Human Impact on Ecosystems

Grades 6-8

Funded in part with a USGBC 2009 Excellence in Green Building Education Incentive Grant

Contents

A view from the roof of the Ford Rouge Complex Visitors' Center looking out toward downtown Detroit.

Glossary

Human Impact on Ecosystems
Middle School Unit Plan

Abiotic – elements of an ecosystem that are not and never were, alive.

Adaptation – adjustment to environmental conditions.

Biotic – elements of an ecosystem that are or were alive.

Brownfield - a parcel of land which was used for industrial or commercial purposes, and may have low levels of contamination.

Consumer – an organism that must eat other organisms to get energy.

Decomposers – organisms that feed on producers or consumers, and return nutrients to the surrounding soil or water.

Ecosystem – a group of organisms that live close together and the environment in which they live.

Food chain – how energy is passed on in an ecosystem. A food web is a collection of inter-related food chains.

Innovation – a new idea, method, or device.

LEED certification – Leadership in Energy and Environmental Design certification is an internationally accepted green building certification.*

Living roof - a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproof membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems.*

Orchard – a planting of fruit trees, nut trees, or sugar maple trees.

Porous pavement – a paving surface that allows water to seep through to a reservoir underneath.**

Producer - an organism that uses energy from the sun to produce its own food.

Remediation – the process of remedying a problem.

Responsible manufacturing – manufacturing processes that attempt to produce goods while inflicting as little harm as possible on the environment.

Sedum – a large genus of flowering succulents.*

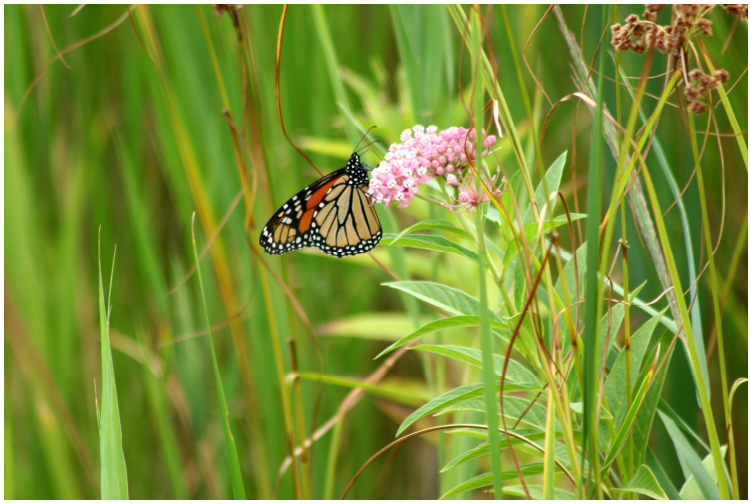
Superfund - the federal government's program to locate, investigate, and clean up the worst uncontrolled and abandoned toxic waste sites nationwide; administered by the Environmental Protection Agency (EPA).

Swale – a low-lying and often wet stretch of land.

Watershed - a region or area that drains to a particular watercourse or body of water.

Wetland - land or areas (such as marshes or swamps) that are covered with shallow water or have soil saturated with moisture.

* definition from Wikipedia
** definition from www.greenworks.tv



Timelines

Environmental Issues

1891 Forest Reserve Act passes Congress; sets aside over 17 million acres of forested land.

1892 1,000 Londoners die due to smog.

1933 Civilian Conservation Corps formed; 2,000 camps opened, trees planted, roads, fire towers, buildings and bridges constructed.

1955 The first international air pollution conference is held.

1957 Increasing CO2 buildup is one surprising conclusion of Scripps Oceanographic Institute scientists.

1970 Environmental Protection Agency (EPA) founded.

1980 Superfund legislation is passed by Congress directing the EPA to clean up abandoned toxic waste dumps.

1990s Strong national opinion polls favoring environment over economic development.

2006 Documentary film *An Inconvenient Truth* opens, stimulating awareness of climate change issues.

2010 BP oil spill devastates ecosystem in Gulf of Mexico.

Ford Motor Company History and Green Initiatives

1903 Ford Motor Company is founded.

1908 Henry Ford introduces the Model T.

1913 Ford introduces a moving assembly line for auto production.

1915 Henry Ford purchases 2000 acres of marshland along the Rouge River in Dearborn.

1917 Construction of the Rouge Plant begins.

1935 National Farm Chemurgic Council, dedicated to industrial use of renewable agricultural resources.

1997 Ford automotive plants first to achieve world environmental standard ISO 14001.

1997 Ford and the UAW sign Rouge Viability Agreement to revitalize the Rouge.

2000 Ford Rouge Center's new assembly plant is the centerpiece of the nation's largest industrial redevelopment project and feature a living roof.

2003 Ford Motor Company Rouge Complex recognized with a Leadership in Energy and Environmental Design (LEED)

National and World Events

1906 Great San Francisco Earthquake

1909 First explorers reach the North Pole

1914 World War I begins in Russia

1929 U.S. Stock Market crashes, Great Depression begins.

1939 World War II begins.

1945 End of World War II and beginning of Baby Boom Generation.

1969 Neil Armstrong sets foot on the moon.

2001 Terrorists hijack planes, crashing them in New York, Pennsylvania, and Washington, DC

Bibliography

Easy Reader*:

Albert, Richard E. *Alejandro's Gift*. San Francisco: Chronicle Books, 1994.

Allsburg, Chris Van. *Just a Dream*. New York: Houghton Mifflin, 1990.

Arnosky, Jim. *Guide to Knowing Animal Habitats*. New York: Simon and Schuster Books for Young Readers, 1997.

Bang, Molly. *Common Ground: The Water, Earth and Air We Share*. New York: Blue Sky Press, 1997.

Burningham, John. *Hey! Get Off Our Train*. New York: Crown Publishing, 1989.

Fleming, Denise. *Where Once There Was a Wood*. New York: Henry Holt & Co., 1996.

Fife, Dale H. *The Empty Lot.* San Francisco: Sierra Club Books, 1991.

Herzog, Brad. *S is for Save the Planet: A How-to-be-Green Alphabet.*

Holling, Holling C. *Paddle to the Sea.* New York: Houghton Mifflin, 1941.

Martin, Jacqueline Briggs. *Washing the Willow Tree Loon*. New York: Simon & Schuster, 1995.

O'Callahan. Jay. *Herman and Marguerite: An Earth Story*. Atlanta: Peachtree Publishing, 1996.

Parker, Steve. (1988). *Pond and River*. Eyewitness Books. New York: Alfred A. Knopf, 1988.

Peet, Bill. *The Wump World*. Boston: Houghton Mifflin, 1970.

Showers, Paul. *Where Does the Garbage Go?* New York: HarperCollins Juvenile Books, 1974.

Seuss, Dr. *The Lorax*. New York: Random House, 1971.

Zoehfeld, Kathleen. *Ladybug at Orchard Avenue*. Norwalk CT: Sound Prints, 1996.

Young Teens:

Cooper, Susan. *Green Boy*. New York : Margaret K. McElderry Books, 2002.

Doolittle, Bev and Elise Maclay. *The Earth is My Mother.* Shelton, CT: Greenwich Workshop Press, 1999.

Golio, Janet and John Michael. *A Present from the Past: An Environmental Adventure.* Santa Monica, CA : Portunus Pub. Co., 1995.

Hiaasen, Carl. *Flush*. New York: Alfred A. Knopf, 2005.

Hiaasen, Carl. *Hoot*. New York: Alfred A. Knopf, 2002.

Nixon, Joan Lowery. *Shadowmaker*. New York: Delacorte Press, 1994.

Thompson, Julian F. *Gypsyworld.* New York: H. Holt, 1992.

* Easy Reader books can be read aloud in class as a context-setting activity, or independent reading for below-grade-level readers.

Connections to National and Michigan Standards and Expectations

National Standards for Science Education

Life Science

Earth and Space Science

Science and Technology

Science in Personal and Social Perspectives

History and Nature of Science

Michigan Grade Level Content Expectations

Science

L.OL.06.51
Classify organisms (producers, consumers, decomposers) based on their source of energy for growth and development.

