Ecology → Oikos + logos (Household + Study)

↳ interaction among organi and their environment.

↳ interaction that determine distribution and abundance of org.

Approaches → Theoritical (Lotka – Voltare r/i betw population of predators and prey animals)

→ Laboratory

→ Field observation

Theophrastus → Botany, Enquiry with plants (10 books).

Carolus Linnaeus → binomial classification, taxonomy.

Malthus → Book → "An Essay on the Principle of Population."

Population → geometric growth

Food → ~~exponential~~ arithmetic growth

Humboldt → Biogeography.

Charles Darwin → Theory of Evolution and natural selection.

Herbert Spencer → "survival of the fittest"

Ernst Heckel → coined term Ecology.

aur bhi hai gande g ande.

Lotka – Volterra → prey - predator r/n.

(5)

Fitness, Natural selection (Variation, Overpopulation, Struggle for existence, survival of Fittest, changes in gene pool).

3 kind of selection (Directional, Disruptive, Stabilising)

Coevolution → 2 or more species that interact closely with one another, with each species adapting with changes in other, eg: funnel - beak size.

Simon's hesiercal principle

Level of organisation: Whole > = sum

Sub-cell → cell → tissue → organ → Organ system → Organism → Populatio
→ community → Ecosystem → Biome → Biosphere

population → same species in same region

community → different spices in same region.

Biodiversity in all forms, at all level of organisation.
↳ genes, species, ecosystem.

Measures → Richness, evenness

α → within ecosystem

β → between ecosystem

γ → between geographies.

Hotspots! →
→ high species richness
→ high degree of endesim
→ high degree of threat

More competition and more predation = more biodiversity.
Intermediate disturbance ↑ biodiversity

Use value
- Direct value → timber firewood
- Indirect value → N_2 fixation etc
- Option value → for future

Non use value
- Existence value → resources continue to exist
- Altrusitic value → use of resource by others in current generation
- Bequest value → saving for future.

Harmonious interaction → live in haramony, no one is harmed.

Inharmonious Interaction →

(+)

Harmonious

Colonies (coral reefs, algae) — Intra

Societies (bee hives, wolf packs) (division of labour) — Intra

protocooperation (both benifit, but not mandatory for survival) — Inter

mutalism (both benifit, + mand) — Inter

commensalism — Inter

(−)

Inharmonious

competition

cannibalism

↳ kill animal of same species eg black widow.

parasitism. (lives on host)

predation (shikar)

ammensalism.

(Trampling of grass due to movement of animals)

Table

Competition → both parties are harmed. (−, −)

Amensalism → one harmed, one no impact (−, 0)

Exploitation → 1 harmed, 1 profit (−, +)

Netrallism → No profit, no loss (0, 0)

Commensalism → (+, 0) (Egets feeding buffaloes)

Mutalism → (+, +)

Protocooperation → cleaner fishes, birds eating bacteria from others body)

Competition → (1) intra vs inter

(2) exploitative (scramble) vs Interference (contest)

both party make full use of resources until finished (overgazing

↳ Interfere others to use it

Allelopathy → influencing others growth, habitat (+, −)

(3) apparent

↳ 2 prey species with common predator.

1 prey species affecting other prey spicies.

eg: exotic shrubs and trees through action of seed predators.

Ethology → study of animal behaviours.

Cost < Benifit → organism will go for that activity.

~~Attt~~ Altruism → selfless concern for well-being of others
~~aattt~~ eg Female squirrels

Kin selection: Evolution of traits that increase survival ultimately reproductive success.

Group selection: Natural selection for traits that favours gops rather than individuals.

Hamilton's rule $rB > C$

* Ethogram: inventory of behaviours exhibited by animals during behavioural exercise. (ethology)

Auto-grooming → stroaching licking body of own
Allo-grooming → ——————— of others.

Autotrophs → makes own food. Hetro trophs.
↳ Photo autotrops → light + self + nourishment
↳ Chemo → Chemicals.

Producers → Primary consumer → secondary . . . . .
plants grasshopper Frog snake Hawk

detritivores → feed on detritus (decomposing plants and animals part).

Food chains:

(1) Grazing herbi → carnivo.
(a) predator food chain (size of org ↑)
Grass → Chital → Tiger
(b) parasatic (size ↓) long chains
Rat → Flea → Parasite

(2) Detritus detritivores → carnivores
Fallen leaves → → short chain

Food web: System of interlocking and interdependent food chains.

