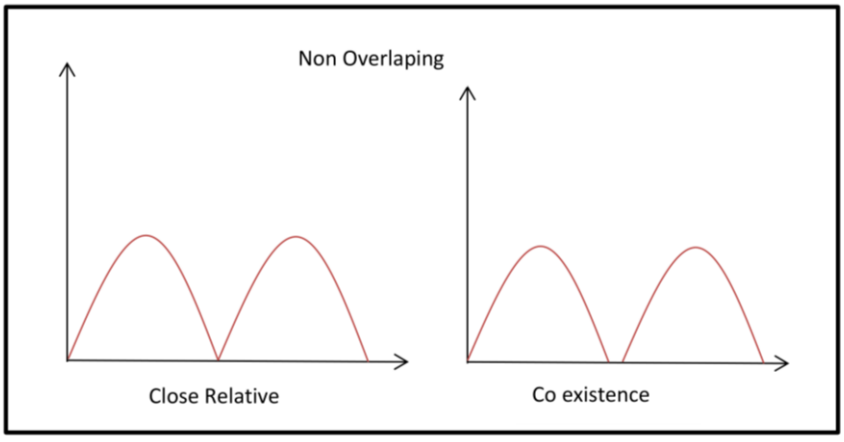
There are three niche concepts

Scientist	***Concepts***	***Name***
Grinnel's	Micro-habitat 1904	Spatial
Odum	Functional role in the ecosystem 1971	Tropical
Hutchinson	Environmental gradient 1957	multidimensional hyper-volume

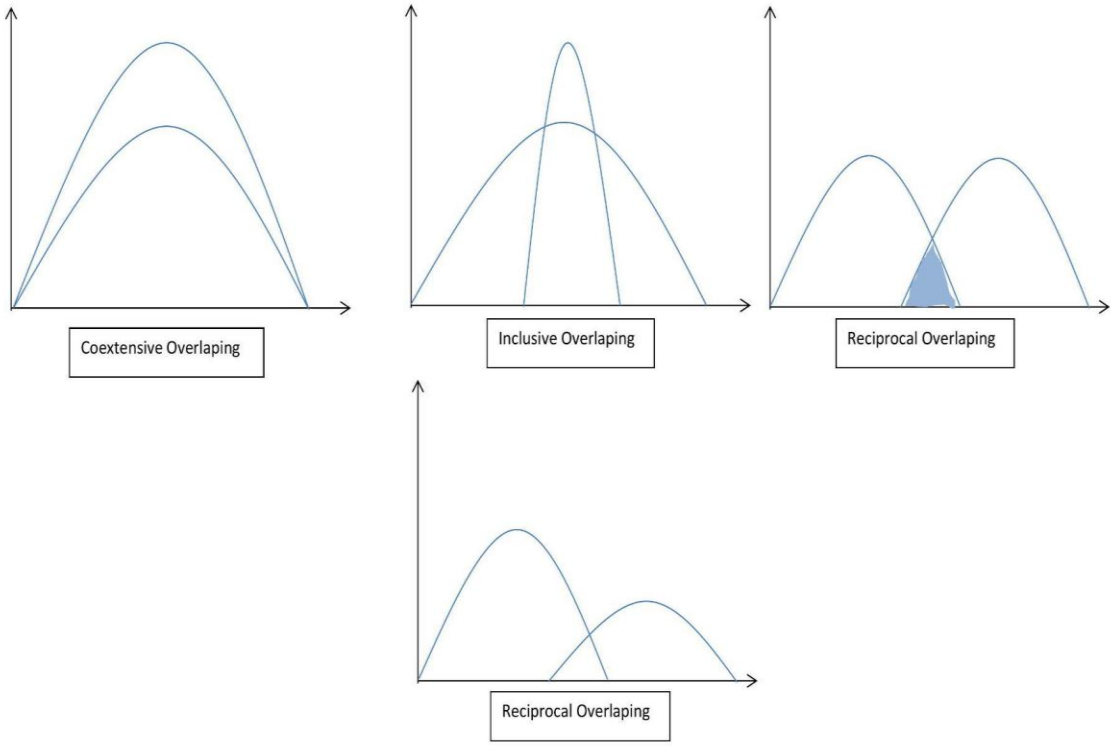
Fundamental Niche: the original micro habitat or hyper dimensional space of an organism before having competition is known as fundamental niche.(FN)

Realised Niche: the micro-habitat or hyper dimensional space left for the organism after being involved in competition or facilitation.(RN)

Competition	*Tolerance/Coexistence*	*Facilitation*
FN>RN	*FN=RN*	*FN<RN*



Niche Overlapping



population ecology

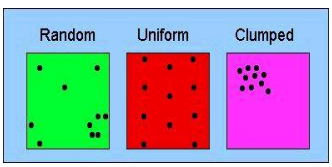
Attributes	r-Selected Species	K-Selected Species
Body Size	Small	Large
Birth rate	High	Low
Death rate	High	Low
Parental Care	Absent	Intense
Density	Very High	
Breeding	Once in a lifetime(Semalparity)	Many times(Iteroparity)
Pattern of dispersion		
Age pyramid	Straight Pyramid	Inverted
Survivorship curves	Type 3	Type 2
Life table		
Models of growth	Exponential	Logistic
Hatutat strategy	Generalist	Specialist
Competition ability	Low	High
Generation time	Low	High

