STUDYING POPULATIONS

Chapter 52 Population Ecology
p.1151-1156, 1158-1168
Chapter 53 Community Ecology
p.1176-1181

Studying Populations

- Characteristics
  - Size (N)
  - Density (D)
  - Dispersion
  - Migration Patterns
- Methods
  - Survey
  - Sampling
  - Tracking

Terms

- Population: a group of individuals of one species that live in a particular area
- Habitat: the specific environment in which an organism lives characterized by biotic and abiotic factors
- Geographic range: the total area occupied by a population (spatial boundary)

- Distinguish between habitat and geographic range (i.e. how are they similar and different)

Density

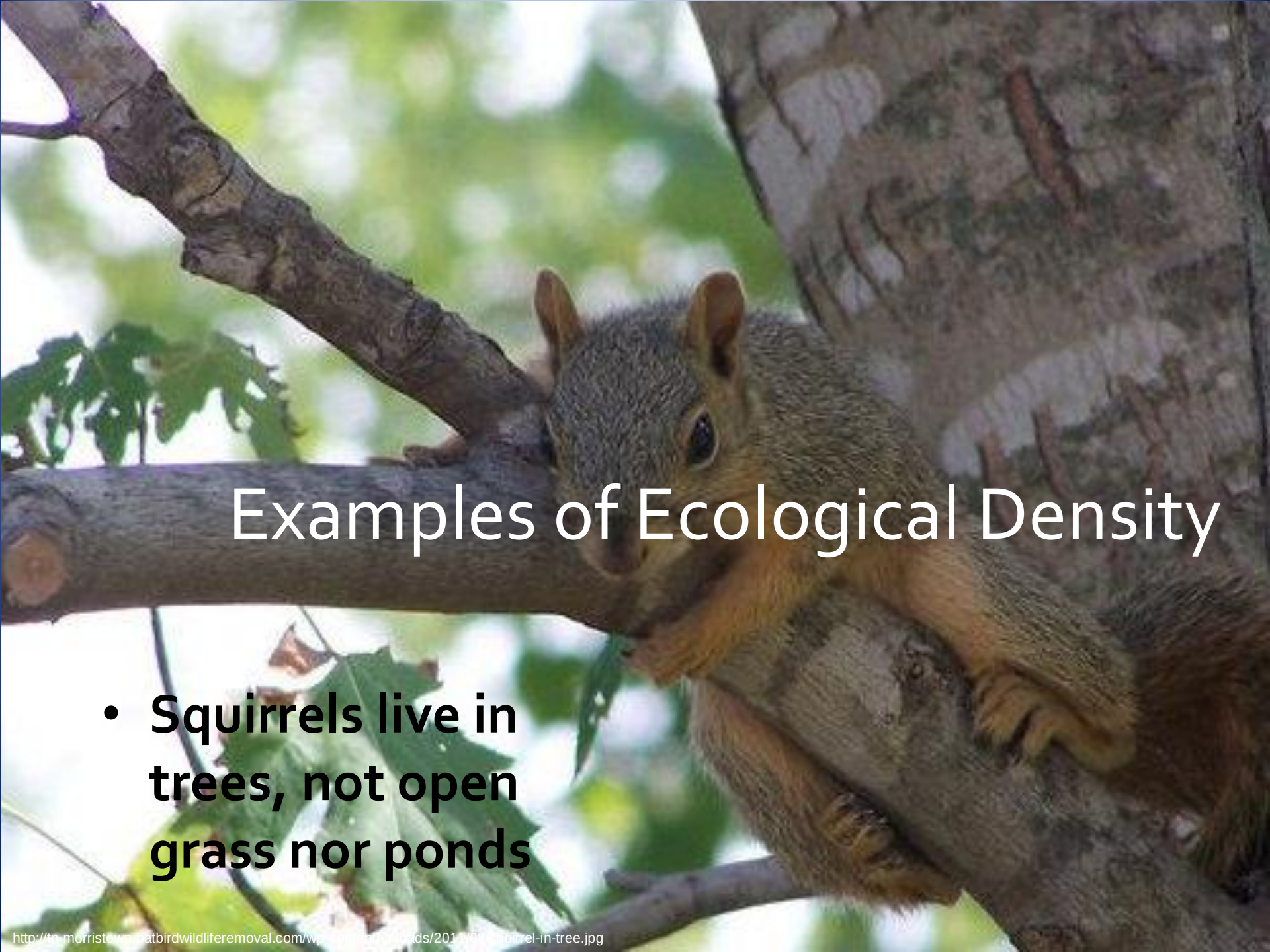
- Number of individuals per unit area or volume
- D = N / A
- N = population size
- A = area

