Populations across space

What is a population?

- It is a group of individuals of the same species living within a given area

Aerial census for African buffalo (*Syncerus caffer*) in the Serengeti of East Africa

Characteristics of populations

- Distribution
- Abundance
- Dispersion*
- Genetic variation*
- Density*
- Age distributions*
- Birth and death rates
- Immigration and emigration rates

Importance of population ecology

- Goals: understand how and why organisms distribute themselves where they do and how populations grow and regulate
  - Population studies hold the key to saving endangered species, controlling pest populations and management of fish and game populations, and understanding human population growth

Distribution limits

- The overall distribution of a population is its geographic range; it includes the size, shape and location of the area it occupies
- The presence or absence of suitable habitat* often determine the extent of a population's distribution; competition, disease organisms and barriers to dispersal also have an influence

**Habitat: place or physical setting in which organism lives*

Current geographic range and predicted future range for the American beech (*Fagus grandifolia*) under two climate-change scenarios

Current range

Potential future range

Overlap

0 400 km

4.5°C warming over next century

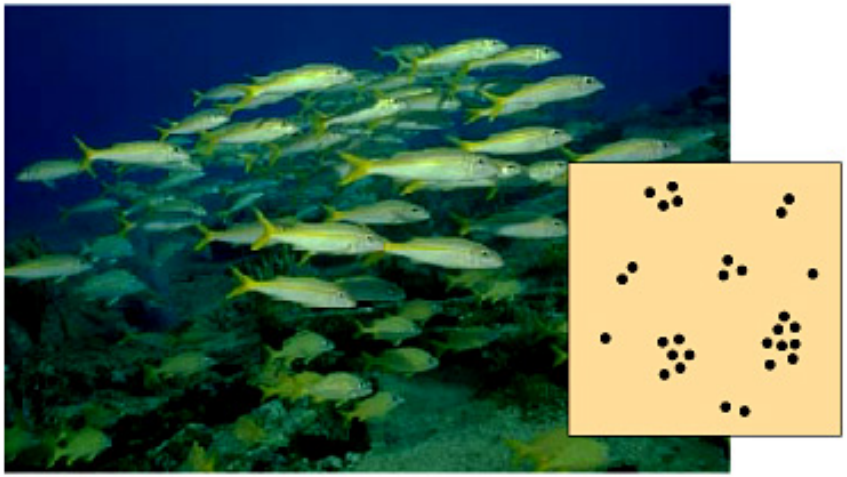
0 400 km

6.5°C warming over next century

Small scale distribution: Dispersion

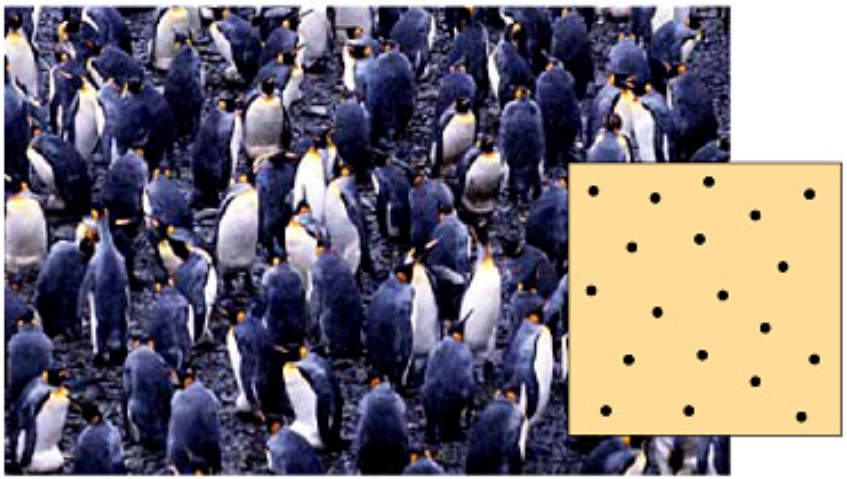
- Dispersion of individuals within a population describes their spacing with respect to one another. Three types:
  - Clumped: individuals are found in discrete groups. Due to social predisposition to form groups, clumped distribution of resources, tendencies of progeny to remain with parents
  - Spaced: each individual maintains a minimum distance between itself and its neighbors. Due to competition
  - Random: individuals are distributed without regard to the presence of others. Due to absence of social antagonism or mutual attraction