- Birth rate
  Denoted as **'b'**
- Death rate
  Denoted as **'d'**

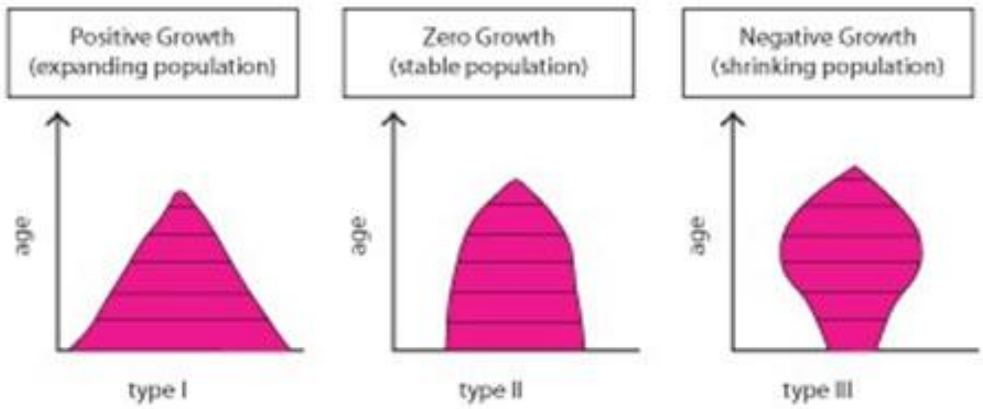
- Growth rate
  A population can increase by Birth rate(b) and Immigration rate(I)
  A population can decrease by death rate (d) and emigration rate(E)
  That is why,
  Growth rate(r) = (b+I) - (d+E)

- Pattern of Dispersion

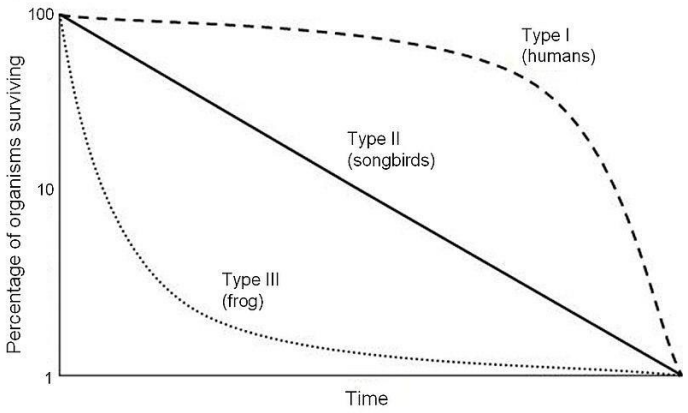
Variance/Mean = . 1 <1 >1 .



- Age pyramid



- Survivorship curves



- Density

Different techniques to calculate density of a population

Head counting method
Line intersect method
Belt transact method
Pitfall trap
Sweep net
Suction tunnel method
<u>Capture mark recapture method:</u>

N = nM**/**R

N= density
n= captured in the first time
M= recaptured in the second time
R= marked in the captured

Species	Quadrant					Frequency	Density	Abundance	Relative frequency	Relative density	Relative abundance
	1	2	3	4	5						
A	50	20	12	-	15	4/5	97/5	97/4			
B	20	30	-	35	20	4/5	105/5	105/4			
C	8	10	-	-	13	3/5	31/5	31/3			
D	16	-	20	15	-	3/5	51/5	51/3			

$$Frequency\ (Fre) = \frac{number\ of\ plots\ that\ contain\ the\ species}{total\ number\ of\ plots\ used}$$

$$Density\ (Den) = \frac{total\ number\ of\ individuals\ per\ species}{total\ area}$$

$$Abundance\ (Abu) = \frac{total\ number\ of\ individuals\ per\ species}{total\ number\ of\ plots\ that\ contain\ the\ species}$$

$$Relative\ frequency\ (Frer) = \frac{frequency\ of\ the\ species}{total\ frequency\ of\ all\ species} \times 100$$

$$Relative\ density\ (Denr) = \frac{density\ of\ the\ species}{total\ density\ of\ all\ species} \times 100$$

$$Relative\ abundance\ (Abur) = \frac{abundance\ of\ the\ species}{total\ abundance\ of\ all\ species} \times 100$$

$$Importance\ Value\ Index\ (IVI) = Frer + Denr + Abur$$

- Life table

Life Table / Net reproductive Rate of population/ Net fertility rate

X	n	d	l_x	b_x	q_x	$l_x.b_x$
0 year	1000	500	1	00	0.5	0
1 year	500	200	0.5	2	0.4	1
2 year	300	100	0.3	3	0.3	0.9
3 year	200	100	0.2	3	0.5	0.6
4 year	100	50	0.1	2	0.5	0.2
5 year	50	50	0.05	0	1	0
						$\sum l_x.b_x$ = **2.7** (R_0)

- X= Age
- n= No. of individuals of similar age
- d= Death
- l_x= Age specific survival rate
- b_x= Age specific Birth rate
- q_x= Age specific death rate
- $l_x.b_x$= Age specific net reproductive rate

