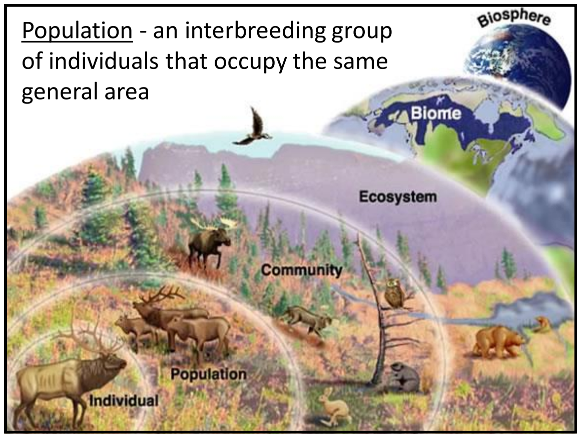
POPULATION ECOLOGY

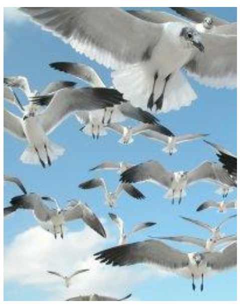
Population - an interbreeding group of individuals that occupy the same general area



Population Characteristics

- There are three characteristics that all populations have:

1) population density,
2) spatial distribution,
3) and growth rate.



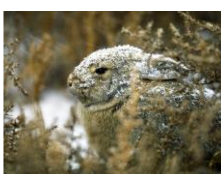
1. Population Density

- Refers to the number of individuals in relation to the space

Population Density = # of individuals / unit area

1. Population Density

Example: What is the density of a rabbit population of 200 living in a 5 km^2 range?



Solution:
Population Density = # of individuals / unit area

1. Population Density

Example: What is the density of a rabbit population of 200 living in a 5 km^2 range?

Solution:
Population Density = # of individuals / unit area
Population Density = 200 rabbits / 5 km^2

1. Population Density

Example: What is the density of a rabbit population of 200 living in a 5 km^2 range?

Solution:

Population Density = # of individuals / unit area

Population Density = 200 rabbits / 5 km^2

Population Density = 40 rabbits / km^2

Density – Dependent Factors

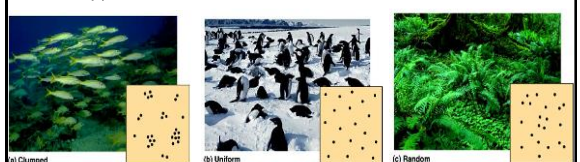
- Population health is often affected by its density.
- Factors that affect a population because of its density are called density-dependent factors.
- E.g. Food supply, competition for mates, spread of disease. (usually biotic factors)

Density – Independent Factors

- Factors that affect a population regardless of its density are called density-independent factors.
- E.g. Forest fires, Flood, Habitat destruction, Pollution (usually abiotic factors)

2. Spatial Distribution

- Refers to the pattern of spacing of a population within an area
- 3 types:



2. Spatial Distribution

- Results from dispersion – the spreading of organisms from one area to another
- Most often due to the resource availability (which may be limited to due to mountains, oceans, canopy level, or even behavior!)

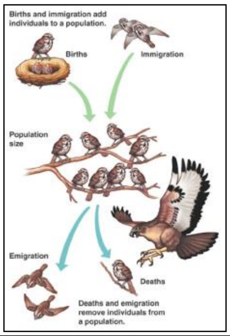
3. Growth Rate

- Refers to how fast a population grows

4 factors determine how a population changes:

1. Natality (birth rate)
2. Mortality (death rate)
3. Immigration (individuals moving into a population)
4. Emigration (individuals moving out of a population)

3. Growth Rate



- Population change can be calculated as:

Population Change =
Births – deaths + immigration - emigration

3. Growth Rate

Example: Calculate the population change in a wolf pack where the wolves experience the birth of 3 pups, the death of a lone wolf, and 1 wolf leaving the pack. No animals moved into the pack.

Solution: Population Change

= Births – deaths + immigration - emigration

3. Growth Rate

Example: Calculate the population change in a wolf pack where the wolves experience the birth of 3 pups, the death of a lone wolf, and 1 wolf leaving the pack. No animals moved into the pack.

Solution: Population Change

= Births – deaths + immigration – emigration

= 3 – 1 + 0 – 1

3. Growth Rate

Example: Calculate the population change in a wolf pack where the wolves experience the birth of 3 pups, the death of a lone wolf, and 1 wolf leaving the pack. No animals moved into the pack.

Solution: Population Change

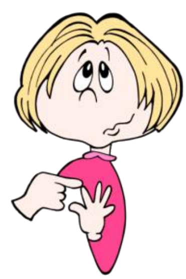
= Births – deaths + immigration – emigration

= 3 – 1 + 0 – 1

= 1 wolf

How do know how many organisms make up a population?

Yes, we count them!