Types of Density

- **Crude density**: number of individuals in the total area of the habitat
  - Used most often. Easiest to determine.
- **Ecological density**: number of individuals in the area actually used by the individuals
  - Is more accurate
  - Useful when population is unevenly dispersed
  - Not useful when habitat changes with species developmental stage
- In the equation D=N/A, the value for area is the only difference

Examples of Ecological Density

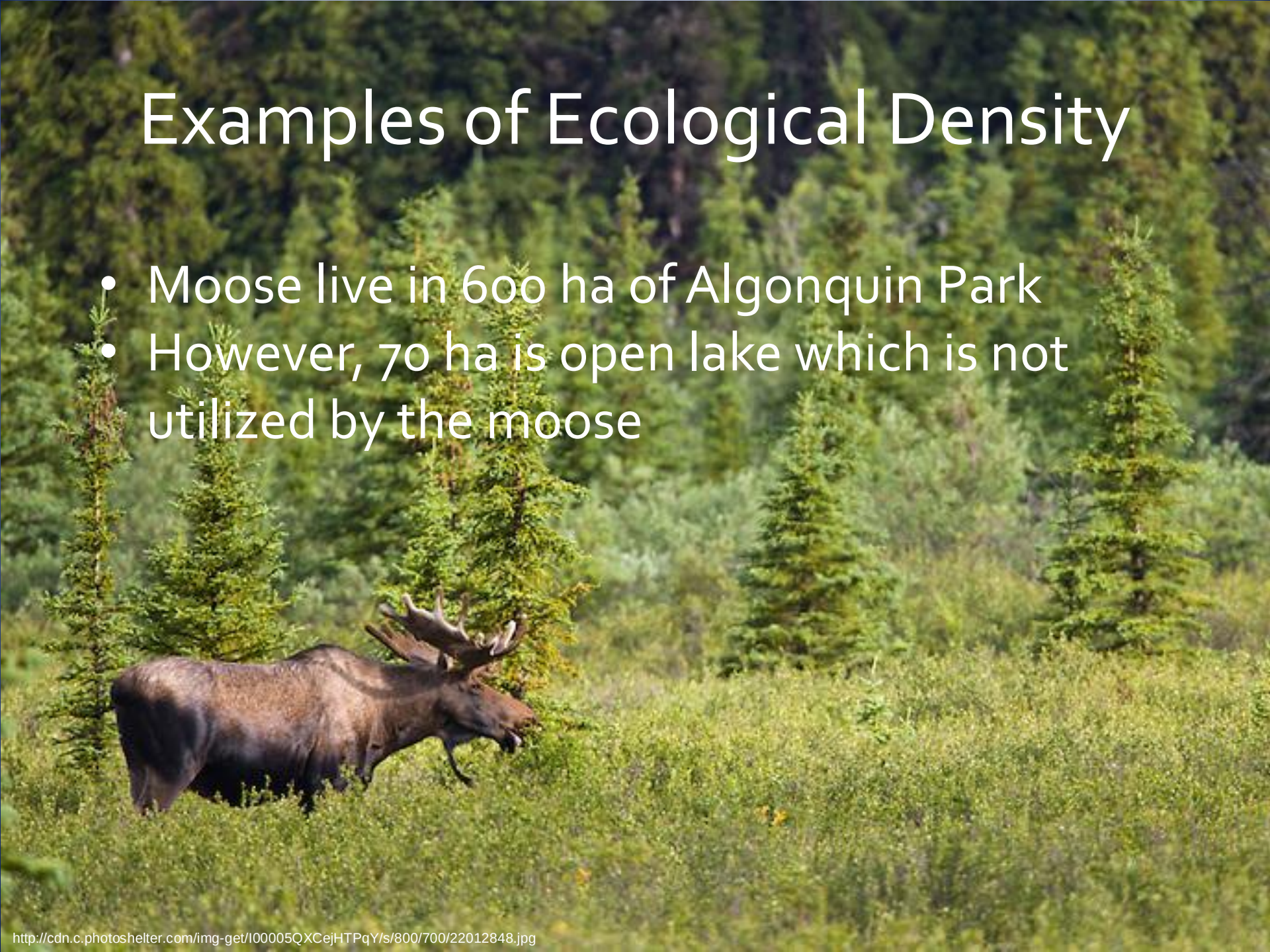
- **Squirrels live in trees, not open grass nor ponds**