(R_0) = net reproductive rate

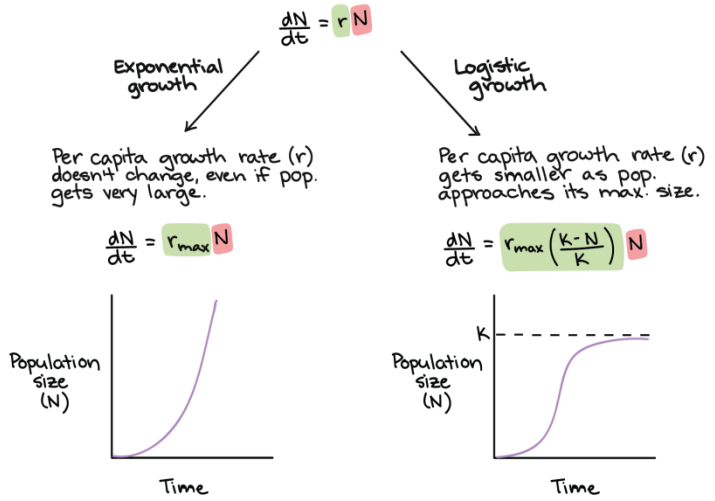
Or

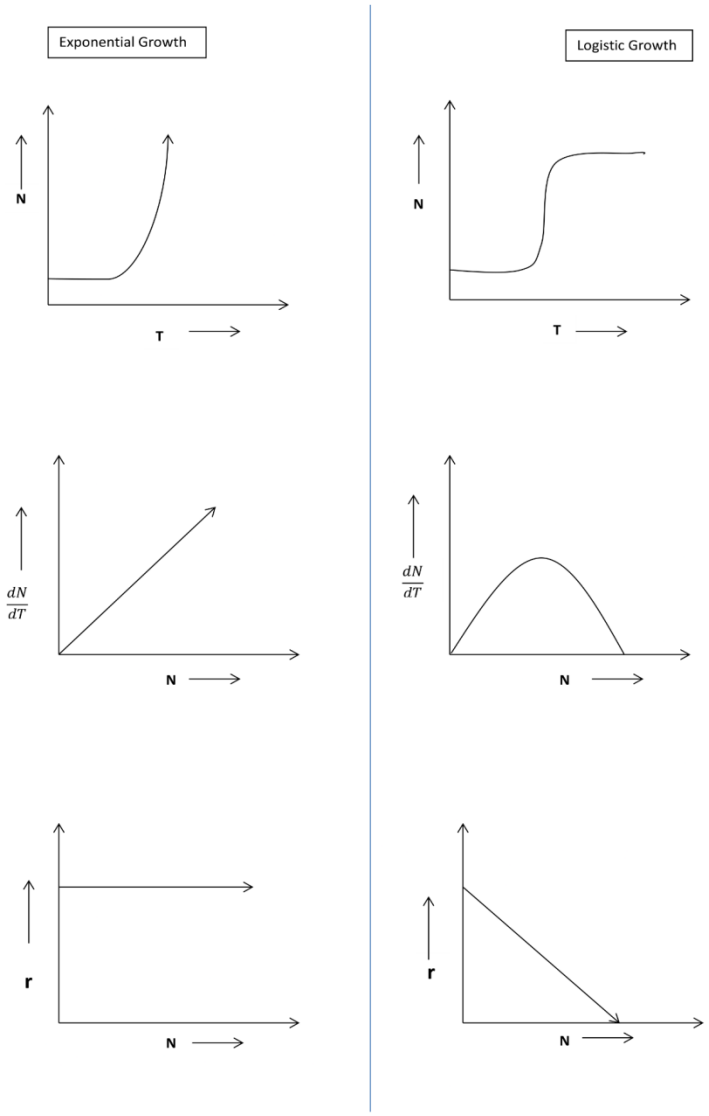
NRP

$R_0 = 1$ = Stable

= less than

- Models of growth





The rate of exponential growth of a bacterial culture is expressed as **generation time**, also the **doubling time** of the bacterial population.

Generation time: The average interval between the birth of an individual and the birth of its offspring.

- Generation Time $\propto$ 1/ Growth rate
- Generation Time $\propto$ Body Size
- Growth rate $\propto$ 1/ Body Size

There are different factors that influence the growth and stability of a population those factors can be divided into two types density dependent and density independent factors. Density dependent factors can be again divided into positively depend and factors and negatively dependent factors. **Positively dependent** factors increase with the increasing density of a population for example deatht rate, competition, disease and predation. **Negatively independent** factors decrease with the increasing density of a population for example birth rate, survival rate and space.

species interaction

Type of interection	**Species1**	**Species 2**
Mutualism	+	+
Competition	-	-
Neutralism	0	0
Predation	+	-
Commensalism	+	0
Ammensalism	-	0

Symbiosis is defined as a relationship or interaction between two different organisms that share similar habitat that must be physically near to each other. Symbiosis include **Commensalism**, **mutualism** and **Parasitism**

community ecology

Quantitative characters	Quantitative characters
Species diversity Structure of community Life form present in community Community services	• Frequency • Density • Abundance • Relative Frequency • Relative Density • Relative Abundance • Important Value Index (IVI)

- Dominant species: *the species that is found in most abundant in a community or ecosystem.*
- Keystone species: *the species that is low in abundance or sometimes rare but have very large effect on the ecosystem.*
- Indicator species: *the species that shows the overall health of the community as lichens, coral*

Growth rate for species 1

$$\frac{dN_1}{dt} = r_1 N_1 \left(1 - \frac{N_1}{K_1} - \frac{\alpha_{12} N_2}{K_1}\right)$$

