Connecting Ecosystems & Climate

Abiotic and Biotic Components

The connections and interactions between the abiotic and biotic components of ecosystems and climate are introduced and explored in this lesson. A hands-on sorting activity, physical webbing and concept mapping are used to encourage students to directly explore the interaction between abiotic and biotic components through the lens of climate change and the potential impact on ecosystems.

Learning Objectives

- define the terms abiotic and biotic
- identify interactions between abiotic and biotic components in ecosystems
- relate climate and abiotic components of ecosystems
- understand impact of changing abiotic factors upon biotic components of ecosystems

Activity Time

- One 50 minute class period

Setting

- Indoor or outdoor learning area

Materials

- **A/B Categories** worksheet that lists abiotic and biotic components for each group of students (optional: cut into pieces, one component per piece)
- ball of string or wool
- optional: assortment of abiotic and biotic items

Subject Areas/Grade Level

Science 10, Social Studies 11;
also Science 8, Biology 11, Civic Studies 11, Geography 12

Keywords

abiotic, biotic, ecosystem, population, limiting factors, climate, weather, climate change

Prescribed Learning Outcomes

Science 10: Life Science

- explain the interaction of abiotic and biotic factors within an ecosystem
- explain various ways in which natural populations are altered or kept in equilibrium

Science 10: Earth and Space Science

- evaluate possible causes of climate change and its impact on natural systems

Prior Knowledge Required

Before starting this lesson, ensure the students have a good conceptual understanding of:

- what aspects of the climate may be changing and why
- how populations increase
- climate versus weather

Use the ***Prior Knowledge Quiz*** to assess student understanding of background knowledge and possible misconceptions.

Introduction

Our global climate is currently changing. How will these changes impact natural systems, especially ecosystems? How will humans be affected? This lesson provides the basis to start exploring and understanding possible answers to these questions by understanding the interactions between abiotic and biotic components of ecosystems and relating these to a changing climate.

Connecting Ecosystems & Climate

The terms biotic and abiotic are used by ecologists to distinguish between the major components of an ecosystem. The biotic components of an ecosystem are all the living organisms from bacteria to plants to animals. The abiotic components are the chemical and physical attributes of the environment, including: water, rocks, minerals and nutrients, topography, soil structure, radiant energy (e.g., light, heat), air pressure, and temperature, wind and precipitation patterns. Organic matter produced by organisms (e.g., wastes and secretions), remaining after death and resulting from decomposition is generally included with abiotic components. Abiotic components can therefore be either organic or inorganic in origin.

There are many complex interactions between the biotic and abiotic components and their associated processes within ecosystems. For example, energy originating from the sun flows through ecosystems. Some abiotic components such as water, carbon and nitrogen are essential for life to exist and are constantly cycling through the biotic component of ecosystems. These, as well as other abiotic components, can have limited availability. As a result, the ability of individuals of various species to grow and reproduce may be affected, thus limiting the size and distribution of the populations.

Ecosystems are located within distinct climatic regions. The climate of a region is determined by the amount and seasonal patterns of the abiotic components of radiant energy (i.e., sunlight), water (precipitation and humidity), temperature, wind, and ocean currents. These in turn have a significant impact on the biotic components of ecosystems, including what species are present or not, and population growth.

Over geological time, the climate on Earth has changed as a result of changes in Earth's orbit, changes in the Sun's intensity, volcanic activity, as well as changes in the atmosphere. Currently, the average global temperature has been increasing over the past 100 years, with a resulting change in regional climates. There is strong evidence to suggest this is due, at least in part, to human activities, especially the burning of fossil fuels that emit greenhouse gases, in particular carbon dioxide (CO_2), to the atmosphere. To fully understand the impact of climate change regionally, students need to understand the interactions between abiotic and biotic components of ecosystems and how this is connected to climate.

Procedure

1 Define biotic and abiotic

- Divide the class into groups of approximately four students. Give each group a set of biotic/abiotic component cards. Make these by cutting the **A/B Categories worksheet** (list of abiotic and biotic components) into separate pieces, one item per "card".

