Climate Change

High School Lesson Plan

Topic Ecology – climate, climate change, and the impact on plant life

Grade Level 9 – 11

Overview

How do changes in the climate impact people in northern New England? Climate change is global, ongoing, and a long-term phenomenon. It can affect both large and small environmental systems, although the effects are not necessarily easy to observe in our daily lives. However, local climate changes can be gauged by observing certain regional indicators, such as maple syrup production.

Gathering sap for maple syrup is part of northern New England's cultural heritage. The collection and boiling of sap for maple syrup began with the native people of the region and continues today. The yearly output of sap depends largely on two factors: individual maple tree species and temperature variations. In northern New England, and particularly Vermont, the climate is ideal for growing sugar maple trees. The normal maple sap season runs from four to six weeks, usually from mid-February into April. If regional temperature patterns change, then what happens to the trees and their sap production?

Introduction

QUEST *Climate Change* addresses many aspects of this topic as it affects New England. The lesson plan concludes with suggested actions that students and families can take to reduce the factors leading to regional climate changes. Lesson activities focus on one particular impact of climate change in northern New England: the production of maple syrup. You may want to have your students explore certain environmental factors in more depth, such as land development, acidic precipitation, amounts of ozone in the atmosphere, and winter storms. All of these affect the forests in northern New England.

Time Allotment

Five to six 45-minute class periods.

Accessing Prior Knowledge

Students should have some basic understanding of the factors that lead to changes in climate, such as gas emissions from certain human activities and the reduction in the earth's forests. More detailed knowledge of these factors is helpful but not necessary. This lesson does not require students to solve the problem. Rather, it enables them to make the connection between the cause (specific gas emissions) and the effect (temperature increases), and to consider why this cause-and-effect relationship is important to them.

QUEST: Investigating Our World is a regional public television series seen on Maine Public Broadcasting Network, Vermont Public Television, and New Hampshire Public Television

Maine Public Broadcasting Network · New Hampshire Public Television · Vermont Public Television PBS

Major funding for Quest is provided by the National Science Foundation. Additional support is provided by Irving Woodlands and by gifts to More Connected, More Maine. The Campaign for Maine Public Broadcasting Network's Programming.

IRVING WOODLANDS, LLC · more connected more Maine The Campaign For Maine Public Broadcasting Network's Programming

1450 Lisbon Street, Lewiston, Maine 04240 · 207-783-9101 · 800-884-1717 · Fax 207-783-5193 · mpbn.net

Concepts to Clarify

Prior research on student thinking indicates that few changes occur in their knowledge about ecological crisis between the ages of 9 and 16. The following may help students change their thinking:

- Students tend to think about the negative effects of environmental change as "killing" rather than harming or changing existing organisms or ecosystems. During the lessons have students consider adaptations that plants might make while the climate changes.

- Provide specific examples from your own community, state, or region of the effects of environmental contaminates. For example, discuss the levels of ozone in the air in the summer. Ask if people die when the levels are high. People are suggested to restrict activity to prevent damage to their lungs but they do not die.

CONNECTIONS TO THE STANDARDS

Maine Learning Results	New Hampshire Curriculum Framework	Vermont Learning Standards	National Science Education Standards	Benchmarks for Science Literacy
Ecology B4 – Analyze the impact of human and other activities on the type and pace of change in ecosystems. **Scientific Reasoning** K6 – Analyze situations where more than one logical conclusion can be drawn.	**Life Science** 3b. Students will demonstrate an increasing ability to understand how environmental factors affect all living systems as well as species interactions. Trace the history of an interaction between man and the environment that demonstrates how human activities can deliberately or inadvertently alter the equilibrium in an ecosystem.	**The Living World: Organisms, Evolution and Interdependence** 7.13.ccc. Describe, model, and explain the principles of the interdependence of all systems that support life (e.g., flow of energy, ecosystems, life cycles, cooperation and competition, human population impacts on the world's ecological systems), and apply them to local, regional, and global systems.	**Content Standards (9-12)** C. Life Sciences: Interdependence of Organisms – Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction, pollution, atmospheric changes, and other factors are threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.	**Chapter 5: The Living Environment** 5D.Interdependence of Life – #3: Human beings are part of the earth's ecosystems. Human activities can, deliberately or inadvertently, alter equilibrium in ecosystems.

Materials Needed

- TV and VCR
- QUEST *Climate Change* video
- Student Handout 1: Maple Syrup in the News
- Student Handout 2: Data Tables
- Student Handout 3: Web Sites for Further Research on Climate Change
- Student Handout 4: *QUEST at Home:* Where's the Sap?
- Computer(s) with Internet access (for teacher to print materials, or for students to either read or conduct research online)

1. Introducing the Concepts

Step 1

In this lesson you will begin to explore the variety of causes of climate change with students to make sure that they understand how it occurs. Be sure to connect temperature changes with specific effects in your region Ask students what they know about changes in climate due to human activity. List all responses on the whiteboard or in some other place where students can see them easily. Discuss each idea briefly, considering whether it is connected to the lithosphere or hydrosphere. Which "sphere" is linked to climate? Are both spheres linked to climate? How is that possible?