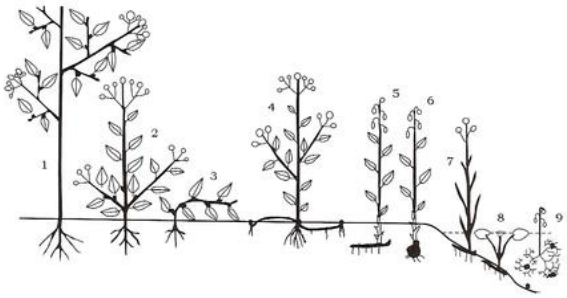
Growth rate for species 2

$$\frac{dN_2}{dt} = r_2 N_2 \left(1 - \frac{N_2}{K_2} - \frac{\alpha_{21} N_1}{K_2}\right)$$

reefs and amphibia.

- Flagship species: the easily recognisable species in a community that represent the specific community for people. (Brand ambassador)
- Umbrella species: *the highly abundant or effective spaces which conservation will lead to overall conservation of the community.(proxy)*

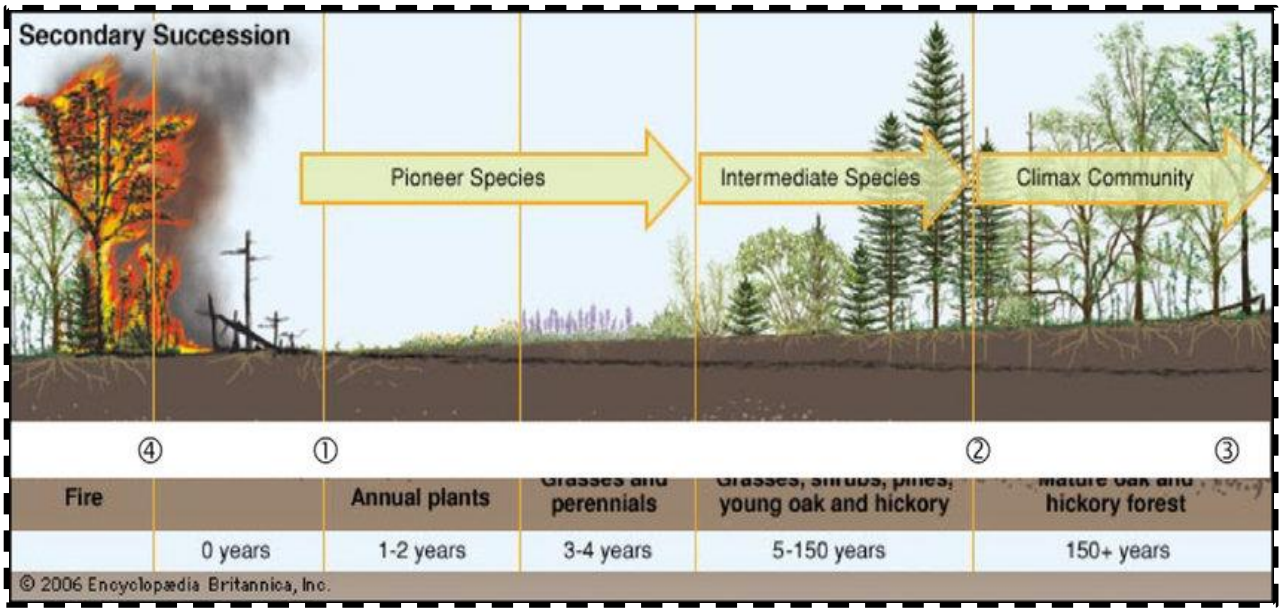
Features	Poor Community	Rich Community
Production	low	High
Stability	low	High
Efficiency	low	High
Species awareness	low	High
Relative abundance	High	Low
Example	Pioneer species	Climax species

