

TEACHING UNIT
Plant Ecology-Global Issues

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Target Grade and Subject

7th grade science & social studies

Unit Overview-I have prepared this unit to meet my needs in the particular school district where I work. The activities and lessons included here could easily be adapted however, to other school districts. I am fortunate to teach at a nature center owned and operated by the Bloomfield Hills School District. Our school district has three middle schools that send 7th graders to the nature center every year. A major focus for 7th grade is ‘plants’ so our program theme has been plant ecology. Since we are an urban-suburban district, our 32 acres have been impacted by many invasive alien species(both plant and animal) and various air pollutants, including ground level ozone and elevated levels of carbon dioxide. In fact, the east border of the property runs along Telegraph Road which carries many thousands of automobiles each day. Therefore, we have an excellent outdoor laboratory to study the effects of mans impact on our environment and witness changes that are occurring on a global scale.

The unit consists of five days of lesson plans, data sheets, web sites, other sources, material lists, suggested assessments, learning objectives, and Michigan content benchmarks. The focus of the unit has two primary areas:

- #1. The impact of greenhouse gases(CO₂) on plants ,ecosystems and climate.
- #2. The impact of invasive alien plant species on our ecosystems.

Students will look at the sources of greenhouse gases, the impacts on plants, and how air pollutants can be monitored with plants. They will investigate via the web, an actual experimental forest in northern Wisconsin where the effects of greenhouse gases are being studied. They will look closely at how humans have accelerated the spread of alien species, sample alien species in the field, and practice protocols that ecologists use in the real world. A highlite of the week occurs on day four when the students visit the nature center to observe first hand many examples of invasive species and effects of local air pollutants. The last day is an opportunity to synthesize the data that was collected at the nature center and hopefully make sense of what they have observed.

The goal of this unit is to bring “awareness” to the students of these two current issues impacting our ecosystems on a global scale. Obviously, given only five lesson plans one would not expect the students to become experts but I believe there are enough “hands-on” activities to leave a lasting impression. Of course if a teacher wanted to extend any of the topics in much greater depth there are resources available to help with that.

Sources Consulted

Books

Air and waste Management Association 1991. Environmental Resource Guide-Air Quality Grades 6-8. “Don’t Take a Lichen for Pollution”.

Krasny, Marianne E. 2003 Invasion Ecology NSTA Press Pgs. 40-41, 49-51.

Web Information

Michigan Curriculum Framework Science and Social Studies Benchmarks, MI Department of Education

<http://aspenface.mtu.edu> (forest productivity experiment)

www.ncdc.noaa.gov/oa/climate/globalwarming.html (climate change/data)

<http://tncweeds.ucdavis.edu> (invasive plants)

Articles

Green Teacher #61 2000. “Climate Change: Good for us?”

The Nature Conservancy newsletter MI, Spring 2003. Invasives.

Lesson Plans

Badgley, Chadde, Grix, Pregitzer 2005. Worm Watch MI Technological University.

Video

Films for the Humanities and Sciences 2004. Plants out of place-Facing the Green Invasion VHS or DVD.

Michigan Science and Social Studies Benchmarks

This teaching unit will address the following science and social studies benchmarks as found in the Michigan Curriculum Framework document.

Science

Ecosystems (LEC) III.5

*Describe common patterns of relationships among populations.

(predator, prey, competition, etc.)

*Predict the effects of changes in one population in a food web on other populations.

(biodiversity, non-native species, etc.)

*Describe the likely succession of a given ecosystem over time.

*Describe ways in which humans alter the environment.

Atmosphere and weather (EAW) V.3.

*Describe health effects of polluted air.

(ozone warnings, acid rain, etc.)

Social Studies

Strand II. Geographic Perspective

Standard II.2 Human/Environment Interaction

*All students will describe, compare, and explain locations and characteristics of ecosystems, resources, human adaptation, environmental impact, and interrelationships among them.

*Explain how humans modify the environment and describe some of the possible consequences of these modifications.