Encourage students to decide whether their ideas are causes or impacts. Ask if they, or anyone else, could prove any of the ideas they have listed. Use this time to assess your students' level of sophistication in understanding climate change.

Step 2

Review the students' list to find specific climate changes that have occurred in Maine/New Hampshire/Vermont. If there are not very many, ask what might be some results of climate change in northern New England (or your state). Help students separate their responses into positives and negatives. Ask whether they could prove any of their listed ideas.

Step 3

Show the section of the QUEST *Climate Change* video that deals with the causes of climate change. Have students record the similarities and differences between their own previously listed ideas and the information provided in the video. After viewing this section of the film, have students discuss their findings as a whole class.

2. Exploring the Concepts

Step 1

Discuss the concept that changes in climate can be measured, but that since these changes are often very small, the time period required to actually see the results can be very long (sometimes taking hundreds,

or even thousands, of years). Review the student-generated list from Introducing the Concepts, Step 1, to see if anyone has identified maple syrup production.

Step 2

If students have not already mentioned maple syrup production, introduce the idea of a connection between maple syrup and climate change. Ask, "How do you think climate change and maple syrup production might be related?" Accept all responses. Then ask, "Why would anyone care about this connection?" List all ideas on the board or other location. (**Note:** As an optional activity, have students research this question and discuss their findings in groups.)

Step 3

Distribute Student Handout 1: Maple Syrup in the News. Review these headlines from various news articles, and discuss the sources of the information. Have students analyze the headlines and try to decide if they are accurate. If they do not seem to be accurate, are they alarmist? Misleading? Do they give the impression that the issue is clearly understood by the news source? Have students develop a timeline to help determine the sequence of news contained in the articles.

Now ask, "What more do you need to know to make a better judgment about the validity of the newspaper headlines?" Accept all answers.

3. Developing the Concepts

Step 1

Watch the next part of the QUEST *Climate Change* video up through the discussion of solutions for reducing greenhouse gases and other factors that lead to climate change. Have students make a new class list of the impacts of climate change. Review this list gathered from the video and compare it with the list they previously generated.

Step 2

Introduce the potential regional impact of climate change on the production of maple sap for syrup. Discuss with students whether this is a valid concern. Have them justify their answers. Then distribute Student Handout 2: Data Tables. Students should review the tables on syrup production and temperatures for New England. They should then make graphs of the data so that they can see trends more easily

Step 3

Have students respond to the following questions:

- Are there any trends in New England's maple syrup production? If so, what are they?
- Does this confirm what is said in the newspaper articles about maple syrup production?
- What other factors might be affecting the production of maple syrup?
- What additional information do you need to understand this issue more fully?
- What other questions do you have?

Discuss students' answers. Ask for evidence that can support their ideas. Talk about other factors that could be affecting maple syrup production. Encourage students to come up with additional questions, since it will lead into the next phase of the lesson.

4. Synthesizing the Concepts

Now that students have begun to ask more in-depth questions and to draw some conclusions about climate change and maple syrup production, you can have them conduct some research.

Step 1

Distribute copies of Student Handout 3. Either have students read the documents described on the handout online, or you may choose to print out copies of the documents for distribution. Individual student groups can each read one article, then share their findings with the whole class. Or, each of the students within a group could read a different article, then exchange information with other group members. Students will use these articles as sources of information to determine the seriousness of the issue at hand. They will also be using the documents to identify a set of debate points that could substantiate their positions or their conclusions from Developing the Concepts, Step 3. Students should make a list of clear and defensible points about the issue of climate change as it relates to maple syrup production.

Be sure that students refer to the questions at the top of Student Handout 3 before they begin their research. These questions will help them to stay focused as they read. Note: The first document mentioned in part B of the handout (Climate Impact on Regional Forests: Chapter 5 – New England Regional Assessment) is the best in terms of content. You may want to read this one yourself for background on climate change.

5. Applying the Concepts

Step 1

To reinforce other aspects of environmental modification due to climate change, have students conduct some Internet research. They might look for further information about maple sap and syrup production as well as the trees and forests of New England. Some examples of appropriate Web sites include:

- New England Regional Assessment *http://www.necci.sr.unh.edu*
- University of New Hampshire's Institute for the Study of Earth, Oceans, and Space – Forest Watch *http://www.forestwatch.sr.unh.edu/*
- Forest Watch – Vermont *http://www.forestwatch.com*
- Cornell University's Maple Research and Extension Program *http://www.maple.dnr.cornell.edu/*

Step 2

Other aspects of this issue that you may want to explore with students include various possible solutions to climate change. Show the class the final part of the QUEST *Climate Change* video.