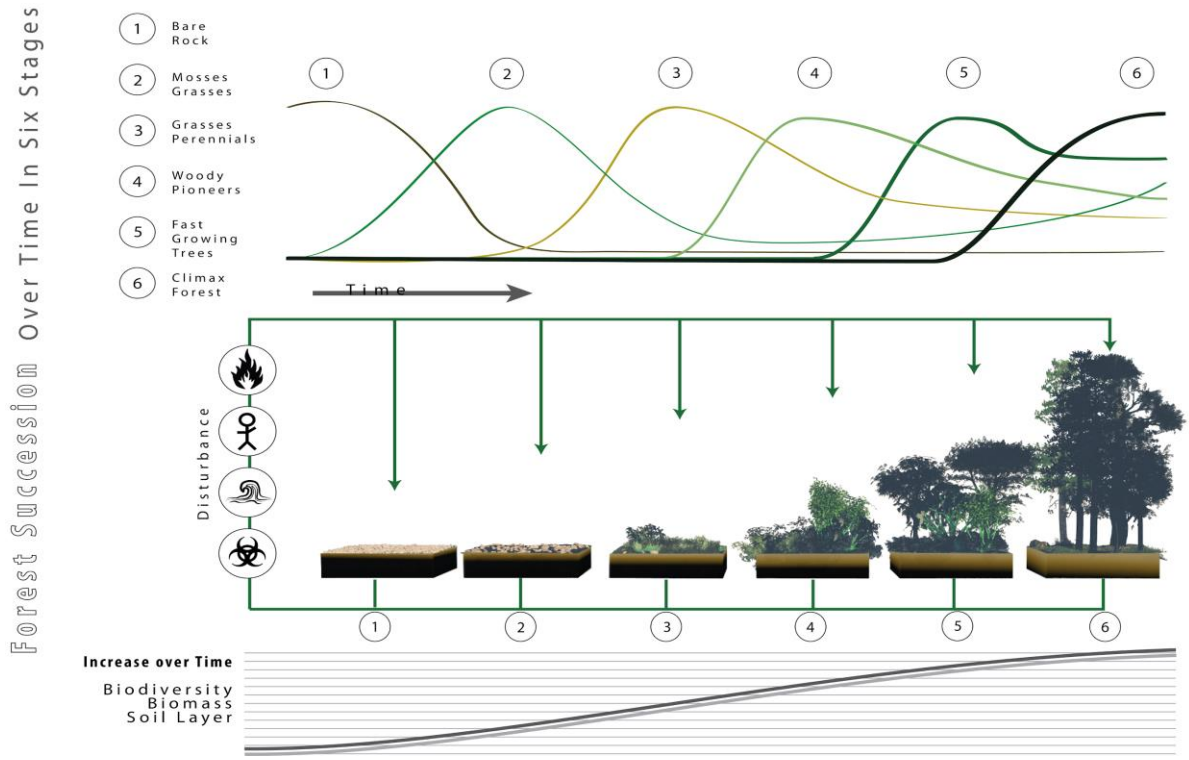


Phenerophyte: Above soild 2-40 neter
Chaemophyte: Buds are close to soild <2
Hemicryptophyte: Buds in soil in unfavorable condition
Cryptographyte: Buds remain inside soil
Therophye: Seasonal Flower

Vertical study: Study of canopy ground an other stages in between
Horizontal study: study of community in different altitude from Ocean ground, water surface to the mountain top.

ecological succession





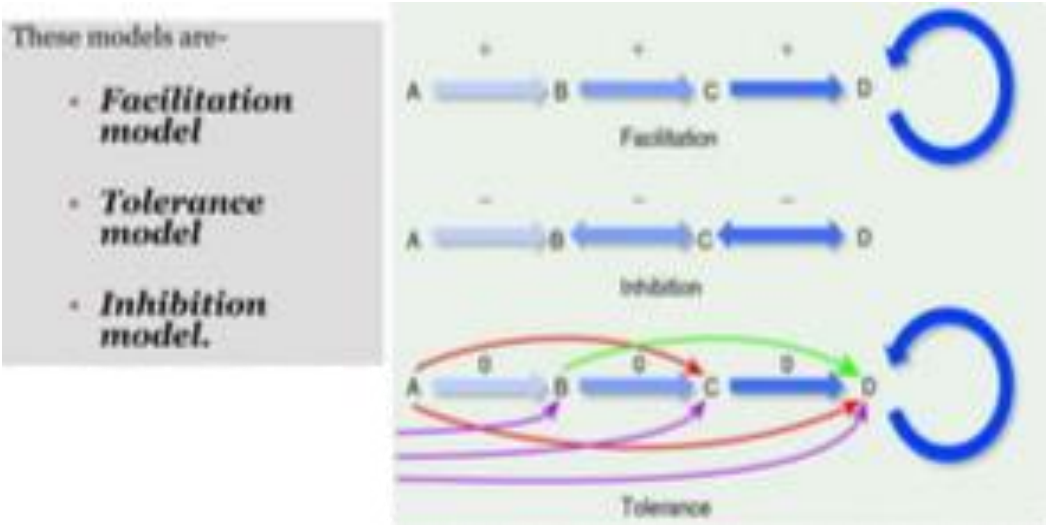
*Intermediate stage Is also known as Seral stage

Type of succession	Bare ground type
Hydrosere	Water
Psemosere	Sand dune
Lithosere	Rock
Xerosere	Dessert
Halosere	Saline water