Pyramid of No.: # of organisms at each trophic level.

Inverted: small # of organism are feeded up by large #.
Tree → Birds → Parasites → Hyperparasites

Spindle: Tree → Fruit birds → Hawk
small # large # small #

or Phytoplankton → Zooplankton → Fish → sea lion

Dumbbell shaped: Grass → Rabbit → Flea
large # small # large #

10% rule

Trophic cascade → Addition/removal of top predators changing entire food web.

Gross primary production → Energy (C) fixed via photosynthesis.

Net pp ——— = Gross − Energy lost via respiration.

Compensation point = photosynthesis = respiration
(Rate evening/early morning)

Efficiency of gross primary production:

$$= \frac{\text{Energy fixed by gross primary production}}{\text{Energy in incident sunlight}}$$

Efficiency of net primary production:

$$= \frac{\text{Energy ——— net primary production}}{\text{Energy in incident sunlight}}$$

Net primary productivity = APAR × LUE

Productivity depends on 7 variables:
→ Solar constant → latitude → cloudiness → dust and water
→ leaf arrangement → leaf area → CO_2 conc.

Types of lakes:
Oligotrophic lake: ↓low primary productivity ↓nutrient content. clear water for drinking. eg: ladakh Tso Moriri

Mesotrophic → intermediate level everything
Eutrophic → high biological productivity due to excessive N and P.
Hypereutrophic → extrimely nutrient rich lake, low oxygen level, dead zones beneath surfaces.

Secchi-depth → measure of amount of turbidity in waters.

N + C + P → Algal bloom
N + C → No Algal bloom.

Nutrient → substance used by org to survive, grow and reproduce.
Macro → Primary → NPK Secondary → Ca, Mg, S.

N → protiens, Vitamins harmones P → ATP
Mg → chlorophyll

Micro → B, Cu, Mn, Zn, Cl, Al, Si, Se, V.

biogeochemical cycle → pathway by which chemical substance move through biotic and abiotic (lithosp, hydrosphere) compartments of earth.

Nitrogen fixation → conversion of N_2 to ammonia.

Nitrogen cycle

$N \equiv N \rightarrow NH_3$

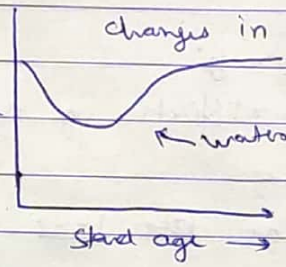
Done by Rhizobium, Azotobacter, Nostoc, Anabaena.

Dead plants and animals decomposition $\xrightarrow{\text{Ammonification}} NH_3$

Haber process & Ostwald process (HNO_3)
(NH_3)

Carbon cycle, water cycle, phosphosn, sulphur cycle.

Kuczera curve



Population organism of same speciesgp. + interbreeding.

$P_{n+1} = P + \underset{(\text{Births})}{\text{Natality}} + \text{Immigration} - \underset{(\text{Deaths})}{\text{Mortality}} - \text{Emigration}$

Population size, density.

Absolute density : No. per unit area.

Relative density : whether area * has more org. than y.

Absolute → Total counts → census of India
→ Sampling
→ quadrats. (square, rect, circ, irregular).
→ capture - recapture.
→ Removal methods

~~Kinds of plot~~

Types of sampling:

→ simple random sampling → equal chance of being selected (random no, lottery)

→ systematic random sampling → selecting every k^{th} unit starting with a chosen no from 1 to k as random start.

→ stratified sampling: taken in equal proportions from homogenous sub samples of heterogeneous sample.

→ Multistage sampling: First select large units and then specified no. of sub units from the selected large units.

→ PPS sampling: prob. of selection is ∝ size of unit.

Capture - Recapture

Step-1 → capture, mark, release

Step-2 → capture, check for marks

$$\frac{\text{animal marked}}{\text{animal caught in sample}} = \frac{\#\text{ of marked}}{\text{Total population size}}$$

Measurement of Relative ppp. density:

↳ pelt cnts; trap; no of artefacts eg nests; plantation cover etc.

Crude birth rate → live births per 1000 individual.

crude death rate → deaths per 1000 individual.

general fertility rate → live births per 1000 females of reproductive age.

age-specific fertility rate, total fertility rate.

replacement fertility rate ≥ 2.