After viewing the rest of the film, lead a discussion about the things that students and other citizens can do to reduce the impact of climate change. Students will benefit from the reminder that they can, and should, be active participants in the life and health of their region, and that they can take positive action to help solve this specific problem.

6. Extending the Concepts

Quest at Home

Distribute copies of Student Handout 4: *QUEST at Home*. Review the handout with students before they take them home. Agree upon a due date for students to return to class with their research findings.

Community Connections

The forests of northern New England are extremely important to many people in the region. Students can develop a survey to gather information about what people in their neighborhood think about northern New England's forests. Possible questions they might consider including in their survey are:

- What do you value about the forests?
- What role does maple syrup have in your state?
- Have you noticed any changes in the number, or the health, of the maple trees in the region?
- Have you noticed any changes in forest tree species?
- Do you think global climate change can alter our forests? Is it already happening?

Career Opportunities

Climate change can be a factor in many careers. Here is a list of some pertinent professions:

- **Research: Scientist, technician, field biologist, data analyst, forester**
  The National Oceanic and Atmospheric Administration, Department of Environmental Protection, and various universities (e.g., Cornell University, University of Vermont, and University of Maine) all employ people who are conducting research about climate change.

- **Planners: Planner, forester, economist**
  State economic development officials and state planners consider the impact of climate change on state revenues and land use. Foresters make planning decisions about tree harvesting and replanting.

- **Agriculture: Forester, tree farmers**
  Both local landowners and larger regional landholders work to become more efficient at maple sap gathering and syrup production as well as overall forest management.

Resources

http://www.ncdc.noaa.gov/oa/ncdc.html
The NOAA site contains a great deal of good information. This particular Web page offers climate maps of the United States.

http://www.onesweetwhirled.org/ireland/learn.html
This site has a guide to understanding global warming. There are also good links to research sites and organizations that are focused on this issue.

http://www.10percentchallenge.org/informationscience.php
Sponsored by an advocacy group, 0% Challenge, this site provides information and scientific background on global warming and its effects in Vermont.

http://www.carboncoalition.org/
Sponsored by the Carbon Coalition of New Hampshire, this site contains information advocating for a responsible energy policy.

http://www.ume.maine.edu/GISP2/DATA/SO4NO3.html
This University of Maine Web site has data on two factors that lead to climate change: sulfate and nitrate concentrations. The data is from the Greenland Ice Sheet Project (GISP2) ice cores and includes data from 1750 to 1990.

http://www.ume.maine.edu/iceage/Research/Contrib/html/contrib9.html
This site has information about ocean levels, particularly as it relates to shorelines and quaternary changes in relative sea level.

http://www.forestwatch.sr.unh.edu/news/symptomology.htm
The Forest Watch site is a scientific investigation site. It is full of information about the study of the white pine and how it is being affected by ozone. This part of the site is related to the symptoms of ozone on these trees.

http://www.cleanair-coolplanet.org/solutions
The Cool Planet site provides some possible solutions to the problem of global warming. It includes some success stories from the Northeast.

Maple Syrup in the News

Vermont Is #1 in Maple Syrup Production

U. S. 2001 – Vermont Farm Bureau – U.S. maple syrup production in 2001 totaled 1.05 million gallons, down 15 percent from last year and 12 percent below 1999. The preliminary value of production was placed at 28.2 million, a decrease of 17 percent for 2000.

New England's Brilliant Autumn Sugar Maples – And Their Syrup – Threatened by Warmth

Ferrisburgh, VT, Sept. 27, 2002 – Associated Press – Sam Cutting, Sr., eases from his pickup, lumbers stiffly in blue jeans and suspenders up a hillside, and cranes his neck toward the maple grove that nearly broke his heart. The crowns are finally spreading again, but some 3-foot-thick trunks are sheared 30 feet from the ground. Dead branches lie scattered in piles like drying bones.

Maple Syrup Harvest Increases 4%

Washington, June 9, 2000 – STAT – The 2000 U.S. maple syrup production was 1.23 million gallons, up 4% from last year's production of 1.19 million gallons, according to numbers compiled by the USDA.

Maple Syrup Production Up 29 Percent Nationwide

United States, June 12, 2002 – New England Agricultural Statistics Service – 2002 maple syrup production totaled 1.36 million gallons, up 29 percent from last year's production of 1.05 million gallons. The number of taps is estimated at 6.58 million, up 1 percent from 2001 totals, or 6.48 million.

Climate Forecasts Come True

Portsmouth, NH, Feb. 20, 2001 – Portsmouth Herald – A panel of the world's leading scientists studying the effects of global climate change says that previous estimates of how warm the planet is getting underestimate the true impact global warming will have on the planet.