- Ask the students to categorize the items on the cards. Do not mention or introduce the terms "biotic" or "abiotic" at this time. Direct the students to sort the items into two groups; they can put aside any items that do not fit into their categories. You may wish to give the students a short time limit to ensure this process is fairly quick and lively while encouraging discussion.

- Alternatively, give the full worksheet to each group and ask them to sort by putting an "A" or "B" next to each item to represent the category they belong to.

- Ask the groups to name and define each of the two categories.

- Invite each group to share the names of the categories they created, making a list on the board.

- Debrief, guiding the discussion to focus on the identified categories of biotic/abiotic (i.e., living/non-living). Acknowledge the groups that came up with reasonable alternate categories. Provide formal definitions of biotic and abiotic (see above Introduction).

2 Challenge student understanding

- Ask the students, "What cards, if any were difficult to categorize?" Discuss why.

- Direct each group to find 3 examples in the classroom, school, and/or schoolyard that are difficult to categorize as biotic or abiotic.

- Have each group challenge another group to categorize their example. Discuss as a whole class, refining and clarifying the definitions.

- Alternatively, have ready an assortment of items for the groups to try to categorize. These can include:
  - Items that were once living things or are comprised of organic matter, e.g., tree stump, blood, fossil, a fruit or vegetable, pickle
  - Items that are a mix of abiotic and biotic components, e.g., soil sample, water from a puddle or tidepool, detritus, vegetable beginning to decompose due to bacteria and/or mould
  - Organic or inorganic compounds, e.g., sugar (carbohydrate), salt (NaCl), metal object, diamond or graphite, glass.

- Review with whole class, discussing why each item is abiotic, biotic or mix of both.

3 Relate abiotic factors to climate

- Ask each group to list all the abiotic components they can that relate to climate. Review weather versus climate if necessary (see Resources).

- Have groups share their list with the whole class and create a master list on the chalkboard. Discuss why each abiotic component is included or not.
  - *Master list should include: sunlight (specifically visible light from the sun), temperature, water (specifically humidity and precipitation), air pressure and wind.*

4 Define ecosystem

- Provide a definition of ecosystem (e.g., the relationships and interactions amongst all the biotic and abiotic components of the environment).

- Ask the class: How do abiotic components affect biotic components within an ecosystem? Explore some possible connections with the students (e.g., limiting factors and population distribution and/or population size due to changing fecundity and mortality rates; changes in community composition over one abiotic component such as elevation or slope direction).

- How do biotic components influence abiotic components? Explore connections (e.g., utilize resources; trees affect humidity level and temperature under their canopy; organisms can trample, burrow into, cause erosion of substrate, etc.)

- Review biotic-biotic relationships (e.g., predator-prey relationships, symbiosis, etc.) and abiotic-abiotic interactions (e.g., weathering of rock due to wind, precipitation, water flow; reflection/absorption of sunlight by water in various phases, etc.)

5 Create an ecosystem relationship web

- In an open area, have students stand and form a circle. Give each student one of the cards from the **A/B Categories worksheet**.

- Start with a student holding one of the abiotic components (ideally sunlight). Ask the student to locate another component, either biotic or abiotic, that they know interacts with their own component. The student holds the end of the string while carefully passing or tossing the ball of string to the other student with the interacting component. The passing student states the interaction or relationship between the two components. The student with the ball of string now repeats the above steps.

- Continue identifying interactions while passing the ball of string until all students are connected in the string web. Assist students as necessary to find an interaction and/or elaborate on the provided response. Students can repeat interactions already identified or include a new biotic or abiotic component.

- Debrief the process. Ask the students "Is this activity representative of an ecosystem? How? Why not? (e.g., It is like an ecosystem in that there are many interactions between abiotic and biotic components; actual

ecosystems have more components with more complex interactions).

- Identify the components in the ecosystem web that may limit the population size or distribution of species (i.e., what are the limiting factors). Though they are species specific, typical limiting factors include the availability of food, water, or shelter, predation and disease pressure.