http://tn-morristown.batbirdwildliferemoval.com/wp-content/uploads/2011/08/squirrel-in-tree.jpg

Examples of Ecological Density

- Moose live in 600 ha of Algonquin Park
- However, 70 ha is open lake which is not utilized by the moose

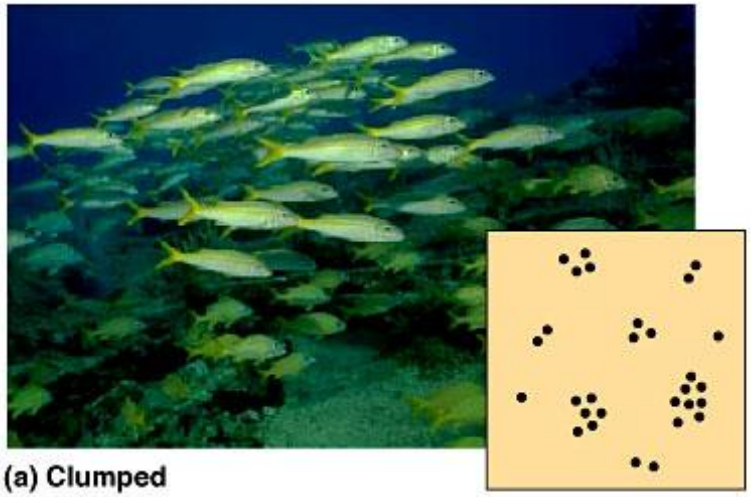


http://cdn.c.photoshelter.com/img-get/I00005QXCejHTPqY/s/800/700/22012848.jpg

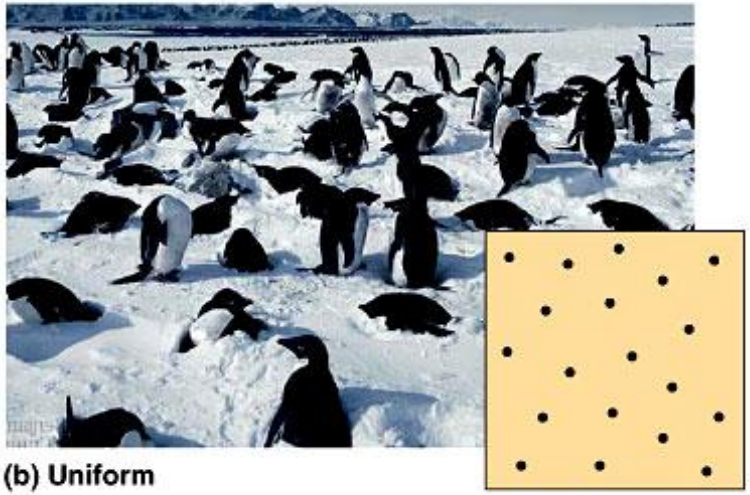
Dispersion

- Distribution pattern of a population
- 3 types:
  - Clumped
  - Uniform
  - Random

