

Title: Metapopulation: A Result of Habitat Fragmentation

Grade Level: 4th grade & higher

Grouping: 2 students per board game

Time: 40 minutes

Synopsis: Habitat Fragmentation, natural and anthropogenic, can result in a metapopulation. Students will discover what a metapopulation is and how each subpopulation plays a role in keeping the species alive. Students will be able to identify “source” and “sink” subpopulations and will be able to understand the environmental impacts that lead them to be a “source” or a “sink”. Genetic Diversity and Gene Flow can also be illustrated through indicated colors of each subpopulation. This information will be used to analyze the survivability of a species.

Purpose: The purpose is for the students to comprehend the impact of habitat fragmentation on species in the wild. The genetic diversity may also be negatively impacted through fragmentation which influences the survivability of the species.

Next Generation Science Standards:

Students who demonstrate understanding can:

- MS-LS2-1.** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]
- MS-LS2-3.** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.]
- MS-LS2-4.** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

Objectives:

- Brainstorm various forms of Natural & Anthropogenic Habitat Fragmentation
- Identify “Source” and “Sink” Subpopulations
- Visualize genetic diversity and understand how important it is to keep a species thriving
- Acquire an understanding of the importance of preventing future fragmentation and aiding already fragmented regions

Introduction/Near-Peer Information:

What is the problem?

Habitat Fragmentation → by limiting the space & areas of where species can live impacts the species' health. Almost all species like to spread out throughout an area rather than be crammed into a small isolated region. Habitat Fragmentation limits where an individual may live and can have serious implications on the species' number (being prey, not having enough resources, not finding a mate, etc.)

What happens next?

Metapopulation Dynamic → subpopulations will form. A "Source" population may arise if one habitat is more favorable than others allowing individuals to travel and thrive in various locations. A "Sink" population may be found if that habitat is hostile for immigrating individuals. The location may appear ideal; however food, water, sun, soil, or an inability to find other mates may cause the species to become locally extinct.

Why does it matter?

Genetic Diversity → species that contain more genetic diversity are able to adapt over time more easily than species with a limited gene pool. Diseases and other health concerns are not as harmful to a population with varying genes, since one gene may show a high resistance.

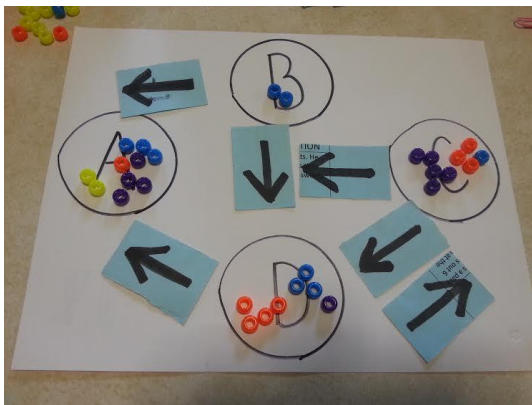
Key Terms

- Metapopulation: group of populations separated by space but consisting of the same species
- Subpopulation: individuals of the same species that are grouped together
- Immigration: an individual moving INTO a new region
- Emigration: an individual EXITING a region
- Source: a subpopulation where individuals are exiting & there are no immigrants into
- Sink: a subpopulation where individuals are immigrating into & no emigration is occurring
- Local Extinction: a species ceases to exist in a chosen geographic area, but will exist outside the specified geographic area
- Genetic Diversity: any variation in DNA within a species (may apply to traits)

- Habitat Fragmentation: habitat loss resulting in the division of large, contiguous habitats into a greater number of smaller patches of lower total area, isolated from each other
- Natural: found in nature
- Anthropogenic: from human activity
- Biotic: living
- Abiotic: nonliving
- Homozygous: the same; uniform
- Heterozygous: mixed; multiple traits shown
- Viability Analysis: determines the probability that a population will go extinct within a given number of years

Real Life Example: Birds separated in patches by deforestation in South America.