L.OL.06.52
Distinguish the ways in which consumers and decomposers obtain energy.

L.EC.06.11
List examples of populations, communities, and ecosystems including the Great Lakes region.

L.EC.06.21
Describe common patterns of relationships between and among populations (competition, parasitism, symbiosis, predator/prey).

L.EC.06.23
Predict how changes in one population might affect other populations based upon their relationships in the food web.

L.EC.06.31
Identify the living (biotic) and non-living (abiotic) components of an ecosystem.

L.EC.06.32
Identify the factors in an ecosystem that influence changes in population size.

L.EC.06.41
Describe how human beings are part of the ecosystem of the Earth and that human activity can purposefully, or accidentally, alter the balance in ecosystems.

E.ES.07.41
Explain how human activities (surface mining, deforestation, overpopulation, construction and urban development, farming, dams, landfills, and restoring natural areas) change the surface of the Earth and affect the survival of organisms.

E.ES.07.42
Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or endangers species.

E.ES.07.81
Explain the water cycle and describe how evaporation, transpiration, condensation, cloud formation, precipitation, infiltration, surface runoff, ground water, and absorption occur within the cycle.

E.ES.07.82
Analyze the flow of water between the components of a watershed, including surface features (lakes, streams, rivers, wetlands) and groundwater.

Online Resources

Middle School Unit

Lesson 1: Parts of an Ecosystem

- Information about wetlands can be found online at the United States Environmental Protection Agency's website www.epa.gov/type/wetlands/index.cfm
- A good resource about wetland protection under Section 404 of the Clean Water Act is the "Recognizing Wetlands" electronic brochure at www.nao.usace.army.mil/technical%20services/Regulatory%20branch/RBwetlands.asp.
- Lesson activities and the game Hydropoly can be found at the Michigan Sea Grant Project FLOW (Fisheries Learning on the Web) website at www.miseagrant.umich.edu/flow/index.html
- Information about the National Wildlife Federation's program for creating a Certified Wildlife Habitat™ can be found at www.nwf.org/Get-Outside/Outdoor-Activities/Garden-for-Wildlife.aspx.

Lesson 2: Damage to Ecosystems

- Locate Brownfield and Superfund clean-up sites in your community with EPA's Cleanups in My Community website tool at http://iaspub.epa.gov/Cleanups/index.jsp?CleanupProgram=Brownfields
- Learn more about Superfund at the EPA at http://www.epa.gov/superfund

Lesson 3: Rebuilding An Ecosystem—The Ford Rouge as a Case Study

- Information about LEED certification from the United States Green Building Council at www.usgbc.org
- The USGBC Green School Buildings website can be found at www.greenschoolbuildings.org/Homepage.aspx
- More information about the green roof at the Ford Rouge Factory at http://www.greenroofs.org/index.php/grhccommittees/290?task=view
- Ford Motor Company's website "Greener Miles", with information about environmental innovation, at http://www.ford.com/innovation/environmentally-friendly

- Useful tools for conducting energy audits for homes or schools can be found at www.energysavers.gov or www.energystar.gov

- Students may wish to calculate their ecological footprint online. One that allows them to create an avatar that simulates their choices can be found at http://earthday.net/footprint2/flash.html. Another useful online tool can be found at http://myfootprint.org

- "Generation G" web video about the LEED certified Sidwell School in Washington D.C. at www.greenschoolbuildings.org/resources/vid_gen_g.aspx

Human Impact on Ecosystems

Unit Plan Overview—Middle School

Overarching Question: What role should citizens have in the restoration of an ecosystem?

Key Concepts

abiotic
adaptation
biotic
brownfield
consumers
decomposers
ecosystem
food chain/web
innovation
LEED certification
living roof
orchard
porous pavement
producers
remediation
responsible manufacturing
sedum
superfund
swale
watershed
wetland

Lessons and Main Ideas

Lesson 1
Parts of an Ecosystem

- An ecosystem is a community of living (biotic) organisms, and the non-living (abiotic) factors with which they interact.
- A wetland is made up of biotic factors such as plants and animals, as well as abiotic factors such as soil, water and nutrients.
- A wetland plays an important role in storm water filtration.

Lesson 2
Damage to Ecosystems

- A brownfield site is a parcel of land which was used for industrial or commercial purposes and may have low levels of contamination.
- Land that is more severely contaminated is designated as a superfund site.
- The Ford Rouge Complex was designated a brownfield site due to decades of pollution and elimination of the site's wetland filtering capabilities.

Lesson 3
Rebuilding an Ecosystem

- Government, industry and citizens are finding innovative ways to remediate brownfield and superfund sites, as well as to protect vulnerable wetlands.

- William Clay Ford Jr. had a vision to remediate the Ford Rouge Factory site, and together with leading green architect William McDonough, brought innovative features to the Rouge including the world's largest living roof, porous pavement, swales and wetlands.
- William Clay Ford Jr.'s vision for Ford Motor Company is to deliver excellent products and services while making the world a better place through responsible manufacturing.

Duration: 7-8 class periods
(45-50 minutes each)

- Lesson Plans—6 class periods
- Unit Project—1-2 class periods depending on project choice

Field Trips

- Ford Rouge Factory Tour
- Local nature centers or wetlands

Assessment

- Performance assessments included with each lesson plan
- Culminating projects (see Supplemental Resources)
- Review/assessment questions (see Supplemental Resources)

Digitized Artifacts

From the Collections of The Henry Ford--PowerPoint Slide Show *Human Impact on Ecosystems* (the "**PP**" numbers below correspond to the slide numbers on the Human Impact PowerPoint)

Lesson 1
Parts of An Ecosystem

- Picture of swales and wetland at FRFT **PP3**
- Aerial View of Ford Motor Company Rouge Plant, January 1948; ID# THF24040 **PP4**

Lesson 2
Damage to Ecosystems

- Aerial view of FMC Rouge Plant c.1930; ID# THF23881 **PP6**
- Aerial view of FMC Rouge Plant c.1939; ID# THF23951 **PP7**
- Coke quenching tower; ID# THF24018 **PP8**
- Aerial view of Ford Motor Company Rouge Plant, January 1948; ID# THF24040 **PP9**
- Locomotive at Cement Plant Powerhouse; ID# THF80861 **PP10**

Lesson 3
Rebuilding an Ecosystem

- Flowers outside Ford Rouge Factory Tour; ID# THF50004 **PP12**
- Flowers outside Ford Rouge Factory Tour; ID# THF56671 **PP13**
- Living Roof at FRFT; ID# THF50020 **PP14**
- Picture of orchard at FRFT **PP15**

Materials

- Computer with access to Internet; digital projector and screen (preferred) or printed handouts of digital images.
- Sign: What role should citizens have in the restoration of an ecosystem?
- Student Activity Sheet #1A: "What Are Wetlands Worth?"
- Answer Key #1A
- Student Activity Sheet #2A
- Answer Key #2A
- Student Activity Sheet #3A
- Answer Key #3A
- PowerPoint Slide Show *The 21st Century Ford Rouge Factory: Environmental Innovations* at http://www.thehenryford.org/rouge/eduResources/environment3.ppt
  PowerPoint Slide Show *Human Impact on Ecosystems* at
- OnInnovation.com video clips from William McDonough interview
- Plastic tub, or wallpaper trough, or food storage containers (rectangular or round deli type)
- drill
- Sedum—low growing varieties; also called Stonecrop (large demo requires 6-3" pots; available at nurseries or garden centers)
- Growing substrate—well draining soil such as Miracle Gro™ soil for cactus/succulents
- Fleece—1/2 yard for large demo
- Naturalaire™ Cut to Fit Reusable Furnace Filter

-

Human Impact on Ecosystems

Lesson 1 Parts of an Ecosystem

Main Ideas

- An ecosystem is a community of living (biotic) organisms, and the non-living (abiotic) factors with which they interact.
- A wetland is made up of biotic factors such as plants and animals, as well as abiotic factors such as soil, water and nutrients.
- A wetland plays an important role in storm water filtration.