Global Warning Poses Uncertain Fate for Maple Industry

Portsmouth, NH, March 13, 2002 – Earth Vision Environmental News – A potent combination of warmer temperatures, shorter winters, increasing drought, and the ravages of forest insect pests threaten to devastate an industry that brings more than $100 million annually to the state of Vermont alone.

Scientists Say Vermont Climate Will Change

Burlington, VT, Nov. 15, 1999 – Associated Press – Warmer global temperatures predicted for the next century could bring dramatic changes to Vermont. In Vermont, that could affect everything from sugar maple distribution to an increasing number of deaths due to heat stress from higher summer temperatures, experts said.

Data Tables

Northern New England Maple Syrup Production, 1994 - 2001 (In Thousands of Gallons)

State	1994	1995	1996	1997	1998	1999	2000	2001
Vermont	435	365	550	395	360	370	460	275
Maine	150	162	167	185	185	195	250	200
New Hampshire	73	64	89	76	67	61	75	45
Massachusetts	40	29	49	44	47	47	39	34

(New England Agricultural Statistics, 2001)

Northern New England Average Temperature Readings for 30 Year Blocks of Time for February, March, and April 1951 - 2000

State	Month	1951 – 1980	1961 – 1990	1971 – 2000
Vermont	February	19.3	19.0	19.9
	March	30.2	30.3	30.3
	April	43.1	42.9	42.8
Maine	February	19.1	18.9	19.7
	March	29.4	29.5	29.7
	April	41.1	41.0	41.3
New Hampshire	February	19.1	18.9	23.0
	March	29.4	29.5	32.4
	April	41.1	41.0	43.5
Massachusetts	February	26.0	25.6	26.9
	March	34.9	35.1	35.5
	April	46.1	45.5	45.7

(National Oceanic and Atmospheric Administration)

Web Sites for Further Research

A. Read the questions listed below before you begin your research. These questions will help you to stay focused on the "big picture" as you read about maple syrup production and climate change in New England.

- What are the trends in New England's maple syrup production?
- Are these trends confirmed in the articles you are reading now?
- What other factors might be affecting the production of maple syrup?
- What is changing in the New England region that affects the reduction in maple syrup production?
- What is causing this change?
- What is the environmental impact of the change?
- What additional information do you need in order to understand this issue more fully?
- What other questions do you have?

B. Visit the following Web sites to research this topic in more depth:

Climate Impact on Regional Forests: Chapter 5 – New England Regional Assessment
http://www.necci.sr.unh.edu/2001-NERA-report.html
This document provides a regional assessment of potential climate change impacts on the New England region. Chapter 5 specifically addresses forests.

Maple Syrup: New England Agricultural Statistics, 2001
http://www.state.vt.us/anr/fpr/forestry/mapstat.pdf
This is a three-page documents with data on maple syrup production, prices, and grades in both New England and the U.S. in general.

Clean Air – Cool Planet Information Center
http://www.cleanair-coolplanet.org/effects/
This is the Web site of a nonprofit organization. A two-page document describes the impact of maple sap/syrup loss and the actions that can be taken to help remedy the situation.

The Potential Consequences of Climate and Change: Northeast. U.S. Global Change Research Program
http://www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewnortheast.htm
This document provides a concise overview of the impact of climate change on the Northeast. There are also embedded models of forestry changes based on Canadian and U.S. climate models.

Where's the Sap?

You're on a QUEST!

In which food products can maple sap be found? Maple sap is actually contained in several unique products. These products can be found in grocery and specialty stores.

With family members, try to find out in what ways, and in what products, maple sap is used. Compare the products containing genuine maple sap with those that have flavored or imitation maple. How do the costs differ? How else do you think these products differ?

A. Market Research

At the grocery store or specialty store:

Find the shelves of maple products. Read various product labels to see where natural maple sap is used. List these products in a journal or notebook, being sure to write down the amount of maple each product contains. Why do you think there isn't more maple sap used in some of the products? What is the pricing difference? Do any of these items contain other types of natural products besides maple syrups?

B. Analysis

Now compare the products you have found. Answer the following questions (and any others you can come up with):

- Which products are similar? Which are the most different?
- How do the prices vary for the same or similar products? Why do you think this is?
- Which products contain very little maple sap but could lead buyers to think they do?
- In how many ways is maple used for cooking?
- Is there a maple product that surprised you?
- What other interesting observations did you make during your maple product research?

QUEST: Investigating Our World is a regional public television series seen on Maine Public Broadcasting Network, Vermont Public Television, and New Hampshire Public Television

Major funding for Quest is provided by the National Science Foundation. Additional support is provided by Irving Woodlands and by gifts to More Connected, More Maine. The Campaign for Maine Public Broadcasting Network's Programming.