Helpful Hints: (these are for teachers/Near-Peers only)



Below is a link for more information.

<http://www.eoearth.org/view/article/171093/>

<http://www.britannica.com/EBchecked/topic/377988/metapopulation>

<http://www.eoearth.org/view/article/153225/>

Material: (listed per group of 2 students)

- Paper or Board listing areas “A”, “B”, “C”, and “D” (x1)
- Dice (x1)
- 10 red beads
- 10 yellow beads
- 10 green beads
- 10 blue beads

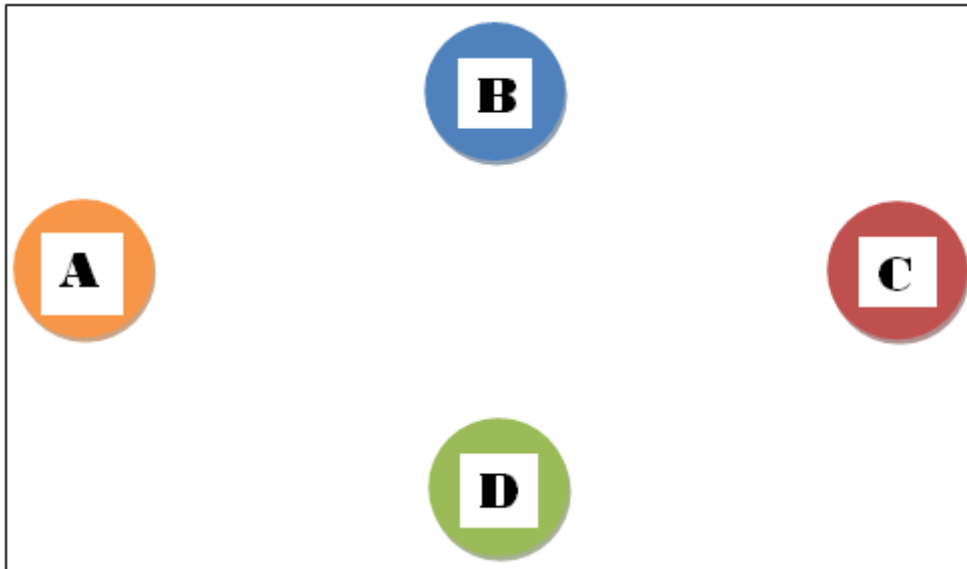
In this completed game, “A” would be considered a sink population, since all arrows point towards “A”. It may be misleading however since “A” has the most diverse and highest number of individuals but over time, the arrows will show that the population in that habitat is unfavorable. Population “B” is considered a Source Population since arrows are going away from the population and no arrows are showing immigrants into “B”.

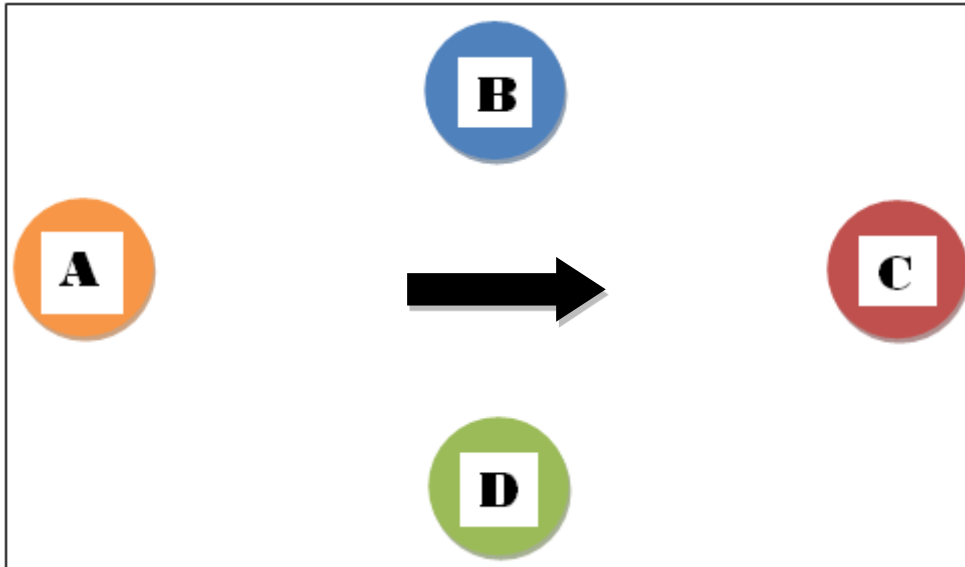
It may be very thoughtful to ask the students why there are so little individuals and explain how in this simulation there is no reproduction. There are