Key Concepts

Ecosystem
Wetland
Watershed
Producers
Consumers
Decomposers
Abiotic
Biotic
Food chain/web
Adaptation

Digitized Artifacts from the Collections of The Henry Ford -- PowerPoint Slide Show *Human Impact on Ecosystems* (the "PP" numbers below correspond to the slide numbers on the Human Impact PowerPoint)

Lesson 1
Parts of an Ecosystem

- Picture of swales and wetland at FRFT **PP3**
- Aerial View of Ford Motor Company Rouge Plant, January 1948; ID# THF24040 **PP4**

Materials

- Computer with access to Internet; digital projector and screen (preferred) or printed handouts of digital images from PowerPoint.
- Sign: What role should citizens have in the restoration of an ecosystem?
- Student Activity Sheet #1A: "What Are Wetlands Worth?"
- Answer Key

Duration 2 class periods (45-50 minutes)

Instructional Sequence

1 Engage

Recommended Picture Book: *S is for Save the Planet: A How-to-be-Green Alphabet* by Brad Herzog

Write or project the following definition on the board:

"**Ecosystem**—a community of living (biotic) organisms, and the non-living (abiotic) factors with which they interact."

- Show students the picture of the Ford Rouge Factory Tour wetland. **PP3**
- Ask students if they can identify what type of ecosystem is in the picture. Students may give responses such as "marsh" or "swamp", and you may tell them that those are names of examples of different types of **wetlands**.
- Ask students to identify as many biotic (living) and abiotic (non-living) features as they can from the picture—things they can see or they can imagine might exist in this wetland. Examples include: plants such as reeds and cattails, birds, frogs and insects (biotic), and sunlight, air, water and soil (abiotic).
- Ask students where they think wetlands can be found. Students will probably give answers such as near rivers and lakes, or out in the "country". We typically think of nature as being far apart from our vision of cities and industrial areas.
- Show the students the picture of the Ford Rouge Factory circa 1948 **PP4**, and share with them that the wetland in the first picture was taken near the factories that they see in the second picture. The site of the Ford Rouge Factory was once a 2,000 acre wetland before Henry Ford filled in the spongy earth to build his factory in the early 20th century. Efforts are underway to restore a wetland ecosystem to this industrial site. In Lesson 3 "Rebuilding an Ecosystem", students will discover how Ford Motor Company is working to repair the damage that was done to the wetlands at its factory along the Rouge River near Detroit.

2 **Explore—**What Are Wetlands Worth?

In this activity, students will be working in small groups to learn more about the features and functions of a wetland ecosystem. They will be responsible for creating a group project from a list of choices that demonstrates their comprehension of the subject matter.

Procedure:

- Post the sign "What role should citizens have in the restoration of an ecosystem?" in the front of your classroom. Inform the students that during the course of this lesson and unit on ecosystems, they should keep that question in mind. They will be asked to reflect upon that question at the end of the unit.

- Divide the class into groups of three students. (Groups of 2 or 4 may be acceptable.) Take the class to a computer lab or provide laptops so that each group has at least one computer to use.
- Hand out copies of Student Activity Sheet #1A: "What Are Wetlands Worth?" and read the background information out loud as a class. Ask the students if they have questions about the background material. Try to avoid going beyond the scope of the background information, as students will be conducting their own research in this investigation.
- Give students 5-10 minutes to complete Part I—Vocabulary Grid. Encourage them to work as a team on this section.
- Before moving on to the next section, verify that all groups were able to find definitions for all of the key vocabulary. You may wish to have groups share their definitions with the class.
- Instruct the student groups to move on to Part II—Form and Function. In this section they will be using Internet search tools to find information that best answers the questions. If groups have more than one computer at their disposal, they may wish to have multiple group members conducting searches. As a group they should discuss the information that they find and narrow it down (merge, eliminate, summarize) to what they feel is the best possible answer, instead of simply writing down the first information they find. Students will likely need the remainder of class day one to complete this section. Collect student activity sheets as the end of the class period.
- At the beginning of class day two, students should return to their groups and receive back their student activity sheet. As a class, discuss the following questions before moving on to the next section.

- Discussion Questions:

  -What is the difference between a biotic and an abiotic factor in an ecosystem?
  A biotic factor is something that is or was alive (example: an insect), while an abiotic factor has never been alive (example: water).

  -How does energy move through a food chain/web in an ecosystem?
  Energy moves through a food chain from the lowest to highest trophic level. The lowest level is the producer (almost always a plant), which gets its energy from the Sun through photosynthesis. The next level is a consumer called an herbivore which eats the producer. Next you have a consumer called a carnivore, which eats the herbivore. This continues until your highest trophic level which is the apex predator (carnivore).

  -What kind of adaptations do plants and animals have in a wetland ecosystem?
  Plants have adaptations that help them to survive being submerged or having their roots in saturated soils—buttress roots, air-filled floating leaves, and hollow stems that transport oxygen to the roots. Wetland animals may have webbed feet for paddling, special fur or skin for swimming and staying warm in the water, and specific reproductive strategies or life cycles that require water.

  -What are the characteristics of a wetland ecosystem?

***Hydrology**—land is submerged or saturated with water for all or part of the growing season. **Hydric soils**—have characteristics that indicate they developed in conditions where soil oxygen was limited. **Hydrophytic vegetation**—"water loving" plants such as cattails and willows.*

-What are the benefits of a wetland ecosystem?
Wetlands provide storm water filtration and improved water quality, flood protection, shoreline erosion protection, wildlife habitat, and recreational opportunities.

- Student groups should read through the RAFT project choices in Part III—Final Product of Student Activity Sheet #1A. Groups will likely need one class period plus extra time outside of class to complete their product. Additional class time to prepare and/or present group projects is at the teacher's discretion.

3 Explain

Wetlands play a vital role in the natural world through flood protection, run-off filtration, erosion protection, wildlife habitat provision, and through other commercial and recreational benefits. The destruction of wetlands by commercial/industrial, residential and agricultural development is one of the biggest threats to species diversity and human health. Citizens, businesses, government and non-profit agencies can all work together to make wetland protection and rehabilitation a priority.

4 Extend

- Students will enjoy applying their knowledge of wetlands to the game "Hydropoly: a Decision-Making Game" which can be found at the Michigan Sea Grant Project FLOW (Fisheries Learning on the Web) website at www.miseagrant.umich.edu/flow/U2/U2-L5.html.

- Students may want to extend their learning at home or at school by creating a Certified Wildlife Habitat™ through the National Wildlife Federation. Information can be found at www.nwf.org/Get-Outside/Outdoor-Activities/Garden-for-Wildlife.aspx.

- Literacy Connection—students can read select chapters from the book "Unquenchable: America's Water Crisis and What to Do About It" by Robert Glennon to learn about the connection between excessive water use and wetland habitat destruction.

- For more information about wetlands, and how they are defined and protected under Section 404 of the Clean Water Act, students can read the "Recognizing Wetlands" electronic brochure at www.nao.usace.army.mil/technical%20services/Regulatory%20branch/RBwetlands.asp.

What is a Wetland Worth?

Name:

Background Information: A wetland is a biologically diverse, critically important ecosystem in which the soil is saturated for all or part of the year. Freshwater wetlands, such as marshes, swamps and bogs, can occur along rivers and lakes, or even inland in low-lying forests. Saltwater wetlands, including estuaries, salt water marshes, and sandy shoreline, occur along the coastline of oceans and seas, and serve as a transition zone between freshwater and saltwater environments. Wetlands are important features of watersheds, and usually serve as an intermediate between terrestrial (land) and aquatic (water) ecosystems.

Wetlands serve a variety of important functions that directly affect the animals that live there, as well as humans who live nearby. One job that is accomplished by a healthy wetland is the filtration of storm water. Soil and pollutants that are washed down-slope during a rain event would flow unchecked into rivers and lakes if there were no wetlands to slow their travel and trap sediments. Sediments and pollutants can be very harmful to fish and other aquatic wildlife.

