Forest Growth & Carbon Capture

Nº. 90

SENIOR

Math/Science

LESSON SUMMARY

In this lesson, students will learn about the dynamic growth rate of a tree as it ages and the variable environmental factors that affect its growth.

SUSTAINABLE FORESTRY INITIATIVE SFI-00001

FORESTS ONTARIO

Focus on Forests

www.focusonforests.ca

Focus on Forests is a program of Forests Ontario.

Activity Information

Grade: Senior

Estimated Duration: 72 minutes (one class)

Materials:
- Computer (if available)
- Climate Change
- Spreadsheet
- Scenario cards

Setting: Indoor

Key Vocabulary: Growth rate, environmental factors, carbon dioxide, carbon neutral

Learning Goals: By the end of the lesson, students will be able to:
- Understand tree growth varies during its lifetime.
- Complete basic spreadsheet and add appropriate labels.
- Understand the importance of trees in the carbon cycle and its influence on the greenhouse effect
- Understand the importance of preservation and conservation of old growth forests and the need to continually plant new forests

Curriculum Links

Mathematics

MCR3U - Exponential Functions

B2. Make connections between the numeric, graphical, and algebraic representations of exponential functions;

B3. Identify and represent exponential functions, and solve problems invovling exponential functions, including problems arising from real-world applications.

MCF3M - Exponential Functions

B1. Simplify and evaluate numerical expressions involving exponents, and make connections between the numeric, graphical, and algebraic representations of exponential functions;

B2. Identify and represent exponential functions, and solve problems involving exponential functions, including problems arising from real-world applications.

MBF3C - Data Management

D1. Solve problems involving one-variable data by collecting, organizing, analysing, and evaluating data.

MDM4U - Statistical Analysis

D1. Analyze, interpret, and draw conclusions from one-variable data using numerical and graphical summaries.

MCT4C - Exponential Functions

A1. Solve problems involving exponential equations graphically, including problems arising from real-world applications.

Science

SNC1D - Biology: Sustainable Ecosystems

B1. Assess the impact of human activities on the sustainability of terrestrial and/or aquatic ecosystems, and evaluate the effectiveness of courses of action intended to remedy or mitigate negative impacts;

B2. Investigate factors related to human activity that affect terrestrial and aquatic ecosystems, and explain how they affect the sustainability of these ecosystems;

B3. Demonstrate an understanding of the dynamic nature of ecosystems, particularly in terms of ecological balance and the impact of human activity on the sustainability of terrestrial and aquatic ecosystems.

SNC1P - Biology: Sustainable Ecosystems and Human Activity

B1. Analyse the impact of human activity on terrestrial or aquatic ecosystems, and assess the effectiveness of selected initiatives related to environmental sustainability;

B2. Investigate some factors related to human activity that affect terrestrial or aquatic ecosystems, and describe the consequences that these factors have for the sustainability of these ecosystems;

B3. Demonstrate an understanding of characteristics of terrestrial and aquatic ecosystems, the interdependence within and between ecosystems, and the impact humans have on the sustainability of these ecosystems.

SBI3U – Plants: Anatomy, Growth, and Function

F1. Evaluate the importance of sustainable use of plants to Canadian society and other cultures;

F2. Investigate the structures and functions of plant tissues, and factors affecting plant growth.

SBI3C – Plants in the Natural Environment

F1. Analyse the roles of plants in ecosystems, and assess the impact of human activities on the balance of plants within those ecosystems;

F2. Investigate some of the factors that affect plant growth;

F3. Demonstrate an understanding of the structure and physiology of plants and their role in the natural environment.

SVN3M – Sustainable Agriculture and Forestry

D1. Evaluate the impact of agricultural and forestry practices on human health, the economy, and the environment;

D2. Investigate conditions necessary for plant growth, including the soil components most suitable for various species, and various environmentally sustainable methods that can be used to promote growth;

D3. Demonstrate an understanding of conditions required for plant growth and a variety of environmentally sustainable practices that can be used to promote growth.

SVN3E – Natural Resource Science and Management

E2. Investigate methods scientists use to classify and monitor natural resources, and conduct investigations using those methods;

E3. Demonstrate an understanding of the sustainable use of resources and its relationship to the biodiversity and sustainability of ecosystems.

Activity Extensions

- Visit Natural Resources Canada to examine the sustainable forest management initiatives undertaken by the federal government - http://www.nrcan.gc.ca/forests/canada/sustainable-forest-management/13183
- Have extra time to explore the Boreal Forest in the virtual world? Play Game for Science's Forestria game. http://www.gameforscience.com/forestia/index.php

References

Stephenson, N.L., A.J. Das, R. Condit, S.E. Russo, P.J. Baker, N.G. Beckman, D.A. Coomes, E.R. Lines, W.K. Morris, N. Ruger, E. Alvarez, C. BLundo, S. Bunyavejchewin, G. Chuyong, S. J. Davies, A. Duqye, C.N. Ewango, O. Flores, J.F. Franklin, H.R. Grau, Z. Hao, S.P. Hubbell, D. Kenfack, Y. Lin, J.-R. Makana, A. Malizia, L.R. Malizia, R.J. Pabst, N. Pongpattananurak, S.-H. Su, I-F. Sun, S. Tan, D. Thomas, P.J. van Mantgem, X. Wang, S.K. Wiser & M.A. Zavala. 2014. Rate of tree carbon accumulation increases continuously with tree size. Nature 507:90-93

http://urbanforestrynetwork.org/benefits/air%20quality.htm

Teacher Preparation

1. Print and cut out scenario cards with enough sets for the number of groups within the class.
2. Split the class into groups of 3-5 students. This part of the lesson can also be completed as a whole class.
3. Ensure that each group or individual has access to the spreadsheet and has it ready to input the numbers.
4. Explain to students that each group represents a tree in a forest and they were all planted together but were located on different sides of the forest and are subject to different environmental variables. Additionally, students will be growing during the activity and each year represents a flip of the card. On each card is a situation of a change in the environment that affects the growth of the tree.
5. Students will enter the environmental factor into the spreadsheet and record the changes of the growth for 30 years.
6. On the right of the table in the spreadsheet template students will see a graph generated for them. Prompt students to label the appropriate labels and titles.
7. Prompt students to write a few sentences describing their graph and debrief as a class following the question prompts provided in the handout.

Modifications:

- For senior math and science classes, teachers may opt to remove the graph in the spreadsheet template and allow students to create their own using Microsoft Excel.
- If there is limited access to computers, students can compute their answers by hand using the given table and draw their own graph.

Teacher Background

Each year trees start growing from a seed that has fallen into a favourable location where it can germinate and produce a seedling. In addition to the major factors that influence tree growth such as sunlight, water, and soil nutrients there are other environmental factors that can promote or hamper growth. These additional environmental factors include the weather, storms, fires, herbivory and changes in the environment.

Trees play many roles in the environment providing animals with habitats, food, and shelter, as well as help stabilizing the soils in the environment. One of the most important roles trees and forests they have is within the carbon cycle. Trees take up carbon dioxide as part of the process of photosynthesis to produce sugars for the plant. Given that each tree takes up 13 to 48 pounds of carbon dioxide per year forests help reduce carbon dioxide concentration in the air. For this reason, wood products are considered carbon neutral as the carbon is trapped within the wood product until it is destroyed or recycled.

Task: Determine how the tree has grown over 30 years based on the its growth rate and environmental factors.

Activity

1. You will receive a computer with access to the spreadsheet template and a set of scenario cards with the environmental factor listed.
2. In groups of 3-5, you will sequentially reveal a scenario. Within each scenario something changes within the environment that can either positively or negatively impact the tree.
3. In the spreadsheet template record the "E-Factor" which is the environmental factor and how much it affects the growth of the tree.
4. After your group and you have completed 30 years or "rounds" add the appropriate labels and titles to the graph.
5. Write a few sentences to describe the graph that has been generated to the right of the table in the spreadsheet template.

Debrief & Class Discussion

(1) How did the growth of the tree change over time?

(2) Given that the amount of carbon dioxide absorbed per year is directly related to the growth rate of the tree.

   a. What recommendations would you suggest to help lower carbon dioxide concentration?

   b. Would your answers change if research has shown that trees that are approximately 10 years old reach its optimal carbon capture rate?

(3) Now knowing that trees are a carbon neutral product, would you try to purchase and use more wood products?

Lack of rainfall during the season (E-Factor **0.8**)	Stormy season caused landslides and destroyed some tree roots (E-Factor **0.6**)
Storm season provided a lot of in wash nutrients into the watershed (E-Factor **2**)	Nearby tree fell down opening the tree canopy and sunlight (E-Factor **4**)
Nearby tree fell down breaking branches and leaves (E-Factor **0.5**)	Brush fire created decaying matter providing additional nutrients. (E-Factor **3**)
Large forest fires has caused significant damages to trees (E-Factor **0.6**)	Many animals have moved into the forest and their faeces (poo) acts as fertilizer (E-Factor **2**)
A nearby oil spill affecting local water supplies. (E-Factor **0.2**)	Climate change caused warmer than average temperatures this year (E-Factor **0.9**)

Climate changed has introduced a new invasive species that damages tree bark (E-Factor **0.8**)	A new disease makes trees sick and affects the uptake on nutrients (E-Factor **0.7**)
Runoff from a farmer's fields into the river introduced above average nutrients to soils (E-Factor **1.5**)	Windstorm caused blow downs and breaking of branches (E-Factor **0.75**)
Flood in the area caused soils to be oversaturated limiting growth (E-Factor **0.9**)	Below average temperatures caused soils to freeze (E-Factor **0.7**)
Beavers fall trees that were competing for resources (E-Factor **3.0**)	Regular year of sunlight, water, and nutrients (E-Factor **1.0**)
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