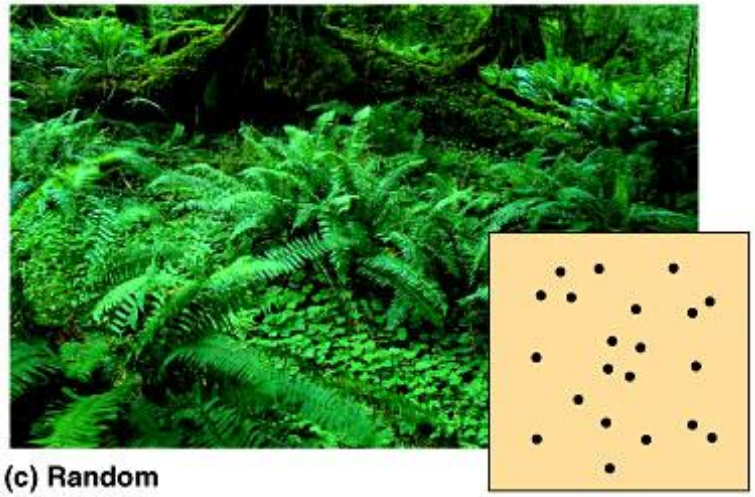
Dispersion



(a) Clumped



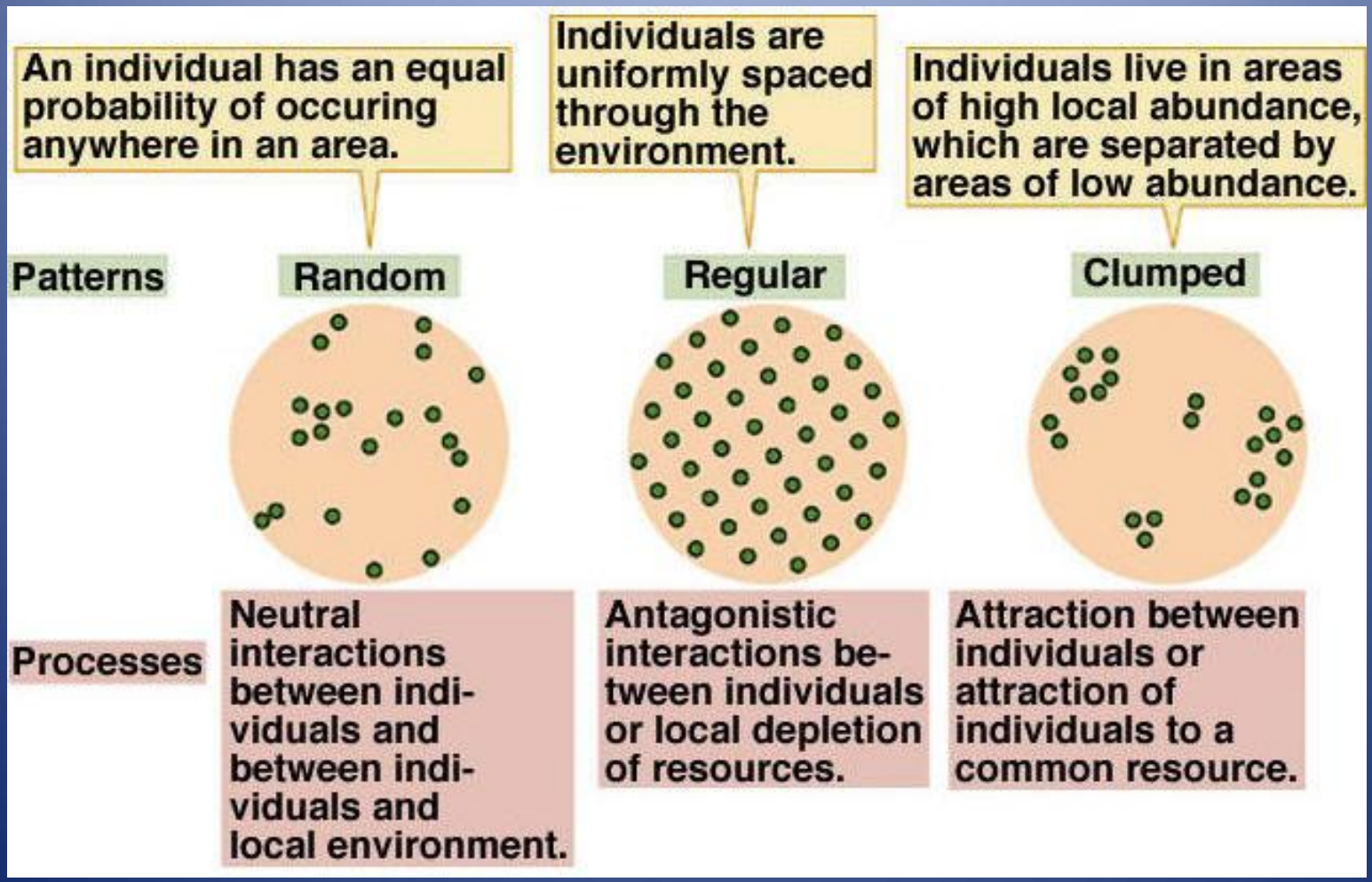
(b) Uniform



(c) Random

http://www.bio.miami.edu/dana/pix/dispersion.jpg

Dispersion


An individual has an equal probability of occuring anywhere in an area.
Individuals are uniformly spaced through the environment.
Individuals live in areas of high local abundance, which are separated by areas of low abundance.
Patterns
Random
Regular
Clumped
Processes
Neutral interactions between individuals and between individuals and local environment.
Antagonistic interactions between individuals or local depletion of resources.
Attraction between individuals or attraction of individuals to a common resource.

Example: Clumped

- School…
- Herd…
- Flock…
- Colony…
- Hive…

Example: Uniform

- **When the population gets crowded, mudskippers maintain territories around their burrows by building mud walls several inches high**
- **At the highest densities, walls become continuous and take on a pentagonal or hexagonal shape, each slightly less than 1 m wide**
- References:
  - http://www.howfishbehave.ca/pdf/can%20fish%20build%20things.pdf
  - http://link.springer.com/article/10.1007%2FBF02350029
  - http://study.com/academy/lesson/populations-growth-density-and-carrying-capacity.html

http://study.com/cimages/multimages/16/individual-territories.jpg https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQNmtGNAUDQG8rOyn60fzsnxhlecjP1qIKSsdC4ke9D-mEugfA-kQ

The Penguin Example


Example: Random

Dispersion

	Clumped	Random	Uniform
Description	Individuals live in areas of high local abundance (patches)	Individuals have equal probability occurring anywhere	Individuals are uniformly spaced throughout the environment
Resource distribution	Uniform	Uniform	Uneven
Resource abundance	Abundant	Abundant	Scarce
Interaction between individuals	Positive	Neutral	Negative
Example	Animals moving in herds	Trees in forest	Penguins

Studying Populations

- Characteristics
  - Size (N)
  - Density (D)
  - Dispersion
  - Migration Patterns
- Methods
  - Survey
  - Sampling
  - Tracking

Methods

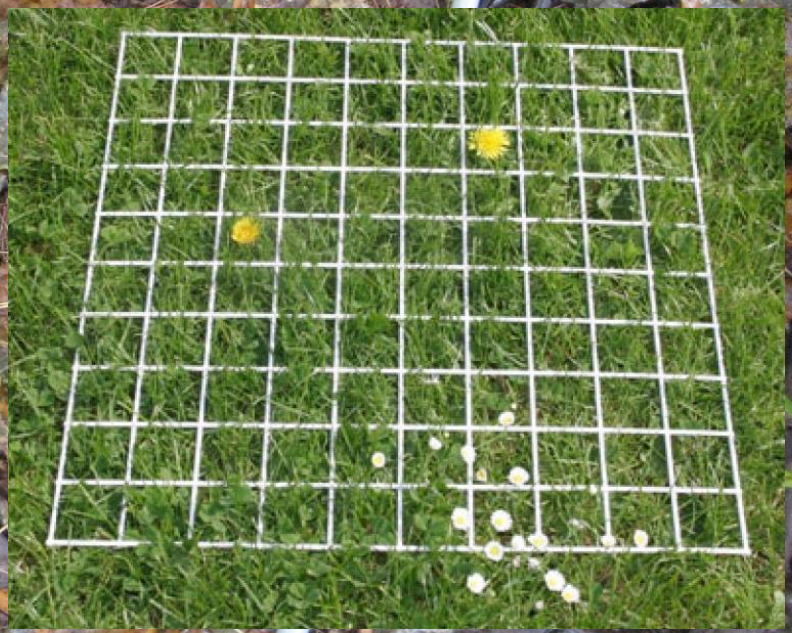
Method	Description	Characteristics
Survey	A count (like a census)	Population size, density, dispersion
Sampling	Taking a measurement from a portion of the population and applying it to the whole	Population size, density, dispersion
Tracking	Monitoring / following an individual organism	Behaviour, migration patterns, dispersion