Wetlands are one of the most threatened ecosystems in North America. At the time of European settlers in the 17th century, the lower 48 states had roughly 220 million acres of wetlands (usgs.gov). Today, only about half of that acreage remains as wetlands. The rest has been filled in and developed for commercial, industrial and residential use. This habitat loss directly affects the species diversity of plants and animals.

In this activity you will be exploring the features and functions of a wetland ecosystem. Your group will utilize the Internet to define key vocabulary and answer questions about wetlands. You will use this information to develop a product that depicts the value of wetland ecosystems.

Part I—Vocabulary Grid—use Internet sources to define the following terms. Work together as a team to find and record these definitions.

Term	Definition
Ecosystem	
Producer	
Consumer	

Decomposer	
Food chain/web	
Adaptation	
Biotic	
Abiotic	
Watershed	
Wetland	

Part II—Form and Function—use Internet resources to find the best answers to the following questions. Information found online at the United States Environmental Protection Agency's website (ww.epa.gov/owow/wetlands/vital/people.html) about wetlands will be helpful for questions #7-11.

1. What are some examples of **biotic** factors in a wetland ecosystem? _____

   _____

2. What are some **abiotic** factors in a wetland ecosystem? _____

   _____

3. Find an example of a wetland ecosystem food chain:

_____ → _____ → _____

Producer — Primary (1st) Consumer — Secondary (2nd) Consumer

→ _____ → _____ → _____

Tertiary (3rd) Consumer — Quaternary (4th) Consumer — "Top Predator"

4. Energy enters the ecosystem food chain in what form? _____

5. What do the arrows in question #3 represent? _____

_____

6. What might happen to the food chain if one element were to be eliminated (by disease or habitat loss, for example)? _____

_____

7. How do wetlands positively affect water quality?_____

_____

_____

_____

8. How do wetlands offer flood protection?_____

_____

_____

_____

9. How do wetlands protect shoreline from erosion? _____

_____

_____

_____

10. How do wetlands provide habitat for wildlife? _____

_____

_____

_____

11. What other benefits do wetlands offer? _____

_____

_____

Part III—Final Product—choose one RAFT (role, audience, format, topic) choice from the list below. If you have an idea for a RAFT project that is not on the list, talk to your teacher for project permission. Use the information gathered in parts I and II of this activity to demonstrate your comprehension of wetland ecosystems.

RAFT Project Choices

Role	Audience	Format	Topic
1. Oil Company CEO	T.V. audience	Nightly news interview	Explaining how your company will protect coastal wetlands from effects of oil spill
2. Zookeeper	Zoo visitors	Podcast	Explaining types of animals in a new wetland exhibit
3. Actor/Environmentalist	Teenagers	Commercial	Explaining how young adults should help protect wetlands
4. Middle school student	Elementary student	Coloring/activity book	Explaining what wetlands are and how they are important
5. Environmentally-aware singer	Radio listeners	Song	Explaining the importance of wetlands to our society
6. Environmental Organization	Adults	Media Campaign—to include billboard and bumper sticker, and choice of brochure or calendar	Explaining the importance of wetlands and why/how they should be protected

What is a Wetland Worth?

Name: **Answer Key**

Part I—Vocabulary Grid.

Term	Definition
Ecosystem	**A group of organisms that live close together, and the environment in which they live**
Producer	**An organism that uses energy from the Sun to produce its own food**
Consumer	**An organism that must eat other organisms to get energy**
Decomposer	**Organisms that feed on dead or decaying plants or animals, and return nutrients to the surrounding soil or water.**
Food chain/web	**How energy is passed on in an ecosystem. A food web is a collection of inter-related food chains.**
Adaptation	**A feature that helps a plant or animal to survive; an adjustment to environmental conditions.**
Biotic	**Elements of an ecosystem that are or were alive**
Abiotic	**Elements of an ecosystem that are not, and never were, alive**
Watershed	**A region or area that drains to a particular watercourse or body of water.**
Wetland	**Land that is submerged, or has saturated soils, for all or part of the growing season.**

Part II—Form and Function

1. What are some examples of **biotic** factors in a wetland ecosystem? **Plankton, cattails, water lilies, fish, turtles, birds**

2. What are some **abiotic** factors in a wetland ecosystem? **Soil, water, air, sunlight**

3. Find an example of a wetland ecosystem food chain:

____**Water Lily**_____ → _____ **Snail** _____ → _____ **Crayfish** _____
Producer Primary (1st) Consumer Secondary (2nd) Consumer

→ _____ **Bullfrog** _____ → __**Northern Water Snake** __ → ____ **Bald Eagle** ____
Tertiary (3rd) Consumer Quaternary (4th) Consumer "Top Predator"

4. Energy enters the ecosystem food chain in what form? **Sunlight**

5. What do the arrows in question #3 represent? **The arrows represent the flow of energy, from one organism consuming another, through the food chain.**

6. What might happen to the food chain if one element were to be eliminated (by disease or habitat loss, for example)? **If one element of the food chain were to be eliminated it would affect the balance of the entire chain. If you lost crayfish, for example, the number of snails would likely increase (lack of a predator), while the bullfrog numbers would decline as they ran out of a food source.**

7. How do wetlands positively affect water quality? **Wetlands filter storm water runoff—removing harmful chemicals and excess nutrients, and trapping sediment before it reaches a river or lake. They also replenish groundwater, which provides drinking water for many people.**

8. How do wetlands offer flood protection? **Wetlands act like a giant sponge, absorbing excess water from rain and snowmelt, and then slowly releasing it into nearby waterways. Wetland vegetation also slows down the flow of runoff and spreads it out over a larger area. These two features help lower flood height and reduce erosion from flooding.**

9. How do wetlands protect shoreline from erosion? **Wetland plants hold soil/sand in place with their roots, absorb wave energy, and break up the flow of stream currents.**

10. How do wetlands provide habitat for wildlife? **Many insects, fish, mammals and birds depend on wetlands for all or part of their life cycle. Most commercial and game fish breed and raise their young in coastal marshes and estuaries. Shrimp, oysters, clams and crabs rely on wetlands for food, shelter and breeding grounds. Some plants and animals, such as cattails and muskrats, need wetlands to survive. Many birds raise their young in wetlands, or use wetlands as a place to rest (migratory birds).**

11. What other benefits do wetlands offer? **Wetlands offer us many plants and animals that we use for food (blueberries, cranberries, fish and shellfish) or medicine (derived from soils or plants). Wetlands also offer recreational opportunities such as hunting, fishing and nature photography.**

Human Impact on Ecosystems

Lesson 2 Damage to Ecosystems

Main Ideas

- A brownfield site is a parcel of land which was used for industrial or commercial purposes and may have low levels of contamination.
- Land that is more severely contaminated is designated as a superfund site.
- The Ford Rouge Complex was designated a brownfield site due to decades of pollution and elimination of the site's wetland filtering capabilities.

Key Concepts

Brownfield
Superfund site
Remediation

Digitized Artifacts from the Collections of The Henry Ford-- PowerPoint Slide Show *Human Impact on Ecosystems* (the "PP" numbers below correspond to the slide numbers on the Human Impact PowerPoint)

Lesson 2
Damage to Ecosystems

- Aerial view of FMC Rouge Plant c.1930; ID# THF23881 **PP6**
- Aerial view of FMC Rouge Plant c.1939; ID# THF23951 **PP7**
- Coke quenching tower; ID# THF24018 **PP8**
- Aerial view c.1948; ID# THF24040 **PP9**
- Locomotive at Cement Plant Powerhouse; ID# THF80861 **PP10**

Materials

- Computer with access to Internet; digital projector and screen (preferred) or printed handouts of digital images.
- Sign: What role should citizens have in the restoration of an ecosystem?
- Student Activity Sheet #2A
- Answer Key #2A

Duration 2 class periods (45-50 minutes)

Instructional Sequence

5 Engage

- Show students the digitized images of the Ford Rouge Complex at its peak in the mid-20th century using the historical information found at www.thehenryford.org/rouge/historyofrouge.aspx#numbers or the PowerPoint Slide Show *The 21st Century Ford Rouge Factory: Environmental Innovations* at http://www.thehenryford.org/rouge/eduResources/environment3.ppt to share with students a brief overview of the Ford Rouge Complex.
- Explain to students that an unintended by-product of the early American manufacturing process was often soil and groundwater contamination as well as habitat loss through ecosystem destruction. Usually this contamination occurred because little was known about the long-term and far-reaching effects of improper waste disposal. It has only been in the last forty to fifty years that a greater scientific understanding has emerged about the harmful environmental effects of poor industrial practices. Ford Motor Company is working hard to remediate and repair environmental damage (as you will see in Lesson 3), but many industrial sites, both here and abroad, are still dealing with the effects of destructive environmental practices.