- 3
- 8 Action Car
 - 3 Food Shortages; Remove Individuals
 - 2 Emigrate Clockwise
 - 2 Emigrate Counterclockwise
 - 1 Emigrate Across the Board
- 5 Cut Out Arrows
- One Definition Card [Key Terms] per group or shared with three groups

Pre-Lab:

Before completing this lab, a paper or board will have to be made to clarify each subpopulation. Different colors shown on the board may represent the beads of that subpopulation, however no colors are necessary. Ten of the same colored beads will be placed in each circle prior to the start of the game. For each board there will be two students working together to discover how habitat fragmentation impacts the species.





Procedure:

This game will be played clockwise starting with subpopulation “A”.

“A” → “B” → “C” → “D” → “A” ...

Part 1: Problem Identification

1. Roll the dice (1-6) to determine how many of the ten individuals (beads) will be taking an action that round.
2. Pick up an Action Card & complete action with “X” individuals
 - a. Emigrate Clockwise: Place in the Circle to the Left
 - b. Emigrate Counterclockwise: Place in the Circle to the Right
 - c. Emigrate Across the Board: Place in the Circle Opposite of the Circle in Play
 - d. Cease to Exist: Remove from Board
3. Place an Arrow Card Down on the Board to illustrate where Individuals moved
*Note: Beads will also illustrate however, the arrow will help clarify
4. Next Person’s Turn will then take place
5. In the situation where one circle contains two or more different colored beads and has to emigrate to a new circle, equal amounts of the colored beads must be taken
6. Continue the game until no more Action Cards remain (2 rounds will have gone by)
7. Identify “Source” & “Sink” Populations through the use of the Definition Card
*Note: A SOURCE AND A SINK POPULATION MAY NOT ALWAYS BE PRESENT
8. Repeat the game until a “Source” & “Sink” Population can be identified

Part 2: Anthropogenic Solutions

This occurs after the initial problem has been displayed: certain genes in the population are rare or no longer in existence. How can people change the fragmentation that has already taken place? Corridors have been implemented in certain regions to allow animals to be able to move to and from each subpopulation. This allows individuals to spread out and each subpopulation may become more heterozygous.

9. First designate two subpopulations where you will place a corridor in between. (“A” & “B”)
10. Before each of these subpopulations turns, all the beads from each area will be picked up, mixed, then divided without looking

*This step should be done in pairs to ensure that separation of the beads is equal and random

11. Continue to play the game by rolling the dice & picking up an Action Card each round
Observe any differences & make notes

Questions:

What might prevent a subpopulation from exchanging individuals in nature with surrounding subpopulations?

How can we help prevent fragmentation?

What might the population look like if there was not any habitat fragmentation?

What other influences effect the survivability of a species?

Do you think that every species will be affected the same way? Will predators and prey be differently affected?

What is there was reproduction, do you think there would be any changes that occur?

How are the colors distributed?

Where do you think the species will thrive the best?