Patterns of dispersion



(a) Clumped

(c) Random



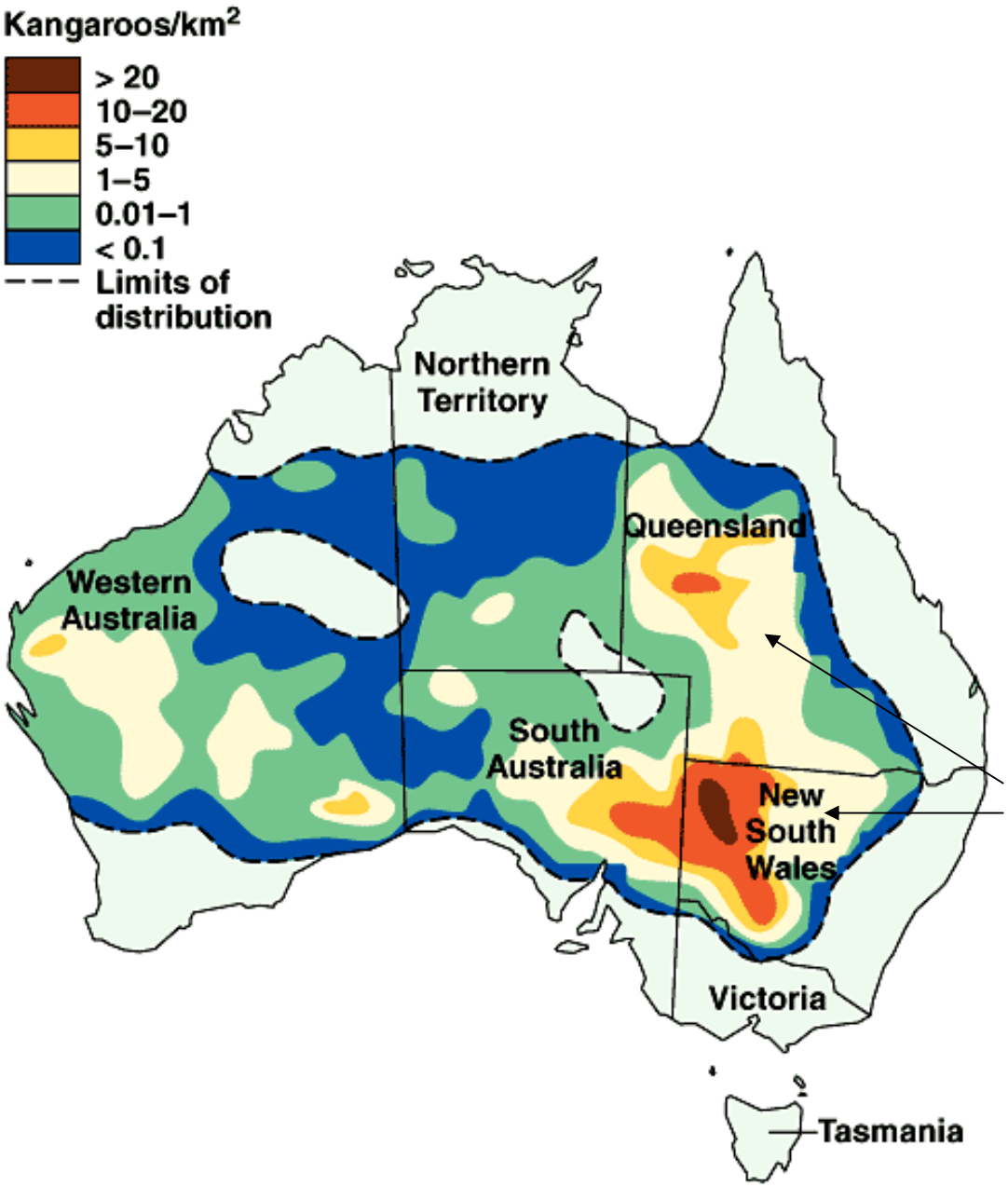
(b) Uniform

Clumped dispersion: buffalo, swans, fish, lupine

Large scale distribution: abundance

- At large scales, populations have clumped distributions
  - The bulk of individuals are concentrated in a few areas of high abundance ”hot spots”
  - In some species, these hot spots tend to be located towards the center of the geographic range
- Processes behind this pattern
  - Variation in habitat suitability
  - Variation in dispersal