6 Explore—

In this activity, students will be working in small groups to learn more about the damage that can occur to ecosystems through poor industrial placement or practices. Students will be creating a short presentation for the class about a superfund site in their county or state.

Procedure:

- Divide the class into groups of three, or allow students to choose their own group. Take the class to a computer lab or provide laptops so that each group has at least one computer to use.
- Hand out Student Activity Sheet #2A: "Everyone's Mess" and read the background information out loud as a class. Explain to them that in this activity they will determine the number of brownfield and superfund sites in their community, region or state. They will then select a unique superfund site for further research. (Due to the nature of the federal legislation concerning superfund site clean-up, more detailed information exists for these sites than for brownfields.) If there are not enough county superfund sites to allow one for each group, you may decide to let groups choose sites in nearby counties.
- Instruct student groups to begin working on Part I—Gathering Information. After completion of the table and questions, groups should move on to Part II. If time is limited, groups should discuss which type of visual aid they will be creating and

completing as homework. They should be prepared to give a short (5 minute) presentation the next day in class with either a poster or slideshow with 3-5 images with labels.

- Class Day Two will be dedicated to group presentations. If the teacher feels it is appropriate, additional class time may be given to presentation preparation.

- After presentations are finished, discuss the following questions as a class:

- Discussion Questions:

-What is the difference between a brownfield and a superfund site?
A brownfield and a Superfund are both sites which have suffered contamination from industrial or commercial practices. A brownfield has lower levels of contamination than a Superfund site.

-How does the government get involved in the clean-up of contaminated sites?
The clean-up of brownfield sites is mostly regulated by state environmental agencies. The U.S. EPA can provide technical assistance or tax incentives for the clean-up costs. Superfund site clean-up protocols are established under federal law—the Comprehensive Environmental Response, Compensation and Liability Act of 1980. The law authorizes the EPA to identify the parties responsible for the contamination and compel them to clean up the site. If a responsible party cannot be identified, the EPA takes responsibility for clean-up, which is paid by a government trust fund.

-What role do businesses play in clean up efforts?
In brownfield remediation, businesses usually take responsibility for the clean-up if they have a plan for redevelopment. In a Superfund clean-up, businesses are required to clean-up the site if the EPA finds them to be the responsible party.

-How can citizens get involved in clean up efforts?
Citizens can make a big difference in clean-up efforts by drawing attention to the pollution and applying public pressure on the businesses and government to "do the right thing." Businesses are often motivated by public perception.

7 Explain

Damage to ecosystems through industrial contamination is an ongoing problem for our society. Once we know of the impairment to the benefits of the affected ecosystem, as well as the long-lasting effects on human communities, clean-up of polluted sites is in everyone's best interest.

8 Extend

- Students may wish to investigate laws at the federal, state and local level concerning development on wetland ecosystems. Some examples of federal laws include the

Clean Water Act, the National Environmental Policy Act, and the Endangered Species Act.

- Students can apply their concern for the environment by researching whether their school has an environmental mission statement or environmental policies concerning the construction of new school buildings. A team of students might push for the adoption of an environmental mission statement or policies, and make a presentation to the administration and school board.

9 Evaluate

Student responses on the activity sheet, responses to discussion questions, and group presentation serve as the evaluation for this lesson. If desired, extension projects can be assigned for further assessment.

The Orchard at the Ford Rouge Complex

Everybody's Mess

Name:

Background Information: As we have learned before, an ecosystem is made up of a community of living organisms and the abiotic factors, such as sunlight, water and soil that support them. Ecosystems have immense value to their inhabitants, as well as to humans who directly and indirectly benefit from the features and functions of the system. Unfortunately, humans, both past and present, don't always return the favor. Through improper waste disposal and poor land management, businesses and industries have caused and contributed to ecosystem pollution and destruction.

The federal government, through the United States Environmental Protection Agency (EPA), works with state and local governmental agencies to identify and clean up contaminated industrial sites. These sites are usually designated as either a brownfield or superfund site depending on the severity of the contamination, with a brownfield being the less contaminated of the two. The level of hazardous waste or pollution necessary to qualify a site for superfund status is more uncommon, but carries such a greater impact that clean-up is regulated by federal law.

In this activity, you will be working with a partner to investigate the brownfield or superfund sites in or near your community. You will be creating a short presentation about your chosen superfund site to give to your class.

Part I—Gathering Information

1. Use the EPA's Cleanups in My Community website tool at http://iaspub.epa.gov/Cleanups/index.jsp?CleanupProgram=Brownfields.

2. Once you have navigated to this screen, you can create a clean-up map by selecting the box for "all cleanups" under Step 1, and then enter your city, county or zip code under Step 2. Click on "map it", and after a moment or two a county map will appear.

3. On the county map you will probably see dots of different colors that represent contaminated sites. If you place the cursor over a dot, the name of the site will appear. On the right hand side of your screen is a list of all sites in the map region.

4. Locate the borders of your county (dashed brown line) by clicking and dragging the map.

5. How many brownfield sites (orange dot) are located in your county? _____

6. Give the name and address of a brownfield site in your county:

   _____

7. How many superfund sites (red dot) are located in your county? _____

8. Give the name and address of a superfund site in your county:

   _____

9. Select a superfund site for further research. Check with your teacher to make sure that no other group has already chosen this site. After you have clicked on the name of the site, a new screen will appear with the company name located at the top. Click on "Superfund NPL" and a progress profile will appear. In the grey box to the right titled "More Details…" click on "More In-Depth Site Details". Use the information on this page to complete the table below.

10. Superfund Site Data Table:

Category	My site
Name of Company (past and present)	
Address	
What was manufactured?	
What are the pollutants?	
What is contaminated?	
Size of contaminated area	
Clean-up progress	
Future clean-up	
Contact person and phone number	

11. Is this site near waterways such as rivers or lakes, or wetlands? _____

12. How might humans be affected by the pollution at your selected site? _____

_____

_____

Part II—Presentation

Use the information gathered above to create a short presentation for the class. You need to create some type of visual aid for your presentation such as a poster or power point slides. Use an image search to find pictures of your selected site or company if available. Pictures of the actual or representative ecosystem that would be affected by the contamination would be appropriate as well. Make sure that your presentation includes the information in the table, as well as your responses to questions #11 and #12. Include additional information if desired.