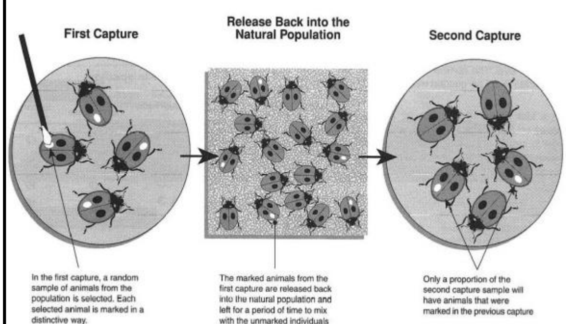
But what about…?

Population Estimation

- When the number of organisms in a population is hard to count, scientists estimate the total population size
- They do this by first sampling the population and then calculating a population size based on the data
- There are 2 main methods: Mark-Recapture and Random Sampling

1. Mark-Recapture Sampling

- Also called 'tagging'
- A sample of organisms is captured and marked and then returned unharmed to their environment
- Over time, the organisms are recaptured and data is collected on how many are captured with marks



1. Mark-Recapture Sampling

$$N = \frac{m \times s}{t}$$

Where:

N = estimated population total

m = # of individuals marked from 1st capture

s = total # of individuals captured

t = # counted that were marked during recapture

1. Mark-Recapture Sampling

Example: In order to estimate the population of sturgeon fish in the river, biologists marked 10 sturgeon and released them back into the river. The next year, 15 sturgeon were trapped and 3 were found to have marks. Estimate the total population.

Solution: $N = \frac{m \times s}{t}$

1. Mark-Recapture Sampling

Example: In order to estimate the population of sturgeon fish in the river, biologists marked 10 sturgeon and released them back into the river. The next year, 15 sturgeon were trapped and 3 were found to have marks. Estimate the total population.

Solution: $N = \frac{m \times s}{t}$ $N = \frac{10 \times 15}{3}$

1. Mark-Recapture Sampling

Example: In order to estimate the population of sturgeon fish in the river, biologists marked 10 sturgeon and released them back into the river. The next year, 15 sturgeon were trapped and 3 were found to have marks. Estimate the total population.

Solution: $N = \frac{m \times s}{t}$ $N = \frac{10 \times 15}{3}$ N = 50 fish

1. Mark-Recapture Sampling

- Best for mobile populations, such as fish and birds

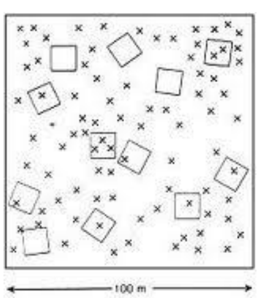
- Problems occur when no marked organisms are captured

2. Random Sampling

- Also called 'quadrat' sampling
- The number of organisms within a small area is counted.
- A sampling frame (quadrat, usually $1m^2$) is used to count the individuals in a mathematical area

2. Random Sampling

- The plots are often placed randomly throughout the sampling area (or if a grid system is used, then plots are chosen at random).
- Population size and density are then estimated based on the plot representation.



2. Random Sampling

1. Find the average # of individuals in the areas you sampled.

$$\text{Average} = \frac{\text{Total \# of Individuals}}{\text{\# of Sample Plots}}$$

2. Random Sampling

1. Find the average # of individuals in the areas you sampled.

$$\text{Average} = \frac{\text{Total \# of Individuals}}{\text{\# of Sample Plots}}$$

2. Multiply the average by the # of plots to find the population estimate.

Estimate = Average x # of Plots Total

2. Random Sampling (Quadrat)

Example: Random sampling was used to count the number of silver maple trees in the forest. The number of trees counted in the grid is shown below.

5			3
	4	4	
		1	

2. Random Sampling (Quadrat)

Solution: 1. Find the average # of individuals in the areas you sampled.

$$\text{Average} = \frac{\text{Total \# of Individuals}}{\text{\# of Sample Plots}}$$

2. Random Sampling (Quadrat)

Solution: 1. Find the average # of individuals in the areas you sampled.

$$\text{Average} = \frac{\text{Total \# of Individuals}}{\text{\# of Sample Plots}} = \frac{5+4+4+3+1}{5}$$

2. Random Sampling (Quadrat)

Solution: 1. Find the average # of individuals in the areas you sampled.

$$\text{Average} = \frac{\text{Total \# of Individuals}}{\text{\# of Sample Plots}} = \frac{5+4+4+3+1}{5} = 3.4 \text{ trees / plot}$$

2. Random Sampling (Quadrat)

Solution: 2.Multiply the average by the # of plots to find the population estimate.

Population Estimate = Average x # of Plots Total

2. Random Sampling (Quadrat)

Solution: 2.Multiply the average by the # of plots to find the population estimate.

Population Estimate = Average x # of Plots Total
= 3.4 trees/plot x 16 plots/area

2. Random Sampling (Quadrat)

Solution: 2.Multiply the average by the # of plots to find the population estimate.

Population Estimate = Average x # of Plots Total
= 3.4 trees/plot x 16 plots/area
= 54.4 trees / area

2. Random Sampling (Quadrat)

- Best for large stationary populations, such as trees or coral

- Problems occur when random sampling is not followed

Any Questions?