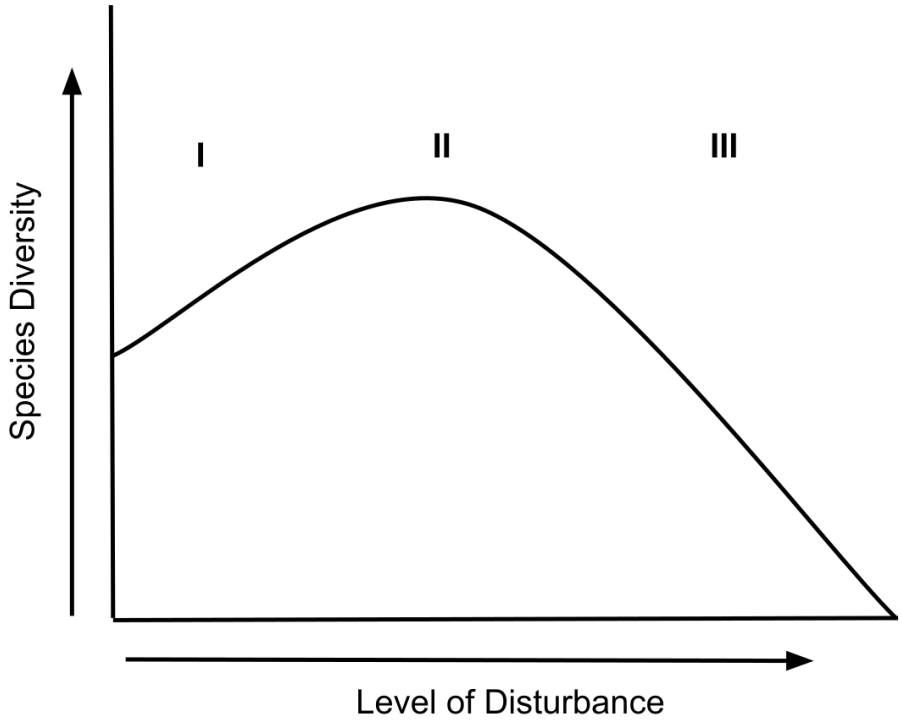
Steps in Succession

- Nudation: Making the land barren.
- Invasion: coming of new or pineer community
    - *Dispersal:* Spread
    - *Ecesis*: Trial to establish
    - *Aggregation* Integration of different species.
- Competition and co-action: Positive or Negative effects on the next or previous community
- Reaction: Environmental change
- Stabilisation: climax community

Three models of succession



The intermediate disturbance hypothesis



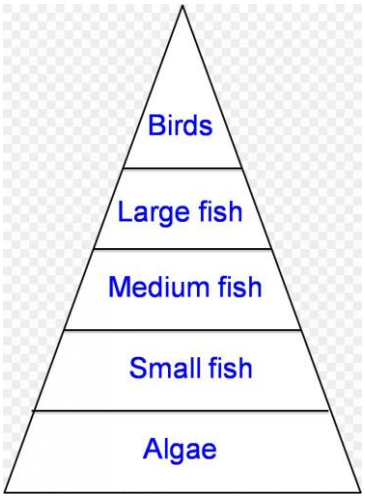
Production

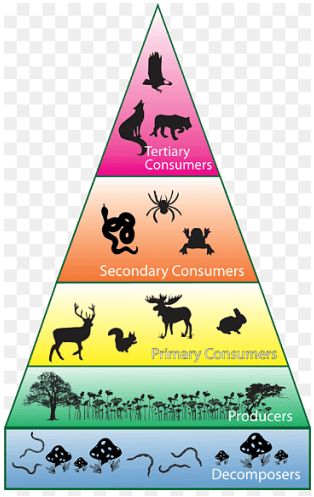
GPP means gross primary production
NPP means net primary production
R means respirational use

NPP = GPP - R
R = GPP - NPP

Ecological Pyramid

Pyramid of number





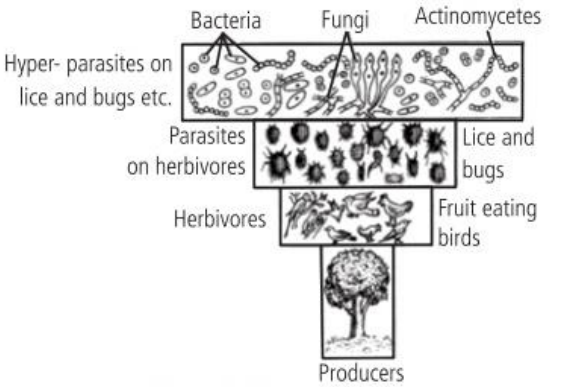
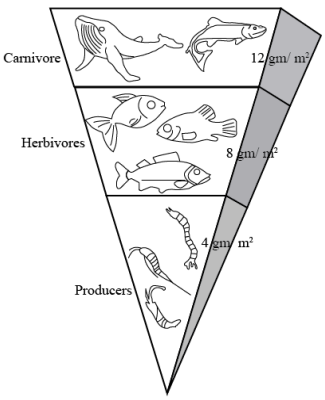
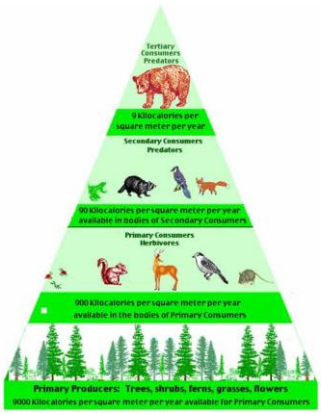