Everybody's Mess

Name: **Answer Key**

Part I—Gathering Information

Give the name and address of a brownfield site in your county: **Answers will vary**

How many superfund sites (red dot) are located in your county? **Answers will vary**

Give the name and address of a superfund site in your county: **Answers will vary**

Superfund Site Data Table: **Example**

Category	My site
Name of Company (past and present)	**State Disposal Landfill, Inc.**
Address	**East Beltline and 3 Mile Rd., NE Grand Rapids, MI 49505**
What was manufactured?	**It was a licensed state disposal facility—residential, commercial, other wastes, possibly accepted liquid hazardous waste**
What are the pollutants?	**Inorganics—lead, copper, cyanide, chromium, VOCs—tetrachloroethane, chlorofluorocarbons, benzene, toluene, xylene compounds, and others**
What is contaminated?	**Groundwater and soil**
Size of contaminate area	**Landfill = 37.6 acres Study area = 800 acres**
Clean-up progress	**Landfill was capped and fenced, gas vents installed, township installed additional municipal wells, air stripper is running to treat contaminated water**
Future clean-up	**Clean-up ongoing**
Contact person and phone number	**Lolita Hill, Remedial Project Manager U.S. EPA (312) 353-1621**

Is this site near waterways such as rivers or lakes, or wetlands? **Yes, approximately 2 miles from the Grand River.**

How might humans be affected by the pollution at your selected site? **Since the landfill was fenced, contact with the contaminated soil has been minimized. The greatest risk for exposure is through people drinking contaminated groundwater brought up by a well.**

Human Impact on Ecosystems

Lesson 3 Rebuilding An Ecosystem—The Ford Rouge as a Case Study

Main Ideas

- Government, industry and citizens are finding innovative ways to remediate brownfield and superfund sites, as well as to protect vulnerable wetlands.
- William Clay Ford Jr. had a vision to remediate the Ford Rouge Factory site, and together with leading green architect William McDonough, brought innovative features to the Rouge including the world's largest living roof, porous pavement, swales and wetlands.
- William Clay Ford Jr.'s vision for Ford Motor Company is to deliver excellent products and services while making the world a better place through responsible manufacturing.

Key Concepts

innovation
living roof
sedum
porous pavement
swale
orchard
LEED certification
responsible manufacturing

Digitized Artifacts from the Collections of The Henry Ford-- PowerPoint Slide Show *Human Impact on Ecosystems* (the "PP" numbers below correspond to the slide numbers on the Human Impact PowerPoint)

Lesson 3
Rebuilding An Ecosystem—The Ford Rouge as a Case Study

- Flowers outside Ford Rouge Factory Tour; ID# THF50004 **PP12**
- Flowers outside Ford Rouge Factory Tour; ID# THF56671 **PP13**
- Living Roof at FRFT; ID# THF50020 **PP14**
- Picture of orchard at FRFT **PP15**

Materials

- Computer with access to Internet; digital projector and screen (preferred) or printed handouts of digital images from PowerPoint.
- Sign: What role should citizens have in the restoration of an ecosystem?

- Student Activity Sheet #3A
- Answer Key
- PowerPoint Slide Show *The 21st Century Ford Rouge Factory: Environmental Innovations* at http://www.thehenryford.org/rouge/eduResources/environment3.ppt
- PowerPoint Slide Show *Human Impact on Ecosystems* at
- OnInnovation.com video clips from William McDonough interview
- Plastic tub, or wallpaper trough, or food storage containers (rectangular or round deli type)
- drill
- Sedum—low growing varieties; also called Stonecrop (large demo requires 6-3" pots; available at nurseries or garden centers)
- Growing substrate—well draining soil such as Miracle Gro™ soil for cactus/succulents
- Fleece—1/2 yard for large demo
- Naturalaire™ Cut to Fit Reusable Furnace Filter

Duration 2 class periods (45-50 minutes)

Instructional Sequence

10 Engage

Write or project the following quote on the board:

"A good company delivers excellent products and services. A great company does all that and strives to make the world a better place." --William Clay Ford Jr.

Ask students to answer the following two questions in their science notebooks after reading the quote:

1. Do you agree or disagree with the premise of the quote, that it is a responsibility of business and industry to "make the world a better place"? Support your view.
2. Do you as a consumer feel that you have a duty to support sustainable businesses with your purchases, even if those products and services are more expensive as a result of responsible manufacturing? Support your view.

- As a method of surveying the class, give each student two small sticky-notes to cast their "votes" as to whether they agree or disagree with the above questions.
- On the board (or on poster board prepared in advance), write out each question with an area below labeled "agree" and "disagree".
- Ask students to come up to the board and place their sticky-notes in the area below each question that corresponds to their viewpoint.
- Once all sticky-notes are placed, ask a couple students from each response group to share their view-point and supporting opinion with the class.
- After discussion, allow students to move their sticky-note to the other column if the discussion persuaded them to change their mind.

11 Explore

In this activity, students will be learning more about the innovative changes that were made to the Ford Rouge Factory in Dearborn, Michigan. Students will watch a power point that illustrates these environmentally-conscious changes, as well as some OnInnovation.com video clips from an interview with Ford Rouge architect William McDonough. The culminating project of this activity is the hands-on creation of a green roof model.

Procedure:

- Hand out copies of Student Activity Sheet #3A: "A Case for Change—Innovation at the Rouge". Read the background information out loud as a class. Ask students if they have any questions about the background material.
- Using a classroom computer and video projector, or a classroom set of computers with headphones (for listening to the interviews) show students the PowerPoint Slide titled *21st Century Ford Rouge Factory: Environmental Innovations* found at http://www.thehenryford.org/rouge/eduResources/environment3.ppt and have them answer the corresponding questions in Part I—Changes at the Rouge of the Student Activity Sheet.
- After the students have finished the slideshow questions, show them the selected clips from the William McDonough interview from www.OnInnovation.com. Students should answer the corresponding questions from Part II—Interview with an Innovator on the Student Activity Sheet.
- Upon completion of Parts I and II, students may be asked to share their thoughts on the changes made to the brownfield factory site at the Ford Rouge, by answering the following discussion questions.

- Discussion Questions:

-How have environmental attitudes changed since the early 20th century?
In the last 100 years, scientists have learned more about the harmful effects of certain chemicals on the human body. As this information has become more available to the general population, people have become more concerned about releasing harmful pollutants into the air, water and soil, where people may come into contact with them. People also know more now about the lasting damage to ecosystems and how that impacts us, both physically and economically.

-Do you think that Henry Ford would have been able to build the Rouge where he did, in current times?
It is very unlikely. With passage of the Federal Water Pollution Control Amendments in 1972 and the Clean Water Act of 1977, the practice of draining or filling wetlands for industrial development was severely restricted. The site of the Ford Rouge Factory is too great of a size (2,000 acres) to allow development in current times.

-How can the innovative changes that William Clay Ford Jr. and William McDonough brought to the Rouge be a model for other businesses?

Other businesses can look at the changes implemented at the Rouge and actually see the benefits. In business they say that money talks, and there is no disputing that the green roof and natural water filtration systems save millions of dollars over a more conventional storm water treatment facility.

-How can their model of environmental innovation inspire you at home and at school?

Many of the innovations at the Rouge can be downscaled and implemented at home or at school. While it may not be possible to install a green roof or wetlands, individuals can plant a rain garden to filter storm water before it flows into storm drains or drainage ditches. Other practices such as water conservation, energy conservation and recycling can easily be implemented at home or school.

- Part III—Building a Green Roof Model is an activity that can be modified according to the number of students, cost of supplies, and teacher goals. It can be implemented as a large-scale classroom demonstration or a small-group hands-on project. The post-activity questions and outcomes will work for either type of set-up.

- Several days ahead of time, start purchasing/accumulating the supplies needed for this activity (See Student Activity Sheet #3A for complete list). To limit teacher/school costs, you can encourage students to bring in some supplies of their own (such as deli containers and fleece, which they may have at home.)

- If conducting this activity as a small-group hands-on project, students should be in groups of three or four. Supplies should be handed out, and students can construct their model according to the procedure on the student activity sheet. If conducting this activity as a large-scale demonstration, students can still assist with the construction of the model, and they can be assigned the measurement/calculations and post-activity questions in small groups.

- Upon completion of the post-activity questions, students should share their answers with the class to facilitate a discussion about the purpose of a green roof, and the motivation behind the green roof installation at the Ford Rouge Factory in Dearborn, Michigan.