Distribution and abundance of the red kangaroo in Australia, based on aerial surveys



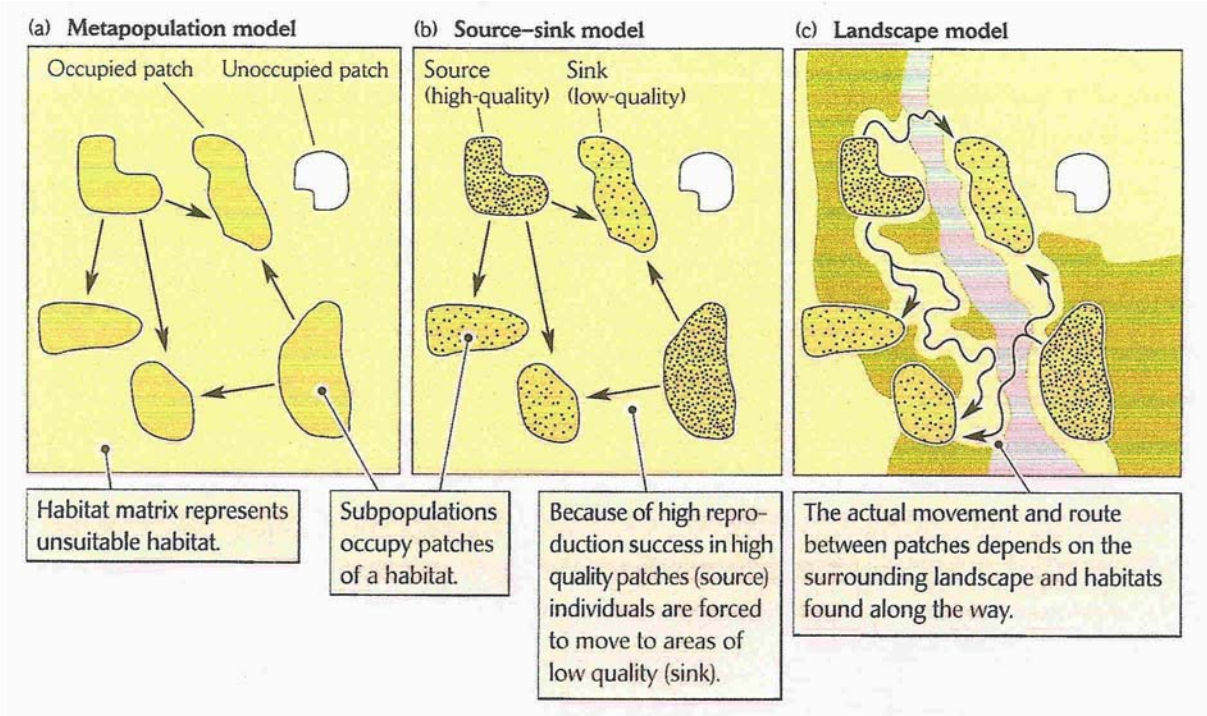
Large scale distribution: heterogeneous landscapes

- The geographic range is a mosaic of habitats patches
- Most populations divided into (sub)populations of individuals living in suitable habitats separated from other (sub)populations by unfavorable habitat
  - Depending on the distances between subpopulations, the nature of the intervening environment, and the mobility of species, areas of unfavorable habitat may or may not be barriers to movement of individuals

Heterogeneous landscapes (cont.)

- Metapopulation model: set of subpopulations occupying patches of a similar quality, between which individuals move occasionally. The intervening habitat (habitat matrix) is barrier to dispersal.
- Source-sink model: difference in quality of suitable habitat patches. In patches of high quality (source populations) individuals produce more offspring than required to replace themselves, thus offspring surplus move to other patches. In patches of poor habitat (sink populations), populations are maintained by immigration of individuals from elsewhere.
- Landscape model: considers differences in habitat quality within the habitat matrix; the quality of one habitat patch can be altered by the nature of the habitat matrix.

Models of population distribution within heterogeneous landscapes



Dispersal

- Movement of individuals within populations
- When individuals disperse widely, they link the dynamics of (sub)populations thus the population functions and evolves as a single structure
- When dispersal is limited different (sub)populations behave independently of one another