Unit-Plant Ecology-Global Issues

Lesson #1 “Plant Wars-the struggle to survive”

Time- 1 class period

Learning Objectives:

Each student will do the following:

1. Explain how the greenhouse effect(elevated CO₂) is capable of changing the climate on earth.
2. Hypothesize what effects elevated temperature and moisture patterns would have on plants.
3. Identify the sources of increasing amounts of CO₂ in the earth’s atmosphere.
4. Hypothesize the effects of increased CO₂ levels on plant growth.
5. Describe the effects of elevated CO₂ levels on forest productivity at the Aspen FACE experiment in Rhinelander Wisconsin.
6. Describe a lichen and explain how it can be used to monitor air pollution.
7. Complete a pre-test before beginning the unit.

Materials

Terrarium	climate change questionnaire	lichen samples
Poster-plant community	greenhouse gases transparency	pre-test
Computers w/internet	web-quest work sheets	

Background Information

Carbon dioxide(CO₂) levels have been increasing in the earth’s atmosphere since the start of the industrial age. During that same time the earth’s average temperature has also increased and the rate is accelerating. Many scientists predict this global warming will cause more violent weather patterns with extremes in moisture and temperature patterns. These changing weather patterns might favor some plants while causing extinctions in others. Research is also being conducted on the affects of the rising CO₂ on forest productivity. One of the research locations is in northern Wisconsin at an experimental forest called Aspen FACE(Free air carbon dioxide exchange). Researchers from several universities and the U.S. Forest Service are working together to study climate change. Early results indicate that trees exposed to high levels of CO₂ are growing very rapidly. While this might appear to be a positive result there may be negative implications in terms of nutrient cycling. Some plants are being used to monitor air pollutants and that includes the lichens. They are generally very intolerant of air pollution.

Procedures

Students should begin by taking the pre-test. Collect when finished and analyze for the level of student understanding.

CLASSROOM

1. Have students observe a plant community poster or terrarium that includes different species of plants. A landscaped setting outside of your classroom window would also work. Explain that while we may not be able to see it, plants are struggling with each other to survive. Some might call it the “plant wars” while scientists refer to it as “competition”. Plants are also struggling to receive proper amounts of water, sunlight, soil nutrients, and space to grow. Have the students come up with ways in which the plants are competing and list on the board. Review and discuss their answers.
2. Explain to the students that we will focus on two different factors that plants have to deal with and that is changing air quality and changing climate. Have them complete the “Climate Change: Good for us?” questionnaire. They will predict the effects of various aspects of climate change. Have them work with a partner. Discuss answers when complete.

- Review the role that CO₂ plays in photosynthesis and the greenhouse effect(use transparency). Brainstorm sources of CO₂ as a class. Ask students to predict the affects of rising CO₂ levels on our forests. Have them write a short journal entry to describe this.

COMPUTER LAB

- Have students visit the website <http://aspenface.mtu.edu>. Pass out the webquest sheet. Have the students work with a partner. Follow the directions on the webquest sheet and answer the questions.
- Have the students visit website www.ncdc.noaa.gov/oa/climate/globalwarming.html. Follow directions on webquest sheet and answer the questions.

CLASSROOM

- Show students examples of different types of lichen. Discuss how lichens are used to monitor air pollution.
- For homework have students write in their journal about how humans can slow the rate of global climate change.

Assessment

- *journal-predicting affects of rising CO₂ levels on plants
- *journal- what can humans do to slow the rate of global climate change?
- *climate change questionnaire
- *web quest exercise
- *Pre-test

Unit:Plant Ecology-Global Issues

Lesson #'s 2 & 3- "The Attack of the Aliens"

Time: 2 class periods

Objectives

Each student will do the following:

- Explain how humans have accelerated the spread of exotic species.
- Name two common local exotic plants that are causing problems in Michigan.
- Prepare a short "breaking news bulletin" about an alien plant that is causing harm in our local ecosystems/or describe how people are fighting the spread of invasive plants. Document a specific location and describe the efforts being made. Check the Nature Conservancy web site for information.(Homework-due Friday)
- Research how purple loosestrife is being managed with a biological control.
- Describe a field sampling method that ecologists use to monitor alien plant species.
- Explain the concept of allelopathy.