- **Teacher info:** One of the reasons that sedum was chosen for the green roof at the Ford Rouge is because it is a succulent that can grow in shallow substrate with limited water (succulents store water in their leaves), which reduces the amount of weight on the roof. Unlike grass, it does not have to be mowed since it grows low and out, instead of up. Even though a sedum roof is lighter than one planted with grass, the steel roof under the green roof at the Ford Rouge still had to be designed to support a greater load than a traditional non-green roof. If a school wanted to design a green roof for its school building, it would likely have to be reinforced, or a new-build to ensure that the substructure could support the load. Your school maintenance department can probably provide information of the load capacity of your current roof. Additional information about green roofs can be found at:
  http://www.facilitiesnet.com/Roofing/article/Green-Roof-Tips-Roof-Structure-and-Maintenance--10075
  http://www.environmentalleader.com/2010/08/10/tips-for-selecting-the-right-green-roof-design/

http://www.thedailygreen.com/living-green/definitions/green-roof

12 Explain

Environmental innovations like those implemented at the Ford Rouge Factory are creating a resource for other corporations who wish to remediate contaminated brownfield or superfund sites, and operate in a sustainable manner. As citizens of our planet, students can support these efforts by learning more about the companies with which they do business.

13 Extend

- A good resource to show the students how green innovation can be implemented at school is the web video "Generation G" about LEED certification at the new middle school at Sidwell Friends School in Washington, D.C. This can be found by navigating through the U.S. Green Building Council's website (www.usgbc.org) to www.greenschoolbuildings.org/resources/vid_gen_g.aspx. This nine-minute video can give students a sense of purpose and empowerment in shaping environmental decisions and policy. After viewing this video, students may wish to develop a plan for energy savings at their school, which they could present to the school board.

- Students may wish to calculate their ecological footprint online. One that allows them to create an avatar that simulates their choices can be found at http://earthday.net/footprint2/flash.html. Another useful online tool can be found at http://myfootprint.org. After students complete the comprehensive quiz, they can investigate steps to reduce their impact. Students may be motivated to create an online or print campaign to convince their peers to minimize their ecological footprint.

14 Evaluate

Student responses to activity and discussion questions, as well as the green roof model analysis serve as the assessment for this lesson.

A Case for Change—Innovation at the Rouge Name:

Background Information: In the previous lesson you learned about contamination from industrial sites that has damaged ecosystems. Designation of these locations as either brownfield or superfund sites allows for coordinated efforts between businesses and conservation agencies to clean up pollutants that remain, as well as to rebuild the damaged ecosystem. In the case of wetland ecosystems, much of the damage has been caused by decisions made decades ago to fill in or drain the wetland in order to build upon the site for industrial or commercial purposes.

In the case of the Ford Rouge Factory, which sits on 2,000 acres of former wetland near the Rouge River in suburban Detroit, Henry Ford likely did not fully understand the impact of filling in the wetland to build his auto factory. After decades of soil contamination from the disposal of waste created by steel production, as well as flooding and drainage issues, the site was designated a brownfield. Ford Motor Company, under the leadership of William Clay Ford Jr. Jr., has begun to rectify the problem by implementing innovative changes at the Ford Rouge Factory to not only remediate the ecosystem, but to produce a product with a greater amount of sustainable materials. The Ford Rouge Factory Tour, which showcases the world's largest green roof, living lab tour through wetlands and an orchard, a LEED-certified visitor center, and an ergonomically-designed truck assembly line, allows the public to see firsthand how an industry leader tackles the issue of brownfield remediation and responsible manufacturing.

Part I—Changes at the Rouge—watch the PowerPoint slideshow *The 21st Century Ford Rouge Factory: Environmental Innovations* at http://www.thehenryford.org/rouge/eduResources/environment3.ppt and answer the following questions.

1. Innovations at the Rouge involve ways of better managing the _____, _____, _____ and _____.

2. The green roof at the Rouge covers _____ acres.

What are the four layers of green roof composed of?

_____ _____

_____ _____

3. Besides the green roof, what are some other innovations at the Rouge for managing water?

_____

_____

4. How are scientists cleaning up the soil at the Rouge? _____

_____

5. Describe one way that daylight and air are being managed at the Rouge? _____

_____

Part II—Interview with an Innovator

1. **William McDonough: Clip #15 "The Rouge Plant" (length 5:48)**

   A. What was the guiding principal of the Rouge Plant redevelopment? _____

   _____

   B. How did William Clay Ford Jr. and William McDonough define the goal for quality soil?

   _____

   C. By installing features such as the living roof, porous pavement, wetlands and swales, how much money did Ford Motor Company save over installing a traditional storm water treatment facility?

   _____

   _____

   D. According to McDonough, this project required massive amounts of what four traits?

   _____ _____

   _____ _____

2. **William McDonough: Clip #17 "The Living Roof" (length 3:51)**

   A. The living roof at the Ford Rouge is composed of what plant? _____

   B. List four of the benefits of the living roof at the Ford Rouge:

   _____ _____

   _____ _____

C. What surprised McDonough about the living roof project? _____

_____

_____

Part III—Building a Living Roof Model

Materials (small-group set-up):
Deli container (pint-size) or reusable storage container (such as Gladware™)—one per group
Naturalaire reusable furnace filter (cut to size), or styrofoam packing peanuts
Fleece (cut to size)
Miracle Gro™ cactus/succulent soil (well-draining)—1 or 2 cups per group
Sedum plant—4" pot—1 per group
Ruler or measuring tape
Digital scale
Sharp object for poking holes in bottom of container (such as a compass point)
Photo demonstration of construction in *Make a Green Roof Model PowerPoint.*

Procedure:

1. Study the diagram of the living roof at the Dearborn Truck Plant. Observe the four layers of the living roof, and read about the purpose of each layer.

2. Assemble materials as listed above.

3. Carefully use compass point to poke four or five small holes in the bottom of your deli container. This will allow water to drain out the bottom.

4. Cut out a piece of furnace filter to fit the bottom of the deli container. If using packing peanuts, arrange a 1" layer on the bottom of your container.

5. Cut out a piece of fleece to fit your container. Place it on top of the filter.

6. Pour approximately 1" of soil on top of the fleece. Remove the sedum plant from the pot and shake any loose soil off of the roots. Place the sedum on top of the soil and press gently down to secure the roots. Add additional soil if needed to cover the roots. (Leave some space at the top of the container for adding water later.)

7. Use the digital scale to find the **weight** of your completed model to the nearest **ounce**. Divide this measurement by 16 to find the weight in pounds. Round to the nearest tenth of a pound and record this value in the data table.

8. Calculating the surface **area** of your model:
   - If the top of your container is a circle, use your ruler to measure the diameter of the container to the nearest quarter of an inch. (Convert this answer to a decimal value; example 4 ¾ becomes 4.75) Divide this number by 2 to get the radius of the circle. Use the formula $A = \pi r$ to calculate the surface area of the container. Record this value in the data table.

- If the top of your container is a rectangle, use your ruler to measure the length and width of the top to the nearest quarter of an inch. (Convert this answer to a decimal value; example 4 ¾ becomes 4.75) Use the formula A= l x w to calculate the surface area of the container. Record this value in the data table.

9. Divide the weight of your model by the surface area to calculate the PSI (pounds per square inch) of your model. PSI is a standard system for comparing roof weight and pressure in the United States. Record this value in the data table.

10. Simulate a rain storm on your roof by watering the model with 1-2 cups of water (pour gently so as not to disrupt the soil.) Wait several minutes to give excess water a chance to drain off. Don't forget to hold your model over a sink or place a collection container beneath it to catch run-off!

11. Repeat steps 7-9 to calculate the PSI of your roof model after a rain storm. Record your values in the data table.

Lab Extensions:

- Measure the water before and after the "rain storm" to quantify the amount of water retained by the roof for the roots of the sedum.
- Create "polluted" water by adding silt or mud to the water before watering, and collecting the run-off to observe the filtering effect of the green roof.
- Collect data long term to gauge the water needs of the sedum, and the weight of the roof over time. Remember that sedum prefers full sunlight, so the containers should be placed near a classroom window with ample sunlight.