Sampling Methods

- Quadrat
- Transect
- Mark-Recapture

- Purpose is usually to determine the total population and/or the population density

Quadrat Method



The math: ratios

(same as transcect)

- What you want to know:
  - Size of total population (N)
- What you already know:
  - size of geographic area (A)
- What you will determine by sampling:
  - Individuals in sampled area (N1)
  - size of sampled area (A1)
- N/A = N1/A1

	Sample	Whole
Size	✓	?
Area	✓	✓

Sample Question: Quadrat

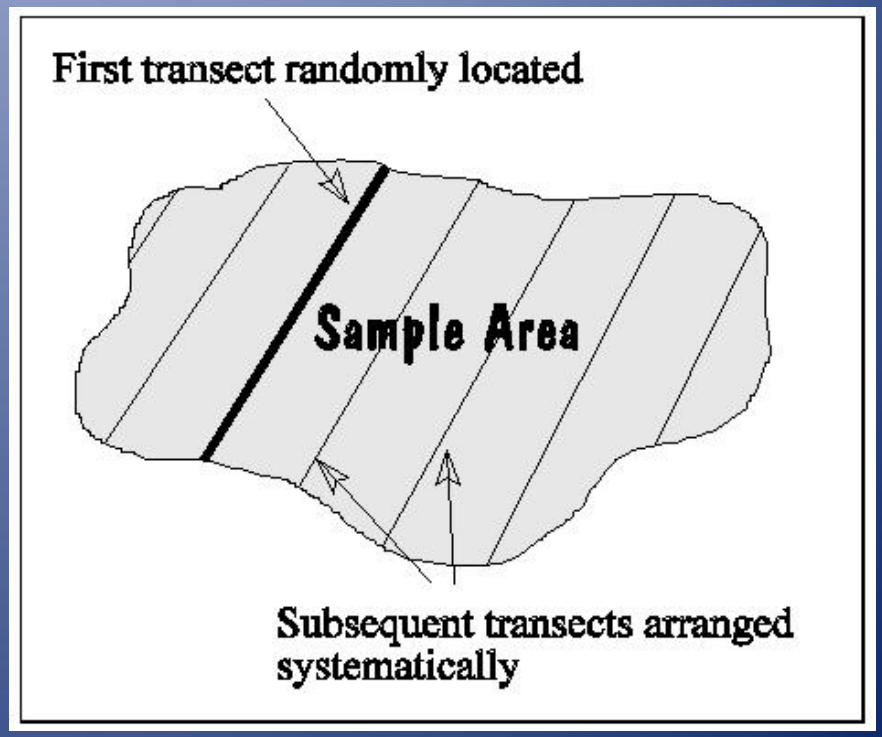
- Ragweed plants occupy a field measuring 100 m x 100 m. A student places three 2.0 m x 2.0 m quadrats in the field. Estimate the population density and size if she finds 18, 11 and 24 ragweed plants in the three quadrats.

Limitations of Quadrat Method

- Only useful for:
  - sessile (immobile) organisms or those that move very slow
  - Small organisms
- Difficult to use in changing terrains
  - i.e. the quadrat might roll down a hill

Transect Method

- Definition of transect: a straight line along which observations are made
- A line placed across a community of organisms, usually in a form of a string between 2 markers
- Subsequent transects are arranged equal distances from each other