6 Ecosystems and climate change

- To introduce the potential impact of climate change on ecosystems, ask one of the students with an abiotic component that is influenced by climate (e.g. part of the climate system) to pull on their string. What do people in the web notice? What might this represent? (e.g., a reasonable response could be "an increase in summer temperatures or precipitation rate due changes in the climate"). Add another abiotic factor pulling on the web.

- Now ask a biotic component to drop their string. What do people notice? Ask those that felt a difference in the tension of their string to also drop their string. What could this represent? (e.g., a possible answer could be "a loss of one population affecting the food web).

- Debrief by asking students to reflect on how a change in climate may affect various components in an ecosystem.

Tip: At the end of the activity, ask all the students to lay the string on the floor, then request one student to start winding up the string, starting with the end that was connected last into the web.

Assessment

1 Ask students to design an experiment to examine the affect of climate related abiotic factors on biotic factors (e.g., amount of water or sunlight available to growing plants). Have students conduct the experiment and provide a full lab report, including a discussion of the potential impact of climate change on ecosystems. Look for evidence that students understand the terms abiotic and biotic, and how some abiotic components are climate factors.

2 In groups, give students 20 minutes to quickly sketch an ecosystem of their choice that highlights 5 biotic and 5 abiotic components. Identify 3 possible interactions between abiotic and biotic components.

3 Ask students to create a concept map illustrating the connections between abiotic and biotic components in an ecosystem and a change in the climate. Use the **Concept Map Rubric** to assess student's concept maps.

Resources

Environment Canada: www.ec.gc.ca/cc/; www.msc-smc.ec.gc.ca/education/scienceofclimatechange/understanding/index_e.html *Both sites provide extensive background information on the science of climate change, as well as other useful information regarding climate change in Canada.*

US Environmental Protection Agency: www.epa.gov/climatechange/index.html *Provides a succinct and clear summary of the science of climate change, along with a wealth of other information regarding climate change.*

NASA: www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html *Provides information regarding the distinction between weather and climate.*

Climate Change North: climatechangenorth.ca *Has a series of printable "backgrounders" suitable for high school students, including an overview of climate change and one addressing the difference between weather and climate.*

Instructional Strategies Online: olc.spsd.sk.ca/DE/PD/instr/strats/conceptmap/index.html *Describes the purpose of and provides instructions for concept mapping as an instructional or assessment strategy in the classroom.*

Sunlight	Earthworm	Deer
Air pressure	Quartz rock	Pebble
Wolf	Shrub	Sand
Iron	Spider	Carbon dioxide
Sugar	Leaf	Water
Algae	Bone	Lichen
Wind	Salt (NaCl)	Grasshopper
Nematode	Tree	Flower
Oxygen	Log	Temperature
Dirt	Bumblebee	Moss
Mushroom	Fly	Seed
Lava	Bacteria	Grass

Connecting Ecosystems & Climate Concept Map Rubric

Name(s) _____

_____

Date _____

	Not Satisfactory	Satisfactory	Good	Excellent
Central Image	Insufficient number of concepts selected to topic. Arrangement of concepts illustrates no understanding of conceptual relationships.	Minimal but acceptable number of concepts, with some relationship to topic. Arrangement of concepts demonstrates simple understanding of conceptual relationships.	Most concepts relating to topic selected. Arrangement of concepts demonstrates an understanding of conceptual relationships.	All significant concepts selected. Arrangement of concepts demonstrates complete understanding conceptual relationships.
Hierarchal Structure	Concepts are displayed in linear sequence. Little or no sense of hierarchal structure.	Limited hierarchical structure used.	Concepts connected in a hierarchical structure.	Concepts connected in a hierarchical structure leading to more specific concepts.
Linkages	Some basic relationships indicated by connected lines. Linking words are simple and repetitive.	Straightforward relationships connected with linking words. Linking words show variety.	Most relationships indicated with a connecting line and labelled with linking words. Linking words are accurate and varied.	All relationships indicated by a connecting line and accurately labelled with appropriate linking words. Linking words are expressive and purposeful.
Cross Links	Cross links not used.	Few cross links are used to illustrate minimal connections.	Cross links used to reflect straightforward connections.	Cross links show complex relationships between two or more distinct segments of the concept map.