

Introduction to Population Ecology

Introduction to Population Ecology
Key Concepts, Definitions, and Principles

1. What Is Population Ecology?

Aspect	Description
Definition	The study of how populations of a single species change over time and space, and how they interact with their environment.
Focus	Births, deaths, immigration, emigration, and the factors that regulate these processes.
Scale	Typically examines a group of individuals of the same species that live in a defined area and can interbreed.

2. Basic Terminology

Term	Meaning
Population	All individuals of a species in a specific area at a given time.
Density	Number of individuals per unit area or volume (e.g., individuals/km ²).
Dispersion (Distribution)	Spatial arrangement of individuals: clumped , uniform , or random .
Age Structure	Proportion of individuals in different age classes; influences growth potential.
Sex Ratio	Ratio of males to females; affects mating dynamics.
Carrying Capacity (K)	Maximum number of individuals that the environment can sustain long-term.
Population Growth Rate (r)	Intrinsic rate of increase; the difference between per-capita birth and death rates.

3. Population Growth Models

3.1 Exponential (Geometric) Growth

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- **Equation:** ($N_{t+1} = N_t \cdot e^{r}$) (continuous) or ($N_{t+1} = N_t + rN_t$) (discrete)
- **Assumptions:** Unlimited resources, constant r , no immigration/emigration.
- **Graph:** J-shaped curve (rapid, unchecked increase).

3.2 Logistic Growth

- **Equation:** ($\frac{dN}{dt} = rN \left(1 - \frac{N}{K}\right)$)
- **Key Feature:** Growth slows as N approaches K ; S-shaped (sigmoidal) curve.
- **Interpretation:** Incorporates density-dependent regulation (e.g., competition, disease).

3.3 Other Models (Brief)

Model	When Used	Core Idea
R-selected vs. K-selected	Life history strategies	R-selected: high r , many offspring; K-selected: low r , high competition.
Allee Effect	Small populations	Positive correlation between population size and individual fitness.
Stage-structured models	Species with distinct life stages	Use matrices (Leslie, Lefkovich) to project age or stage classes.

4. Factors Controlling Population Size

4.1 Density-Independent Factors

- **Definition:** Influence populations regardless of density.
- **Examples:** Weather extremes, natural disasters, habitat destruction, pollutants.

4.2 Density-Dependent Factors

- **Definition:** Effects intensify as population density changes.
 - **Examples:**
 - **Intraspecific competition** for food, space, mates.
 - **Predation** (more prey ? more predators).
 - **Disease** (higher transmission at high density).
 - **Territoriality and aggression.**
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5. Population Regulation Mechanisms

Mechanism	Type	Typical Outcome
Birth rate (b)	Density-independent or dependent	$b \uparrow \rightarrow \text{growth}$; $b \downarrow \rightarrow \text{growth}$