Materials

Computer lab w/internet	paper towel	electronic scale
Alien plant list	ruler	plant succession pieces
Invas. Species profile worksheet	earthworm key	earthworm data sheet
Trowels/containers/jars	2 buckets	Video-Plants out of place

Outdoor area where earthworms live

Background Information

Alien plant species have been arriving at a steady pace in this country since the time of the early settlers. Usually about 99% of the plants do not become a problem in our native ecosystems. However, the remaining 1% are creating problems on a global scale. They are out-competing natives, reducing biodiversity, and creating expensive nuisance problems. The aliens often have advantages over the natives that enable them to survive including having a lack of predators, disease resistance, longer growing seasons, and allelopathic properties that discourage other plants. Some aliens grow in dense stands thus limiting wildlife, insects, and other plant species. Ecologists have developed ways of monitoring alien species and of controlling them. Biological controls can be used on some species (purple loosestrife) while chemical and mechanical controls are used on others. Many scientists believe the spread of alien species is second only to loss of habitat as the primary reason for the loss of earth's biodiversity in recent years.

Procedures

DAY 1

- *have students volunteer to read what they wrote in their journal the previous day about how humans can slow global climate change
- *Lead a short discussion on what we consider "alien" plants
- *show ten minute clip of video-"Plants out of Place-Facing the Green Invasion", discuss
- *provide a list of local invasive alien plants
- *have students work in pairs to complete worksheet, "Invasive Species Profile", use the internet as a resource
- *when completed, ask students to provide key information on the following items-list answers on the board for all to see (name of plant, where from, what problems, habitat found, how introduced)
- *record as many as time allows on the board
- *discuss with entire class trends, implications, etc.
- *introduce the concept of allelopathy and how it favors invasives

DAY 2

- *Explain to class that you are all going outside to collect an invasive animal species that impacts plants (earthworms). Mention that the students must keep their specimens healthy and that they will be returned outside at the end of the lab
- *Have students work in pairs. Each should bring a trowel and small collecting jar.
- *demonstrate how and where to find the worms
- *collect as many worms as time allows-bring back to lab
- *students should follow directions on earthworm data sheet
- *when finished, all worms and other material is dumped in the buckets-teacher returns outside later
- *compare species/sizes/etc.
- *collect data sheets
- *pass out "plant succession puzzle pieces"
- *have students work with a partner to arrange them in proper order
- *review correct sequence on overhead or board

Assessment

- *worksheet (Invasive species profile)
- *earthworm lab sheet
- *homework-news bulletin or report on people fighting invasive species

Unit: Plant Ecology

Lesson #4 (Field Experience) E. L. Johnson Nature Center

Time- 2 hours on-site...add travel time

Objectives

Each student will do the following:

1. Observe a buckthorn thicket. Note impact on plant succession, ground leaf litter, and surrounding plants(allelopathy).
2. Compare and investigate three different habitats(evergreen forest, hardwood forest, buckthorn thicket), noting the impact of invasive species. Measure depth of leaf litter, identify and, measure earthworms, identify other invertebrates, and measure soil ph.
3. Observe lichen to note potential damage from air pollutants.
4. Compare growth rates of red pines by counting the whorls of branches and noting how far apart the whorls are located(showing how much the tree grew in a given year). Hypothesize why the growth rates differ.
5. Observe purple loosestrife plants that have been affected by biological controls(beetles).
6. Count, identify, common alien plants growing in random plots using proper ecological protocols.
7. Observe aspen trees that have died due to high ozone levels and ash trees that have died due to the emerald ash borer.

Materials

*needed materials are listed on the field data sheets

*students should bring pencils to record data

*wear proper clothing for the field, weather conditions, etc.

*teacher should bring 3 digital camera's

*all other materials for the field are supplied by the nature center

*divide the students into equal groups of ten or less

Background Information

The students will compare various components of three different habitats, focusing on the effects of invasive alien species, especially plant species. They will also see real world examples of lichen bio-monitoring, allelopathic affects of buckthorn, plant succession suppression, ash borer damage, ground level ozone damage, biological control of purple loosestrife, and habitat restoration. They will also census the alien plant species, noting how dominant they are. While many alien plant species survive at the nature center, recent habitat rehabilitation efforts have provided a more diverse flora.