Fig.: Pyramid of numbers in parasitic food chain

Pyramid of biomas





Pyramid of energy

__Always upright

Ecosystem ecology

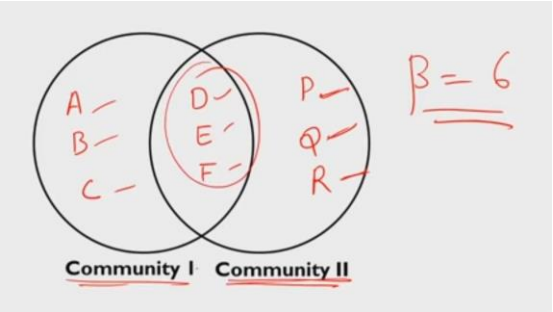
Biodiversity

- **Genetic Diversity**
- **Species Diversity**

a. Species Richness:
b. Species Evenness

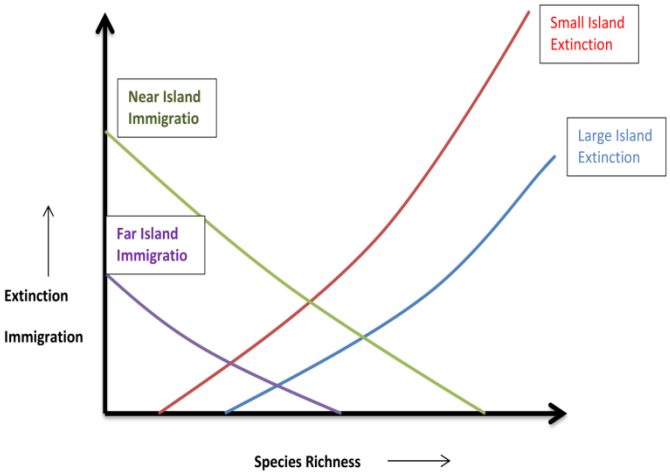
- **Ecosystem Diversity**

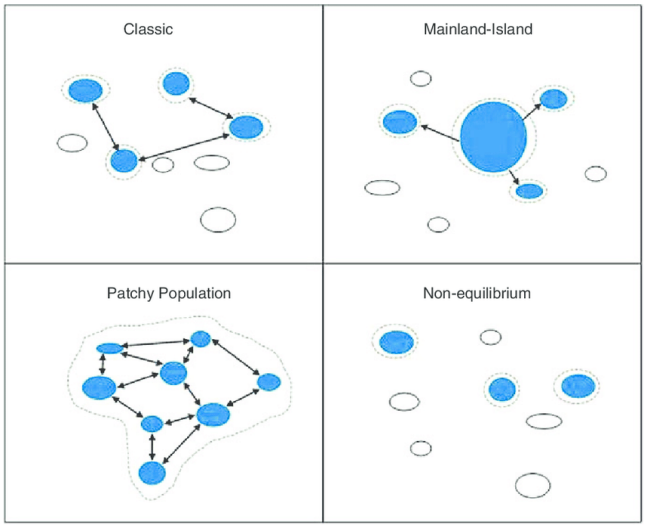
a. Alpha diversity: local diversity within a community.
b. Beta diversity: diversity between two community. Usually measured in the term of change in number of spaces between two community.



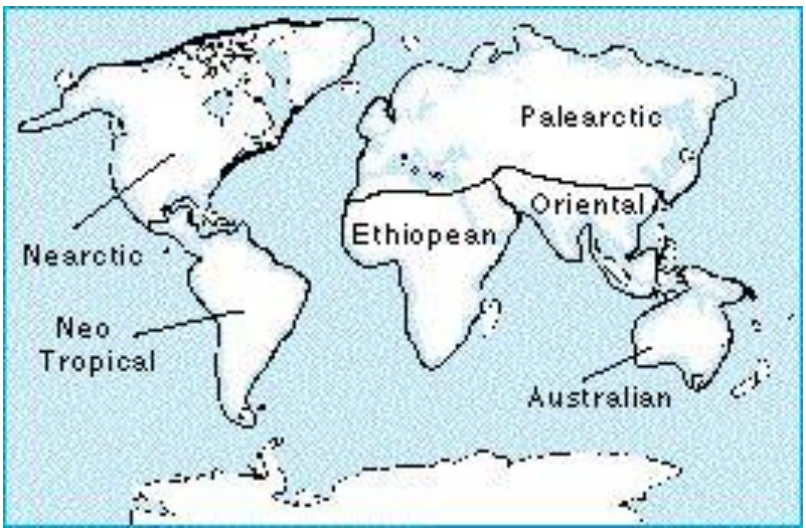
c. Gama Diversity: it is the regional diversity represented by the basis richness among the communities present in a landscape
d. Delta Diversity: Biome Diversity
e. Epsilon Diversity: Biosphere Diversity

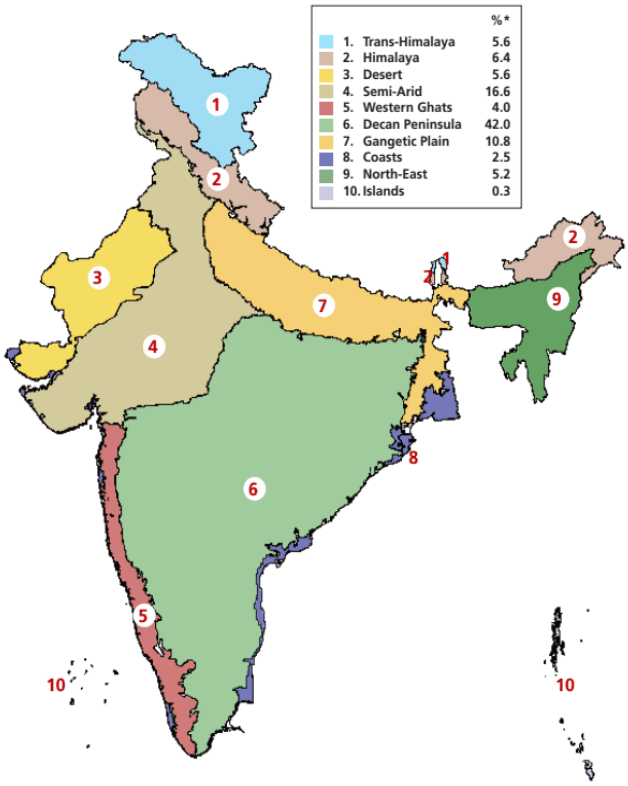
biogeography





Biogeographic region of the word





Biogeographic region of India

conservation biology

Eutrophication: if nutrition level of water bodies increased in an unprecedented manner this phenomenon is known as eutrophication.