Transect Method

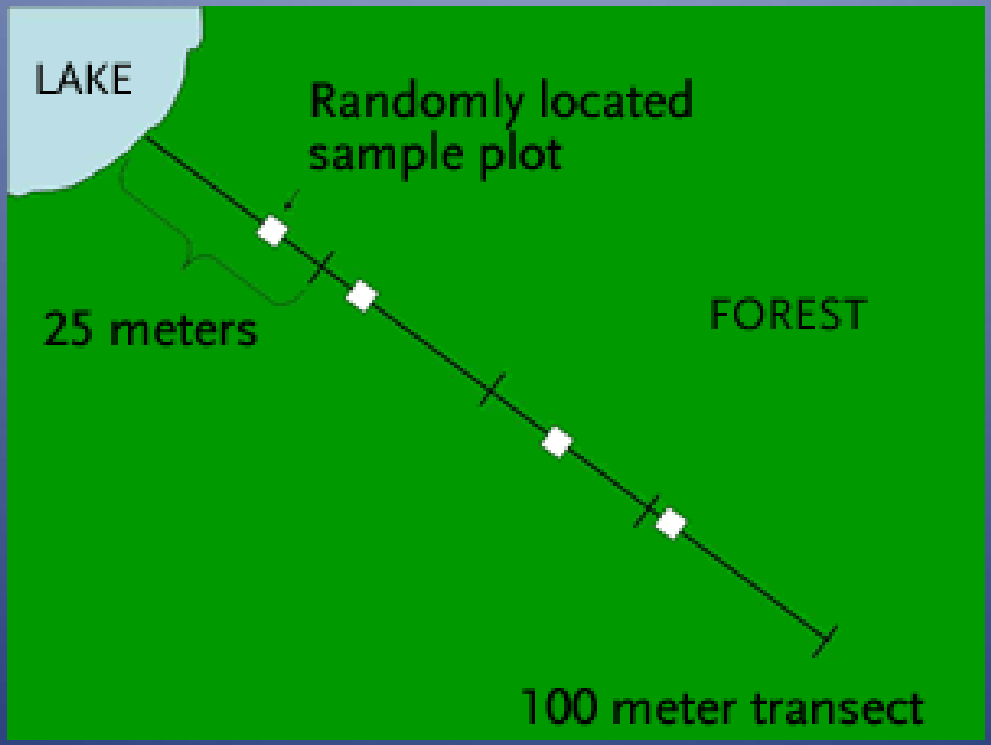
- Starting point and direction of sampling is randomly determined
- The distance sampled varies depending on the type of organism:
  - Sessile (stationary organisms) may be counted within 1 m of transect
  - Mobile organisms will have a larger distance (e.g. 50 m from transect)

Transect Method

- 3 types of transects:
  - Point
  - Continuous
  - belt

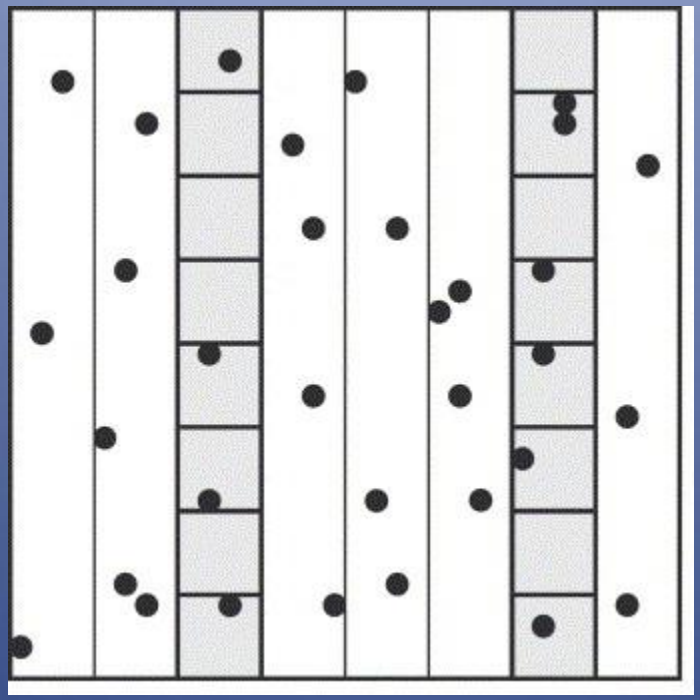
Transect Method: Point Sampling

- The string is marked off at equal intervals to indicate where a count is to be taken.



