MODULE 6: POPULATION ECOLOGY

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The definition of *population ecology* is the study of how various factors affect population growth, rates of survival and reproduction, and risk of extinction.

CHARACTERISTICS AND DYNAMICS

Population ecology is the branch of ecology that studies the structure and dynamics of populations.

Population ecology, study of the processes that affect the distribution and abundance of animal and plant populations. The definition of *population ecology* is the study of how various factors affect population growth, rates of survival and reproduction, and risk of extinction.

- *In population ecology* a population is a group of individuals of the same species inhabiting the same area.
- Population ecology is important in conservation biology, especially in the development of population viability analysis (PVA) which makes it possible to predict the long-term probability of a species persisting in a given habitat patch.

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CHARACTERISTICS

- Ecologists use various terms when understanding and discussing populations of organisms. A population is all of one kind of species residing in a particular location. *Population size* represents the total number of individuals in a habitat. *Population density* refers to how many individuals reside in a particular area.
- **Population Size** is represented by the letter N, and it equals the total number of individuals in a population. The larger a population is, the greater its generic variation and therefore its potential for long-term survival. Increased population size can, however, lead to other issues, such as overuse of resources leading to a population crash.
- **Population Density** refers to the number of individuals in a particular area. A low-density area would have more organisms spread out. High-density areas would have more individuals living closer together, leading to greater resource competition.
- **Population Dispersion:** Yields helpful information about how species interact with each other. Researchers can learn more about populations by studying they way they are distributed or dispersed.

CHARACTERISTICS

- Population distribution describes how individuals of a species are spread out, whether they live in close proximity to each other or far apart, or clustered into groups.
- *Uniform dispersion* refers to organisms that live in a specific territory. One example would be penguins. Penguins live in territories, and within those territories the birds space themselves out relatively uniformly.
- *Random dispersion* refers to the spread of individuals such as wind-dispersed seeds, which fall randomly after traveling.
- *Clustered or clumped dispersion* refers to a straight drop of seeds to the ground, rather than being carried, or to groups of animals living together, such as herds or schools. Schools of fish exhibit this manner of dispersion.

HOW POPULATION SIZE AND DENSITY ARE CALCULATED

- **Quadrat method:** Ideally, population size could be determined by counting every individual in a habitat. This is highly impractical in many cases, if not impossible, so ecologists often have to extrapolate such information.
- In the case of very small organisms, slow movers, plants or other non-mobile organisms, scientists scan use what is called a *quadrat* (not "quadrant"; note the spelling). A quadrat entails marking off same-sized squares inside a habitat. Often string and wood are used. Then, researchers can more easily count the individuals within the quadrat.
- Different quadrats can be placed in different areas so that researchers get random samples. The data collected from counting the individuals in the quadrats is then used to extrapolate population size.

Population density

- Population density measures the number of individuals per unit area, for example, the number of deer per square kilometer. Although this is straightforward in theory, determining population densities for many species can be challenging in practice.

Measuring Population Density

- One way to measure population density is via the quadrat method. In the quadrat method, all the individuals of a given species are counted in some subplot of the total area. Then that data is used to figure out what the total number of individuals across the entire habitat should be.

- **A population is a collection of individual organisms of the same species that occupy some specific area.**
- **The term "population dynamics" refers to how the number of individuals in a population changes over time.**
- Biologists study the factors that affect population dynamics because they are interested in topics such as conservation of endangered species (for example, the Florida panther) and management of fish and wildlife. In addition, basic knowledge about the processes that affect population dynamics can be used to predict future patterns of human population growth.

POPULATION DYNAMICS

METAPOPULATION

- Regional groups of interconnected populations are called **metapopulations.** These metapopulations are, in turn, connected to one another over broader geographic ranges. The mapped distribution of the perennial herb *Clematis fremontii* variety *Riehlii* in Missouri shows the metapopulation structure for this plant over an area of 1,129 square km (436 square miles). There is, therefore, a hierarchy of population structure from local populations to metapopulations to broader geographic groups of populations and eventually up to the worldwide collection of populations that constitute a species.

- **Population dynamics** is the branch of life sciences that studies the size and age composition of populations as dynamical systems, and the biological and environmental processes driving them (such as birth and death rates, and by immigration and emigration). Example scenarios are ageing populations, population growth, or population decline.

ECOLOGICAL SPECIATION

- **Ecological speciation** is the process by which ecologically based divergent selection between different environments leads to the creation of reproductive barriers between populations. This is often the result of selection over traits which are genetically correlated to reproductive isolation, thus speciation occurs as a by-product of adaptive divergence

CATEGORIES/TYPES OF SPECIATION

- Four main categories of Speciation. The categories are:
- 1. Allopatric Speciation
- 2. Parapatric Speciation
- 3. Sympatric Speciation
- 4. Alloparapatric Speciation.

ALLOPATRIC & SYMPATRIC SPECIATION

- **Allopatric speciation**
- It occurs when the new species evolves in geo- graphic isolation from the parent species. The species range, becomes subdivided by a bar- rier such as a new mountain range or the change in the course of a river.
- Gene flow between the two subpopulations becomes impossible allowing evolution to proceed independently in each. Natural selection may favour different genotypes on either side of the barrier and random genetic drift and mutation could contribute to divergence.

- **Sympatric Speciation:**
- Sympatric speciation describes a situation where there is no geo- graphical separation between the speciating populations. All individuals are, in theory, able to meet each other during the speciation process. This model usually requires a change in host preference, food preference or habitat preference in order to prevent the new species being swamped by gene flow.

PARAPATRIC & ALLOPARAPATRIC SPECIATION

- **Parapatric Speciation:**
- This form of speciation occurs where the speciating populations are contiguous and hence only partially geographically isolated. They are able to across a common boundary during the speciation process. Where a species occupies a large geographical range it may become adapted to different environmental (e.g. climatic) conditions in different parts of that range.
- Intermediate or hybrids, will be found but the large distances involved prevent the two types from merging completely.

- **Alloparapatric Speciation:**
- It is specialised kind of speciation where differentiation in isolation takes place through barrier breakdown processes, as influenced by gradual environmental variation.