Career Connection:

Ecologist

- Studies the interactions among organisms and their environment, both biotic & abiotic factors
- May either work in the field or the lab to understand a species more clearly

Geneticist

- Studies the genes, heredity, and variation in living organisms
- May work as a consultant or medical doctor
- Evolutionary Biology

Lobbyist

- Hired by a business or a cause to persuade legislators to support the business or cause
- Paid to win favor from politicians

Research Scientist

- Engages in a systematic activity to acquire knowledge

Zoologist

- Studies animals from their cells to history of evolution of the species
- Works in the field and observes in various locations & environments

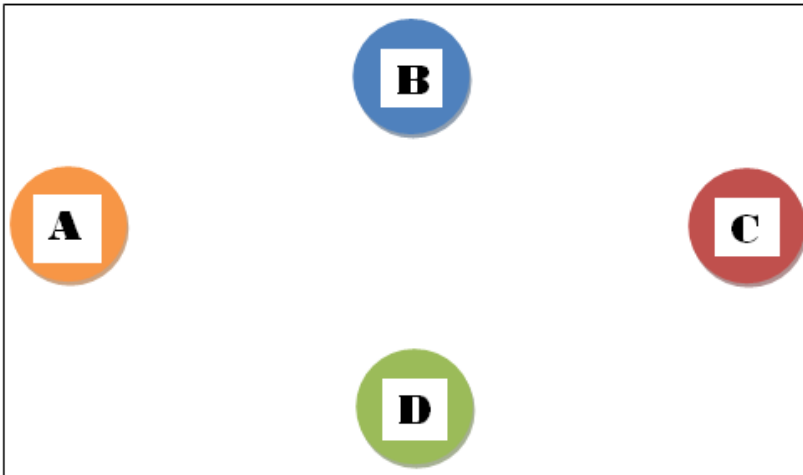
Metapopulation

Rules:

- Place 10 beads of each color on a specific subpopulation
 - Example: Red on “A”
- Starting with subpopulation “A” & moving clockwise
 - roll the dice
 - draw an Action Card
 - move beads from the subpopulation
- Use arrows on the board to show emigration from each population

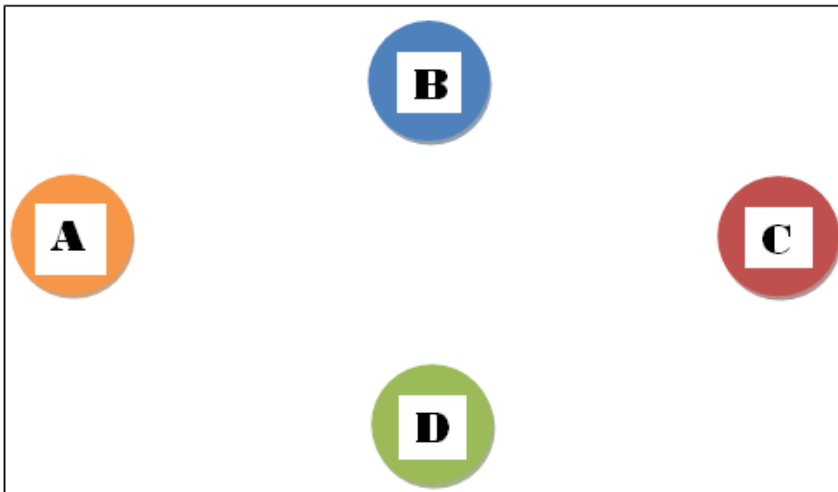
Exercise 1:

- Illustrate (with arrows) where individuals immigrated & emigrated
- Identify “Source” & “Sink” Populations



Exercise 2:

- Draw the Corridor between two subpopulations by a zigzag line
- Illustrate (with arrows) where individuals immigrated & emigrated
- Explain how this illustration may be different from the previous illustration



VOCABULARY

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***Genetic Diversity:** any variation in DNA within a species (may apply to traits)

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Natural: found in nature

Anthropogenic: from human activity

Biotic: living

Abiotic: nonliving

***Homozygous:** the same; uniform

***Heterozygous:** mixed; multiple traits shown

Viability Analysis: determines the probability that a population will go extinct within a given number of years

*indicates for an older age group such as upper middle school or high school