Transect Method: Continuous Sampling

- Whole area along the line is counted



Transect Method: Belt Sampling

- A form of quadrat sample

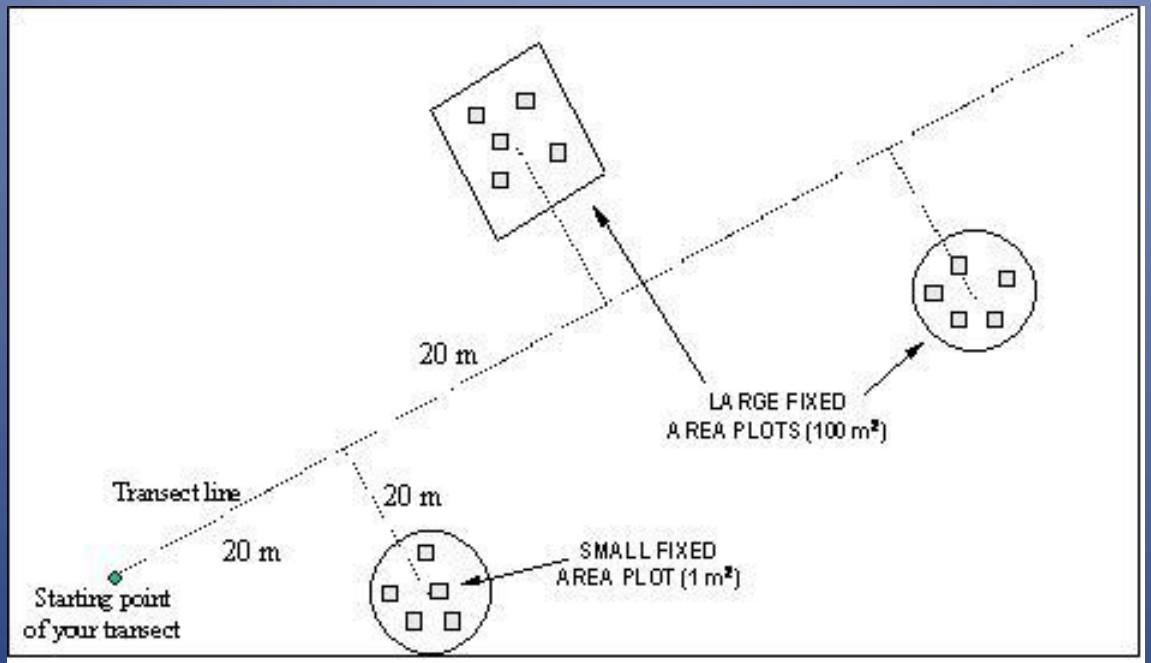


Figure 1-1. Establishment of a transect line with study plots

The math: ratios

- What you want to know:
  - Size of total population (N)
- What you already know:
  - size of geographic area (A)
- What you will determine by sampling:
  - Individuals in sampled area (N1)
  - size of sampled area (A1)
- N/A = N1/A1

	Sample	Whole
Size	✓	?
Area	✓	✓

Sample Question: Transect

- The number of moose in three continuous transects were counted with these results: 9, 5, 8. The size of each transect was 0.5 km x 8 km. The total area being studied was 8 km x 8 km. Estimate the size and density of the moose population.

Advantage of Transect Method

- When population:
  - has a **low density**
  - have individuals that are **very large**
  - is mobile (but easily visible from afar)
- Useful for determining information on the **distribution (dispersion)** of a species
- When area:
  - Has **environmental gradients** that change the distribution and density patterns in a sampled area

Mark-Recapture Meth

Mark-Recapture Method

- First capture: mark all captured organisms
- Second capture: count number of organisms captured and number of marked organisms in the capture
- Do the math (ratios!) to determine population size

The math: ratios

	First capture	Second capture
Marked	✓	✓
Total	?	✓

- What you want to know:
  - Size of total population (N)
- What you know from the first capture:
  - Number of marked individuals (M1) in a population
- What you know from the second capture:
  - Number of marked individuals (M2)
  - Total number of individuals in capture (N2)
- $M1/N = M2/N2$

Sample Question: Mark-Recapture

- Wildlife researchers surveyed an area of wetlands where 80 ducks were captured in traps, marked with permanent metal bands, and then released. Two weeks later, 100 ducks were captured. Of the ducks recaptured, 12 were marked. Estimate the total size of the duck population.

Advantage of Mark-Recapture Method

- Useful for mobile organisms

Mark-Recapture Limitations

- Discuss factors that could affect the reliability of a mark-recapture data

Sampling Summary

	Quadrat	Transect	Mark-recapture
Description			
Method			
Types of populations			
Advantages			
Limitations			

Simulations

- Quadrat: Sunflower seeds
- Mark-recapture: Marshmallows