Physiological longevity ≥ Ecological longevity.

normal lifetime — dead before time (prey).

Precision → values are close to each other

Accuracy → values are close to actual / true value.

Bias → error.

Pan traps: device used for passive collection of insects filled with liquid medium.
↳ for pollinators trapping.
pan traps appears as flowers to them.

Rate of Pop. Growth =

$$N_{t+1} = R_0 \times N_t$$

No. of female offsprings produced per female per generation.

↳ PP size of generation t.

R_0 is not constant. Varies with pp size.

logistic growth eq

$$\frac{dN}{dt} = rN \times \left(\frac{K-N}{K}\right)$$

r → intrinsic growth rate
N → Pop at time t
K → carrying capacity of env.

S → curve logistic growth eq.

Lotka Volterra equation
↳ studies r/n b/w prey and predator pp.

$$\frac{dV}{dt} = rV - \alpha VP$$

$$\frac{dP}{dt} = \beta VP - qP$$

V → prey population
P → predator population
α, β, r, q → constants.

$$\frac{dP}{dt} \Rightarrow \beta VP - qP$$

$$\frac{dV}{dt} = rV - \alpha VP$$

↳ more predator population, less prey population (sirf yad karne ke liye)

they both are cyclic ie inc. decrease ↑ ↓ ↑ ↓ ↑ ↓ ↑ ↓ . . .

Population studies and applications:

dynamics	static
change with time?	eg. cond^n and avg values.

Locusts are special grasshopper having swarming phase.

2 forms
- Solitary phase (no threat)
- Gregarious phase ~~(pests)~~ (pests)

Community ecology

Ecotone → transition area where 2 communities meet and ~~begin~~ integrate, can be sharp or diffuse.

What is community described by? Its richness, abundance, dominance.

Importance value index → Relative density + R. Freq + Rel. dominance
ranges from (0-300)

+ve association of 2 species → present or absent in both

-ve → presence of one but absence of other.

Guilds → species which utilise resources in similair ways.
eg:- Fruit eating birds.

Niche → is multidimensional description of resorce needed, habitat requirne and env. tolerance.

Fundamental niche ≥ Realised. (Post competetive.

Index of similarity = $2c/(a+b)$

Form

Accidental species → present rarely in a community (by chan
Indifferent species → no real affinity to particular community.
Preferential spec → specific abundant in one community.
* Selective species → most frequently found in a particular communi
but also present occasionally in others.
Exclusive species → almost completly to particular community

Stability of Community? Resistance : Resilience
resist. recover

Rocks → Crustose lichen → Foliose → Moss → Harbaceous → Shrub → Forest.

Ecological succession → process of change of species structure of ecological community over time.

Sere → A seral community is intermediate stage found in ecological succession advancing towards climax community.

Types → Hydrosere → county in water
Xerosere → dry area
lithosere → rocks
Psammosere → sand.
Halosere → county in saline body

Pioneer species → hardy species which establish themselves in disrupted ecosystem. and trigger process in ecological succession.

* Climax → biological county of plants, animal fungi, ~~ecological~~ ecological succession in development of vegetation. over time

Climatic climax → controlled by climate
Edaphic climax → ——— soil cond".
Catastropic climax → ——— events like wildfire
Disclimax → ——— disturbance (men or domestic animals)

Primary succession: ecological succession on surfaces which earlier didn't have succession eg lava rock.

Secondary succession: disturbance or removal of pre-existing community.

Cyclic succession: Periodic changes arising from fluctuating species interaction or recurring events eg flooding events.

Hydrosere ~~primate~~ succession (inside water)

water → Phytoplankton → Submerged → Floating → Reed swamp → sedge medow → woodland stage → climax stage.

Secondary succession

forest → Fire → half destroyed → Herbaceous stage → shrub → Woodland → climax

Secondary and cyclic are faster than Primary.

Autogenic succession → brought by changes in soil caused by org there

Allogenic succession → caused by enviromental influence ~~i.e vegetation~~ eg erosion, volcano.

7 phases of succession (boring) !!!

3 theory of climax.

community dominance index = $\frac{y_1 + y_2}{y} \times 100$ (y_1: 1st; y_2: abundance of second spcs)

Dominance ↑ Productivity ↑ diversity ↓

Resilience is measured by elasticity and Amplitude.
Distribution and Abundance

Biogeography → geography distribution of life on Earth and the reason for continents, islands & oceans.
Bio + geo
Range → area within species can be found.