Data Table:

Roof Conditions	**Weight (lbs.)**	**Surface Area (inches)**	**PSI**
Dry			
Wet			

Post-Activity Discussion Questions:

1. How were the layers of your living roof model similar to the layers of the living roof at the Ford Rouge? _____

_____

_____

_____

_____

_____

2. How did the sedum work in the same manner as plants in a wetland? _____

_____

_____

_____

3. What changes would you like to make to your model? _____

_____

_____

4. How could the innovations at the Ford Rouge Complex be implemented at your home or school on a smaller scale?

_____

_____

_____

_____

_____

The world's largest green roof on the Dearborn Truck Plant

A Case for Change—Innovation at the Rouge Name: **Answer Key**

Part I—Changes at the Rouge

1. Innovations at the Rouge involve ways of better managing the **water, soil, daylight, and fresh air.**

2. The green living at the Rouge covers **10.4** acres.

3. What are the four layers of the living roof composed of? **The top layer of the green roof is composed of crushed shale, sand, peat, compost and dolomite. The next layer is made of an absorbent fleece. The third layer is a porous drainage layer, and the final layer is a plastic membrane that prevents water from leaking onto the roof.**

4. Besides the living roof, what are some other innovations at the Rouge for managing water? **Porous pavement, wetlands and swales**

5. How are scientists cleaning up the soil at the Rouge? **Phytoremediation is the process by which plants and trees are planted to clean up the soil with their root systems.**

6. Describe one way that daylight and air are being managed at the Rouge? **Examples: air replacement and cooling, large glass monitors (windows) and energy efficient glass.**

Part II—Interview with an Innovator

1. William McDonough: Clip #15 "The Rouge Plant" (length 5:48)

A. What was the guiding principal of the Rouge Plant redevelopment? **The guiding principle was to build a "quality workplace."**

B. How did William Clay Ford Jr. and William McDonough define the goal for quality soil? **The goal was for "children to be able to play in the dirt" and be safe.**

C. By installing features such as the living roof, porous pavement, wetlands and swales, how much money did Ford save over installing a traditional storm water treatment facility? **They saved somewhere between 17-35 million dollars.**

D. According to McDonough, this project required massive amounts of what four traits?

The traits this project required were hope, creativity, teamwork and leadership.

2. William McDonough: Clip #17 "The Living Roof" (length 3:51)

A. The living roof at the Ford Rouge is composed of what plant? **sedum**

B. List four of the benefits of the living roof at the Ford Rouge:

Four from the following: makes oxygen, creates habitat, accrues solar energy, absorbs particulates, cools the building in summer and warms it in winter, and shunts the wind load.

C. What surprised McDonough about the living roof project? **He was surprised that birds started nesting within 5 days, and by how light the roof was (only seven pounds per square foot).**

What role should citizens have in the restoration of an ecosystem?

Human Impact on Ecosystems
Culminating Projects

These projects are designed as opportunities for students to demonstrate their learning and their response to the overarching question for this unit, "What role should citizens have in the restoration of an ecosystem?" Consider introducing these projects at the beginning of the unit so that students can gather information along the way.

Choose the project option or options that best fit your class's needs:

Online Individual Project
Media Campaign

Select a topic from one of the unit's three lesson plans for further study. Use online resources to learn more about the issue, and develop a plan for a persuasive media campaign. Inspire your fellow students to make a change that leads to a positive impact on our environment. This campaign should include multiple, diverse products, such as a brochure, bumper sticker or billboard, newspaper article/editorial, podcast, and/or video PSA

Offline Individual Project
Survey

Design a survey to assess your fellow students' attitudes about the environment. Conduct your survey during academic downtime such as in the cafeteria at lunch or in the school foyer before or after school. If you would like to survey adults as well, another good forum for administering your survey would be at a school sports event or parent-teacher conferences. Survey questions should be written in either a "yes or no" or "strongly agree—agree—neutral/no opinion—disagree—strongly disagree" format. Sample survey questions:

- It should be illegal to build on a wetland of any size.
- Hunting and fishing should not be allowed in any wetland.
- The government should encourage consumers buying from environmentally-friendly businesses by offering rebates or tax incentives.
- Private property owners should have the right to do what they want with their land, including filling in a wetland.

Offline Group Project
Design a board game

Reuse an old game board to design a new, improved version of the game from an environmental standpoint. Games such as Candy Land or Monopoly, with a "path" to follow, and "draw-a-card" format are good choices to modify. Students should be encouraged to decorate the board, design new game-pieces, and rewrite the cards and instructions. Once each group is finished with their new board game, groups can trade and play each other's games.

Name:

Human Impact on Ecosystems
Review/Assessment Questions

1. What are some of the biotic and abiotic features of an ecosystem? _____

_____

_____

_____

_____

2. How does energy flow through an ecosystem's food chain/web?

_____

_____

_____

_____

_____

3. What are the beneficial functions of a wetland? _____

_____

_____

_____

_____

_____

4. What are the similarities and differences between a brownfield and a superfund site?

_____

_____

_____

_____

_____

5. What type of site is the Ford Rouge Factory, and how did it become contaminated?

_____

_____

_____

_____

_____

6. What environmental innovations were implemented at the Ford Rouge Complex to address contamination, wetland destruction and employee health? _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

7. How can the environmental innovations at the Ford Rouge Factory serve as a model for other businesses in the United States and abroad? _____

_____

_____

_____

_____

Name: Answer Key

Human Impact on Ecosystems
Review/Assessment Questions

1. What are some of the biotic and abiotic features of an ecosystem? **Biotic features of an ecosystem include all things that are or once were alive. Biotic organisms in a wetland ecosystem, for example, would include plankton, insects such as dragonflies, crayfish and small reptiles, nesting birds, mammals such as otters and muskrats, and plants such as cattails and reeds. Abiotic features are things that are not, nor have ever been, alive. This would include air, water, soil and sunlight.**

2. How does energy flow through an ecosystem food chain/web? **Energy enters an ecosystem food chain from the Sun. Plants, which are called producers, capture this energy from sunlight during photosynthesis, and use it to make glucose, which is a form of stored energy. Consumers eat the plants, and eventually get eaten by other consumers, which passes the stored energy up the chain. The final consumer, also called a top predator or apex consumer, eats prey that represents all of the energy of the chain or web below it.**

3. What are the beneficial functions of a wetland? **Wetlands positively affect water quality by filtering storm water runoff and replenishing groundwater. Wetlands also offer flood protection, shoreline erosion protection, wildlife habitat, plants and animals for human food and medicine, and recreation.**

4. What are the similarities and differences of a brownfield and a superfund site? **Brownfield and superfund sites are both industrial, commercial or agricultural sites that are contaminated from past or present use. A brownfield has a lower level of**

contamination than a superfund, and its cleanup is not regulated by the federal government like a superfund site.

5. What type of site is the Ford Rouge Factory, and how did it become contaminated? **The Ford Rouge Factory is a brownfield site. It mainly became contaminated from wastes from steel production (polyaromatic hydrocarbons).**

6. What environmental innovations were implemented at the Ford Rouge Factory to address contamination, wetland destruction and employee health? **To address contamination, Ford has planted native plants and an orchard. These plant and trees will break down harmful chemicals with their roots. The green roof on the Dearborn Truck Plant at the Ford Rouge also addresses contamination issues, since the sedum filters harmful pollutants from storm water runoff on the roof. Porous pavement on site also filters storm water, which reduces the risk of runoff polluting the Rouge River nearby. To replace the damaged ecosystem at the Rouge site, Ford has rebuilt wetlands and created swales to filter storm water and provide wildlife habitat. Animals such as insects, birds, frogs and small mammals can be seen living in this new habitat. To promote employee well-being, Ford has added more natural lighting and better ventilation and heat-exchange.**

7. How can the environmental innovations at the Ford Rouge Factory serve as a model for other businesses in the United States and abroad? **Ford serves as a role model by showing that environmental innovations, such as the green roof, can actually save a company money over traditional practices. Other companies will also emulate their practices if they can demonstrate that consumers are eager to buy vehicles that are more environmentally-friendly, even if the sticker price is slightly higher.**