Procedures:

1. The entire group will meet briefly with the nature center manager to discuss the human history of the property so students will understand how man has impacted the flora.
2. Divide into smaller groups-nature center staff will lead each group through a series of stations in the various habitats:

- A. Buckthorn thicket-follow the directions on the “Forest Floor Inventory” data sheet. Note how plant succession has been suppressed and the allelopathic effects of buckthorn resulting in bare mineral soil.
 - B. Sugarbush-hardwood forest
Observe the lichens/conduct the forest floor inventory/note lack of invasives
 - C. Evergreen forest
Conduct forest floor inventory/age red pines/note any invasives
 - D. Pond
Observe purple loosestrife plants
 - E. In between stations students will observe ash borer damage and harmful effects of ground level ozone to aspen trees.
 - F. Mixed hardwoods
Students will census alien plant species in square meter plots and estimate % cover.
Directions and materials are listed on the “Alien Plant Plot Study” data sheet.
3. The entire group will meet briefly at the end to wrap-up, get student impressions on the alien plant problem, and provide directions for analyzing the data in tomorrow’s session.
4. Back at school have students write in their journal on this topic-“Is the invasive alien plant problem something we should be concerned about? Why?”

Assessment

- *data sheets will be reviewed in class the next day to compare and interpret the data collected
- *wrap-up discussion at the end of field trip
- *journal entry after returning to school

Unit: Plant Ecology-Global Issues Review

Lesson #5 Data Review

Time: 1 class period

Objectives

Each student will do the following:

1. Analyze/compare the data collected at the nature center with other students data and from past years. Note differences and trends.
2. Explain why the composition and depth of the leaf litter was different in the three habitats observed.
3. Analyze the plant species found in the plot study, determine if they are native or alien. Compare results with other students plots and with past years.
4. Explain what kind of information this study, conducted over several years, will provide the nature center manager.
5. Discuss the allelopathic affects of buckthorn, the impact of buckthorn on plant succession, and the impact on the overall biodiversity of the nature center.
6. Explain why growth rates of red pine might differ.
7. Summarize the effectiveness of the biological control beetles on purple loosestrife at the nature center.

Materials

Field data sheets

Pre-post test

Nature center data from previous years

Wildflower field guides

Background Information

The students will now have a chance to analyze the data that they collected in the field. They will not only compare results with their fellow students but also compare to past years to look for trends.

Explain to students that this is some of the most important work that scientists do. Encourage them to think carefully when trying to explain why certain results occurred. This unit is completed by administering a post test to see how much understanding was gained during the week.

Procedures

1. have the students sit with their team members from yesterday.
2. students should first look at the three “forest floor inventory” sheets.
3. The teacher can lead a discussion comparing leaf litter depth, soil ph, worm species found, and other invertebrates found. The teacher can share/compare data from previous years. The questions asked should be directed toward “why” the results occurred this way and what are the long term implications. Students may be able to graph some of the data.
4. students should then look at the data from the plot study
5. students should use wildflower field guides to determine if their plants listed are alien or native.
6. Once again the teacher should lead a discussion about what was observed and why. Also discuss the long term implications.
7. Discussion should focus on the impacts of buckthorn invasion.

8. Summarize the “limiting factors” affecting the growth rates of red pines.
9. Discuss the effectiveness and limitations of using biological controls.
10. Administer the post-test/collect and analyze for understanding.
11. Collect Journals to review the reflections that were assigned.
12. Collect homework assignment that was assigned earlier in the week and all data sheets.

Assessment

- *during discussion, check for depth of understanding
- *collect journals, check for depth of understanding
- *post test
- *lab sheets, check for accuracy, etc.
- *homework writing assignment-collect

Unit Assessment Summary

There are several assessment pieces embedded throughout the unit. Here is a listing of those assessments:

- *pre-test/post-test
- *journal entries(several)
- *climate change questionnaire
- *web quests
- *class discussions
- *data sheets-lab
- *data sheets-field
- *creative writing homework assignment

Lesson #1 & 5
Plant Ecology-Global Issues
Pre/Post Test

Name _____

1. The “greenhouse effect” is caused by...
2. How do plants use carbon dioxide? You may sketch an answer if you prefer.
3. A lichen is :
 - A. not a plant
 - B. a type of tree
 - C. comprised of a fungus and an algae
 - D. found in the ocean.
4. An increase in carbon dioxide levels would increase/decrease the rate of plant growth.
5. List one way in which humans have helped spread invasive alien plant species.
6. Circle two common local invasive alien plants.