Pull factor → condⁿ that attracts org.
Push factor → condⁿ that repeal organism.
Why they live where they like?

Dispersal → movement of individuals away from place of birth into a new habitat to survive and reproduce.
Anthropogenic factors: man-made factors.
→ clearing forest, pollution.

Liebig's law of minimum: The rate of any biological process is limited by that factor in least amount relative to requirement, so there is single limiting factor.

Shelford's law of tolerance: The geographical distribution of a species will be controlled by that environmental factor for which the org. has the narrowest range of tolerance.

Median altitude of malaria increase with temperature

Migration → regular/season movements, along fixed routes

3 modes of dispersal.
(1) Diffusion: Gradual movement over several generation after across hospitable terrain. eg lions ka tha kuch → lions in gir landscape.
(2) Jump dispersal: Quick movement over large distances, often across unsuitable terrain eg: Zebra ka tha kuch
(3) Secular dispersion: dispersion in evolutionary time; migrants are divergent from origin pop. eg humans out of Afr

Allelopathy → influencing the growth, habitat of other species tve or -ve ly.

Management of threatened species

- Threat to species
In | Ex-situ conservation

(1) Threat to species

Push Factor → Declining pp paradigm (towards smaller no)
→ small pp paradigm (forward extinctions).
↳ (Allee effect, stochastic death)

(large pp size)
deterministic factor → birth rate, death rate, pp structure.
(small pp size)
stochastic factor → - demographic stocasticity.
- env variation and fluctuation
→ catastrophes (forest fire)
→ genetic processes.

extinction factors

HIPPO
→ Habitat loss
→ Invasive species
→ Pollution
→ Human over-population
→ Over-harvesting.

Species richness (S) = $C \times A^z$
↳ size of habitat
if Area is reduced 90%.
species richness is halved.

4 impacts on habitat
→ habitat degradation → quality of habitat goes down
→ habitat loss → when degradation becomes high and habitat is no longer usable.
→ habitat fragmentation - landscape is broken into different part and they become isolated / loss of ecosystem.
eg: roads, railways

→ Habitat displacement ⇒ shifting of wildlife.

Population vaibility analysis: (PVA) ability of pp to ~~exist~~ persist or extinct.

In-situ conservation (On-site conservation)
cons. within habitat
Ex-situ — (off site) outside natural habitat.

In-situ → reserves, natural parks.
Ex-situ → Bring animals to a particular area.

In-situ Process strategies (1) where to make? ~~Size/shape/Management~~
level of threat is medium.
(2) Size: Big > small
(3) Management → 5 tools
↳ axe, cattle, plow, gun, fire.

Improving degraded habitats:
→ Recovery → all on nature
→ Rehabilitation / Reclamation → Shifting habitat towards greater value, but not original
→ Restoration → Trying to retur to original.
→ Enhancement → Improve the value of habitat
→ Replacement → Creating new habitat in place of degraded habitat.
Forest → Mine → Wet land.

Mitigation (Wiki: act of reducing pain, severe of something.)

Ex-situ. eg: Zoo, aquaria, captive breeding facilities, Seed banks

Seed → An embryonic plant enclosed with outer protective coating.

	seed life span
Micro biotic	< 3 yrs
Meso biotic	3 – 15
Macro biotic	15 – 100 yrs.

Human Ecology:

~~Anthropo~~ Anthropocene → epoch date commencement of significant human impact on earths ecology, climate

Trinity 1945 → Begning of Anthropocene.

Quantum of human impact

$I = P \times A \times T$ → Tech. advancement.

Impact ↵ ↓ ↳ Affluence

pp

Moor's law: In microprocessor, no of transistor double every 2 yrs.

~~low birth rate~~

5 demographic transitions stages, currently in low birth rate low death rate

Malthus → 'An essay on Principle of Population"

human pp → geometric progn Food → arithmatic progn

Malthusian growth model → $P(t) = P_0 e^{kt}$

doubling time = $\frac{1}{k} \log 2$.

Critisism to model:-

(1) PP growth is not as suggest

(2) Agri growth is not as suggest

(3) Does n't incoporate new lands available

(4) Neglects role of technology

positives checks -> increase mortality rates, thus keeping the population in check, active in nature, and included such things as disease, war, vice, misery, flood and the most powerful check of all, famine.

negative/ preventive check -> reducing fertility rates; preventive checks include birth control and celibacy, foresight, late marriage, moral restraint

(3)

Sustainable development: meets needs of present also taking care of future generations

3 pillars of Sustainability

- environmental: air, water quality, less pollution, resource usage.
- economic: job security, natural resource accounting. life cycle cost assessment.
- social: protection to health, education / promotion / maintenance / access.

Triple bottom line → environmental + social + financial (economic)

EIA (Environmental Impact Assessment)

Stages of EIA :

(1) Screening → determine which project require full / partial EIA.

(2) Scoping → to identify which potential impacts are relevant to assess, to identify alternative soln that avoid impacts and derive terms of reference for the impact assessment.

(3) Assessment and Evaluation → Do it

(4) Reporting (5) Review (6) Decision making. (7) Monitoring.

Clean technology → anything that reduce negative impacts.
eg Water purification, waste management.

Ecology of change

Oil spills : release of petrochemical into environment.
(Terrestrial, marine) (Natural, accidental, Intentional)

oils are classified on basis of specific density

Petrogenic hydrocarbons → derived from mineral oils.

Pyrogenic → derived from incomplete burning.

Biogenic → derived from biological process acting on mineral oil.

Vulnerability → chances that resource will be exposed to oil.

Sensitivity → assume resource is exposed and describes relative effect of that exposure.

Toxicity → potential of material to have adverse effects on living

- Acute Toxicity → harmful effects in org. through single / short term exposure.
- Chronic Toxicity → over extended period. effects are seen.

Biomagnification → increase conc. of toxic substance at higher level of food chain

Reducing impact on ecosystem of toxic substance :

- cleaning
  - scoop
  - Burn oil
  - Disperse
  - fertilisers
- recovery

Plastics: Classification of Plastic Debris:

→ ~~Mega~~ Macro → >20 mm
→ Meso → 5 – 20 mm
→ Micro → < 5 mm

↓ fragmentation continues. ↑ also possible

(30 yrs)

Impacts of Climate change:

Forcing → (Climate) → Responses → changes in all 5 components

- change in plate tectonics (earth crust)
- change in earth's orbit
- Chages in suns strength
- Anthropogenic forces (human activity)

How to overcome climate change?

(1) Mitigation → A human interventions to reduce the sources or enhance the sinks of greenhouse gases. (~~Reducing emissions, Ocean sinks~~)

(2) Adaptation → A djustment with change in system.

Adapative capacity: Ability of system to adjust climate change. to moderate potential damages

Maladaptation:

~~Maladaptation~~: → Any changes in natural system that increases vulnerability to climatic stimuli.

→ an adaptation increases vulnerability rather than decreasing.

Optimum Yield problem:

~~PP 22~~

$$P_{n+1} = P_n + \text{Natality} + \text{Immigration} - \text{Mortality} - \text{Emigration}$$

Weight of stock of population

$$S_2 = S_1 + R + G - M - F$$

(G: Growth of weight of fish remaining alive.)

R: Birth, M: Death, F: Fishing / killing.

For sustainable ~~load~~ $S_2 = S_1$

i.e. $R + G = M + F$

$$\frac{dN}{dt} = rN \times \left(\frac{K-N}{K}\right)$$

Maximum growth rate occurs at mid point of ~~S curve~~ Sigmoid function.

El Nino → some irregular / complex series of climatic change affecting equitorial Pacific region.

Match - mismatch hypothesis: ?

It also food matches with growth pp increase else ↓.

Ludwig's ratchet: ? harvesting rate increases , unidirectional

Pest → ~~Pests~~, animal / plants detrimental to human concerns. including crops etc → Mice, Snails, Foxes.

pest population is controlled when not causing excessive economic damage.

Ecotoxicolgy: study the effects of toxic chemicals on bio. org.

~~4 principles of~~ Ecological Restoration:

→ Ecological integrity
→ Long term sustainability
→ Benefits and engages society
→ Informed by past and future

Bioremediation: process to treat contaminated media, by altering environmental cond° to stimulate growth of micro organisms and degrade target pollutants.

Phytoremediation: ? use living plants to clean up soil, air and water contaminants.

eg -> root zone treatment plant.