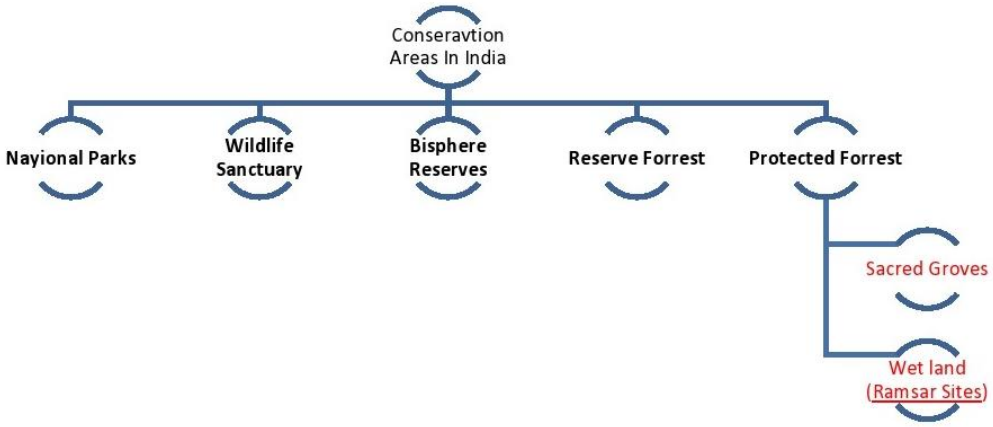
Bio accumulation: accumulation of chemical of anytime in an animal individual throughout life history is known as bio accumulation.

Biomagnification/ Bio-amplification: accumulation of chemical of anytime from one trophic level to another and gradually increasing the concentration of it towards the higher traffic level is known as biomagnification or bio amplification.

Conservation regions of India:

National Parks: Protected areas that allow limited human activities but prioritize the preservation of flora, fauna, and their ecosystems.

Wildlife Sanctuaries: Protected areas that provide a safe habitat for wildlife and plants and prohibit any form of commercial exploitation of natural resources.



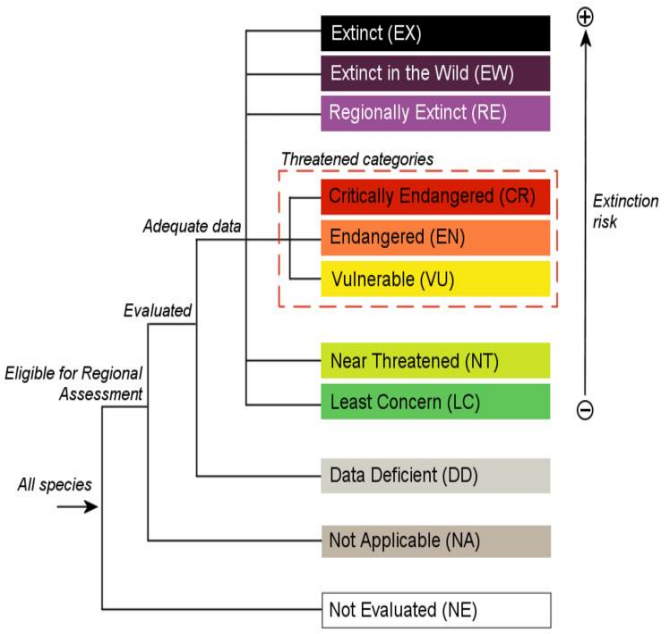
Biosphere Reserves: Protected areas that balance conservation and sustainable use of resources, serving as a model for sustainable development.

Conservation Reserves and Community Reserves: Protected areas that provide a habitat for wildlife, but also allow traditional and sustainable use of resources by local communities.

Ramsar Sites: Wetlands of international importance designated under the Ramsar Convention for the conservation and wise use of wetlands.

Sacred groves are small forested areas surrounding temples, shrines, or other religious monuments. They are considered sacred and are protected by local communities and religious beliefs, resulting in the preservation of flora, fauna, and their ecosystems.

Red data book:



1. Extinct (EX): A species is considered Extinct when there is no reasonable doubt that the last individual has died.
2. Critically Endangered (CR): A species is considered Critically Endangered when it meets any of the following criteria:
   - An estimated population size reduction of 80% over the last 10 years or three generations, whichever is longer.
   - A population size of less than 50 individuals.
   - A continuing decline of at least 20% within the next five years or two generations, whichever is longer.
   - Extremely small or restricted populations.
3. Endangered (EN): A species is considered Endangered when it meets any of the following criteria:
   - An estimated population size reduction of 50% over the last 10 years or three generations, whichever is longer.
   - A population size of less than 250 individuals.
   - A continuing decline of at least 20% within the next 10 years or three generations, whichever is longer.
   - Small or fragmented populations.
4. Vulnerable (VU): A species is considered Vulnerable when it meets any of the following criteria:
   - An estimated population size reduction of 30% over the last 10 years or three generations, whichever is longer.
   - A population size of less than 10,000 individuals.
   - A continuing decline of at least 10% within the next 10 years or three generations, whichever is longer.
5. Near Threatened (NT): A species is considered Near Threatened when it is close to meeting the criteria for Vulnerable and requiring close monitoring.
6. Least Concern (LC): A species is considered Least Concern when it has a widespread and abundant population, and it is not facing significant threats.