MAP 4484 Modeling in Mathematical Biology: Spatial Ecology

Spatial Ecology Study Guide for MAP 4484 Modeling in Mathematical Biology

I. Key Concepts

A. Spatial ecology is the study of how organisms interact with their environment and the physical and biological factors that influence the distribution and abundance of species.

B. The spatial scale of an ecosystem can range from a single organism to a global landscape.

C. Spatial ecology examines the interactions between organisms and their environment, including how they move, how they use resources, and how they interact with other species.

D. Spatial ecology also examines how the physical environment affects the distribution and abundance of species, such as how climate, topography, and land use affect species distributions.

E. Spatial ecology is an important tool for understanding and managing ecosystems, as it helps us to understand how species interact with each other and with their environment.

II. Definitions

A. Abundance: The number of individuals of a species in a given area.

B. Distribution: The pattern of where a species is found in an area.

C. Niche: The role of a species in its environment, including its habitat, diet, behavior, and interactions with other species.

D. Habitat: The physical environment in which a species lives.

E. Landscape: A large area of land that includes multiple habitats.

F. Movement: The process of an organism changing its location.

G. Dispersal: The movement of individuals away from their birth site.

H. Metapopulation: A group of populations that are connected by dispersal.

III. Equations

A. Lotka-Volterra Equation: This equation describes the dynamics of predator-prey interactions. It states that the rate of change of the predator population is proportional to the product of the predator and prey populations.

$dP/dt = aP - bPQ$

Where P is the predator population, Q is the prey population, a is the predator's growth rate, and b is the predator's death rate.

B. Diffusion Equation: This equation describes the spread of a substance through a medium. It states that the rate of change of the concentration of the substance is proportional to the product of the diffusion coefficient and the second derivative of the concentration with respect to space.

$\partial C/\partial t = D\partial 2C/\partial x2$

Where C is the concentration of the substance, t is time, x is space, and D is the diffusion coefficient.

IV. Rules

A. Species distributions are determined by the availability of suitable habitats and resources.

B. Species interactions can affect the distribution and abundance of species.

C. Species move in response to changes in their environment.

D. Dispersal is an important factor in determining the distribution of species.

E. Metapopulations can be used to model the dynamics of species distributions.