Sugar maple	trillium
Red oak	dames rocket
Buckthorn	white pine
7. Explain what a biological control agent is.
8. An “allelopathic” plant:
 - A. emits chemicals that prevent other plants from growing nearby
 - B. does not grow in Michigan
 - C. strangles other plants
 - D. is a good choice to enrich the soil
9. Earthworms in Michigan are considered “alien” because:

10. Label the normal stages of plant succession in order(1-6) beginning with bare mineral soil:

_____ tall weeds/grasses/shrubs

_____ bare mineral soil

_____ tall sun-loving trees dominate canopy/shorter shrubs/shade tolerant trees moving in

_____ mosses/lichens/weeds

_____ more shrubs/sun loving trees/less weeds-grasses

_____ tall trees/understory shade tolerant trees & shrubs/variety of ground plants

11. Explain why invasive alien plants are harmful to native ecosystems.

Lesson # 1

Climate Change: Good for us?
Questionnaire

Season _____

Type of Climate Change

How would it affect me?

How would it affect
Plants around me?

*More rainstorms

*Less rain or snow

*More Sunshine

*Less Sunshine

*Higher daytime temperature

*Lower daytime temperature

*Higher wind speed

#1. Website <http://aspenface.mtu.edu>

Directions:

- *visit the above website
- *click on “results”
- *scan the “implications of results”
- *click on “growth response”
- *answer the following questions after reviewing the graphs

A. Indicate under which experimental condition listed below, trees grew the most when exposed to:

High levels of CO₂ _____ O₃ _____ CO₂ +O₃ _____

B. Using the graphs, summarize what effect rising levels of CO₂ seem to have on tree growth.

#2. Website www.ncdc.noaa.gov/oa/climate/globalwarming.html

Directions:

- *visit the above website
- *scan through the listed questions on the site to help you answer the following

A. What is the greenhouse effect and is it affecting our climate?

B. Are greenhouse gases increasing?

C. How can we predict the future of global change?

Lesson #2
Common Invasive Alien Plants of our Area

Common Buckthorn

Glossy Buckthorn

Honeysuckle

Dames Rocket

Water milfoil

Spotted Knapweed

Garlic Mustard

Canada Thistle

Multi-flora Rose

Norway Maple

Autumn Olive

Purple Loosestrife

Tree of Heaven

Motherwort

Earthworm Data Sheet

Team _____

Species Found	length(cm)	weight(grams)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Directions:

- *use the earthworm key to identify your species
- *measure the length of your worm(s) and weigh on the electronic scale
- *read the background information, “Earthworm Invasion: Changing Nitrogen and Carbon Cycling”, and describe below how earthworms are affecting forest ecosystems.

Alien Plant Plot Study

Date _____ Team _____ Plot # _____

Materials

Square meter plots(Plastic PVC pipe)/plant key/data sheets/clipboards/pencils

Procedures

1. Once your team of three has been assigned to sample one of the square meter plots in the study area, identify the plants growing there using the plant key. (do not remove plants)
2. Select the most common plant in your plot. Count how many individuals are growing within any one of six quadrats within your plot(note the strings tied to the PVC pipe that divide your square meter into six equal sections).
3. Estimate the % cover of this plant throughout your entire square meter plot.

Species Found	Native	Alien
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Most Common species _____ # of individuals in 1/6 plot _____

Estimated % cover of this plant _____

Forest Floor Inventory

Date _____ Team _____

Habitat _____

Materials

Each team should have a square meter plot(PVC pipe)/ruler/2 trowels/jar/worm key/invertebrate key/ph meter/3 data sheets/clipboard/pencil/share a digital camera

Procedures

1. Lay a square meter plot randomly in n the sampling area
2. Use the digital camera to photograph forest floor plot
3. Measure the depth of the leaf litter. Describe the composition.
4. Using a trowel, carefully peel back layers of leaf litter searching for earthworms. Capture any that you find, identify, and release.
5. Once you have reached mineral soil, look for worm castings. Count the castings within your plot.
6. Continue to sift through the top few inches of soil searching for earthworms or other invertebrates. List all species found on the data sheet.
7. Record the soil ph using the meter.
8. Carefully level your sample area, replace the leaves and other materials.

Depth of leaf litter _____cm

Composition of leaf litter _____

Species of worms found and # _____

of worm castings found _____ soil ph _____

Other invertebrates found-list: