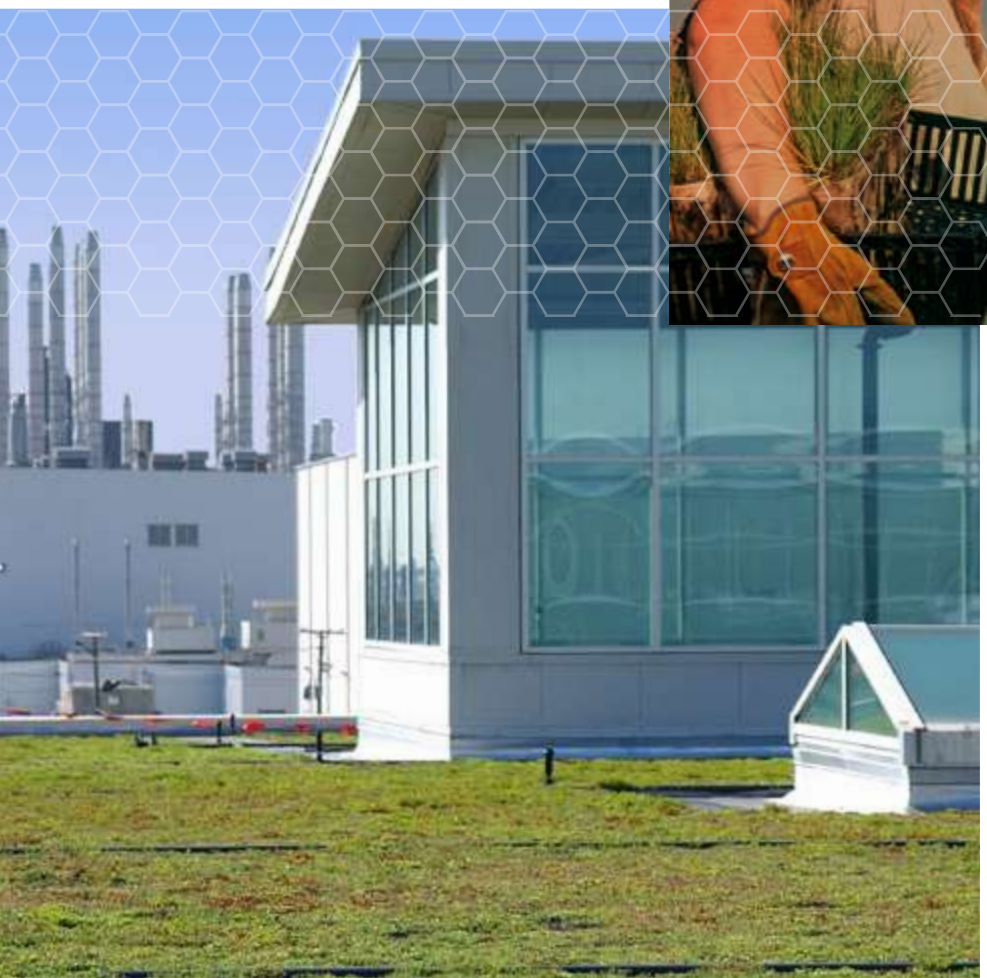
the Henry Ford®

Human Impact on Ecosystems

Ford Rouge Factory Tour



Science & Technology
Middle School Teacher Packet

Contents

All images are from the collections of The Henry Ford unless otherwise noted.
Funded, in part, with a USGBC 2009 Excellence in Green Building Education Incentive Grant.

Teacher Packet Overview

For nearly 100 years, the Ford Rouge Complex in Dearborn, Michigan has been an icon of American innovation. Now you and your students can view an industrial marvel through the lens of environmental innovation. In this unit, you and your students will use resources, documents and photographs from the Ford Rouge Factory Tour to explore the overarching question, **What role should citizens have in the restoration of an ecosystem?** Students will also make relevant connections between historical and modern-day stewardship of the environment and their own lives today.

This Teacher Packet is divided into two sections: a Teacher Guide and a Unit Plan. The Teacher Guide section includes resources to complement the Human Impact on Ecosystems Unit Plan. You will find a glossary, a timeline, context-setting activities, a bibliography, curriculum links and curriculum-supporting field trip suggestions. The Unit Plan section follows this Teacher Guide and includes lesson plans, student handouts, answer keys, culminating project ideas, extension activities and review and assessment questions. If you cannot fit the whole unit into your schedule, use the lessons or activities most relevant to your needs.

This Teacher Packet promotes educational use of the Ford Rouge Factory Tour at The Henry Ford. The tour features environmentally friendly practices in and around the Dearborn Truck Plant where Ford Motor Company manufactures the F-150 and other trucks. We hope you and your students will find these resources engaging and relevant.

These resources are made possible, in part, with funding from a United States Green Building Council (USGBC) Excellence in Green Building Education Incentive Grant for Pre-K-12.

Human Impact on Ecosystems | Teacher Guide

Glossary

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 that was used for industrial or commercial purposes and may be contaminated.

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 interrelated 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 covered with a layered mat and vegetation. A living roof benefits the surrounding environment and the building it covers.

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

Porous pavement – a type of surface for sidewalks, road or parking lots that allows water to pass through into the ground, rather than run off the top of the surface.

Producer – a type of surface for sidewalks, road or parking lots that allows water to pass through into the ground, rather than run off the top of the surface.

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 succulent groundcover plant that is resistant to drought.

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.

Timeline

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 2,000 acres of marshland along the Rouge River in Dearborn.

1917 Construction of the Rouge Plant begins.

1935 National Farm Chemurgic Council founded; 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 features a living roof.

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

Environmental Milestones in the USA

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

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 favor 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.

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 9/11 terrorists hijack planes, crashing them in New York, Pennsylvania and Washington, D.C.

Connections to Michigan, Common Core, and Other National Standards and Expectations

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 nonliving (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 and climatic change and 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.

Common Core State Standards

Literacy in Science and Technical Subjects

Grades 6-8

RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection and research.

WHST.6-8.10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes and audiences.

English Language Arts

Grade 6

RI.6.1 Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

RI.6.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative and technical meanings.

RI.6.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

RI.6.10 By the end of the year, read and comprehend literary nonfiction in the grades 6–8 text complexity band proficiently, with scaffolding as needed at the high end of the range.

W.6.4 Produce clear and coherent writing in which the development, organization and style are appropriate to task, purpose and audience.

W.6.7 Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.

W.6.8 Gather relevant information from multiple print and digital sources; assess the credibility of each source; quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.

W.6.9b Draw evidence from literary or informational texts to support analysis, reflection, and research.
b. Apply grade 6 reading standards to literary nonfiction (e.g., "Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not").

W.6.10 Write routinely over extended time frames (time for research, reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes and audiences.

SL.6.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups and teacher-led) with diverse partners on grade 6 topics, texts and issues, building on others' ideas and expressing their own clearly.

SL.6.2 Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text or issue under study.

SL.6.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning and well-chosen details; use appropriate eye contact, adequate volume and clear pronunciation.

SL.6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.

L.6.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 6 reading and content, choosing flexibly from a range of strategies.

L.6.6 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Grade 7

RI.7.1 Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

RI.7.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative and technical meanings; analyze the impact of a specific word choice on meaning and tone.

RI.7.10 By the end of the year, read and comprehend literary nonfiction in the grades 6–8 text complexity band proficiently, with scaffolding as needed at the high end of the range.

W.7.4 Produce clear and coherent writing in which the development, organization and style are appropriate to task, purpose and audience.

W.7.7 Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.

W.7.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

W.7.9b Draw evidence from literary or informational texts to support analysis, reflection, and research.
b. Apply grade 7 reading standards to literary nonfiction (e.g. "Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims").

W.7.10 Write routinely over extended time frames (time for research, reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes and audiences.

SL.7.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups and teacher-led) with diverse partners on grade 7 topics, texts and issues, building on others' ideas and expressing their own clearly.

SL.7.2 Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text or issue under study.

SL.7.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning and well-chosen details; use appropriate eye contact, adequate volume and clear pronunciation.

SL.7.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.

L.7.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 7 reading and content, choosing flexibly from a range of strategies.

L.7.6 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Grade 8

RI.8.1 Cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.

RI.8.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative and technical meanings; analyze the impact of specific word choices on meaning and tone, including analogies or allusions to other texts.

RI.8.10 By the end of the year, read and comprehend literary nonfiction at the high end of the grades 6–8 text complexity band independently and proficiently.

W.8.4 Produce clear and coherent writing in which the development, organization and style are appropriate to task, purpose and audience.

W.8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

W.8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

W.8.9b Draw evidence from literary or informational texts to support analysis, reflection, and research.
b. Apply grade 8 reading standards to literary nonfiction (e.g., "Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced").

W.8.10 Write routinely over extended time frames (time for research, reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes and audiences.

SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups and teacher-led) with diverse partners on grade 8 topics, texts and issues, building on others' ideas and expressing their own clearly.

SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning and well-chosen details; use appropriate eye contact, adequate volume and clear pronunciation.

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

L.8.4 Determine or clarify the meaning of unknown and multiple-meaning words or phrases based on grade 8 reading and content, choosing flexibly from a range of strategies.

L.8.6 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

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

Bibliography/Online Resources

Print (Easy Reader*):

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

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

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

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

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

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

Print (Young Teens):

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

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

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

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

Thompson, Julian F. *Gypsyworld*. New York: Henry Holt & Co., 1992.

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

Bibliography/Online Resources

Continued

Online Resources

– Refer to PDF of this document for live links. Available at http://www.thehenryford.org/education/erb/HumanImpactTeacherPacket.pdf.

– The 21st Century Ford Rouge Factory: Environmental Innovations at the Rouge http://www.thehenryford.org/rouge/eduResources/environment3.ppt.

– Human Impact on Ecosystems PowerPoint http://www.thehenryford.org/education/erb/HumanImpact.ppt.

Lesson 1: Parts of an Ecosystem

– Information about wetlands can be found online at the United States Environmental Protection Agency's website http://water.epa.gov/type/wetlands/types_index.cfm.

– A good resource about wetland protection under Section 404 of the Clean Water Act is the "Recognizing Wetlands" electronic brochure at http://www.nao.usace.army.mil/Missions/Regulatory/RecognizingWetlands.aspx.

– 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 cleanup sites in your community with EPA's Cleanups in My Community website tool at www.epa.gov/cimc.

– 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 is 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 is at http://www.greenroofs.com/projects/pview.php?id=12.

– Ford Motor Company's website Greener Miles, with information about environmental innovation, is at http://corporate.ford.com/our-company/sustainability.

– 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. Scroll to the middle of this page: http://www.earthday.org/ and select the Footprint tab to calculate your ecological effect on the planet. 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. is at http://www.sidwell.edu/about_sfs/envstewardship.aspx.

Field Trip Enhancements
at the Ford Rouge Factory Tour

Flexing for the Future
During this hands-on activity, students work together to discover the flexibility of the modern moving assembly line.

Test-Drive Smart Tools
Handle a "smart tool" that workers use on the factory floor and simulate steering wheel installation on a Ford F-150 pickup. Discover the connections between advanced tooling (process), skilled workers (people) and the end quality of the vehicle (product).

Environmental Scavenger Hunt Banners
Be an Eco-Detective. Find these banners as you make your way through the Ford Rouge Factory Tour. Learn Eco-facts and important moments in Eco-History, then determine the size of your Eco-Footprint!

Human Impact Self-Guided Itinerary
Explore the factory through the lens of how citizens, industry and government all play a role in ecosystem restoration.
http://www.thehenryford.org/education/erb/ItineraryHumanImpact.pdf

Human Impact on Ecosystems | Unit Plan

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 nonliving (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 that was used for industrial or commercial purposes and may be contaminated.
- 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

Total 7-8 class periods (45-50 minutes each)

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

Field Trip Enhancement

- Ford Rouge Factory Tour
- Local nature centers or wetlands
- Download and use the self-guided itineraries that have been developed to supplement this unit plan

Assessment

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

Materials

- Computer with access to Internet; digital projector and screen (preferred) or printed handouts of PowerPoint slides
- Sign: What role should citizens have in the restoration of an ecosystem?
- Student Activity Sheet 1: What Is a Wetland Worth?
- Answer Key 1
- Student Activity Sheet 2: Everybody's Mess
- Answer Key 2
- Student Activity Sheet 3: A Case for Change — Innovation at the Rouge
- Answer Key 3
- 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 http://www.thehenryford.org/education/erb/HumanImpact.ppt
- OnInnovation.com playlist "Human Impact on Ecosystems" http://oninnovation.com/topics/detail.aspx?playlist=2294
- Plastic tub, wallpaper trough or food storage containers (rectangular or round deli type)
- Drill
- Sedum—low-growing varieties; also called stonecrop (large demo requires six 3-inch 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

Lesson 1 | Parts of an Ecosystem

Overview

Main Ideas

– An ecosystem is a community of living (biotic) organisms and the nonliving (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

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

PowerPoint slide show "Human Impact on Ecosystems" http://www.thehenryford.org/education/erb/HumanImpact.ppt (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 Ford Rouge Factory Tour 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 1: What Is a Wetland Worth?
– Answer Key

Duration 2 class periods (45-50 minutes)

Instructional Sequence

ENGAGE

Picture book recommendations:
– *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 nonliving (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 (nonliving) 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 under way 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.

EXPLORE

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 two and four 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 1: What Is a Wetland 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 1, page 5. 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.

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 nonprofit agencies can all work together to make wetland protection and rehabilitation a priority.

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 http://www.nao.usace.army.mil/Missions/Regulatory/RecognizingWetlands.aspx.

What Is a Wetland Worth?

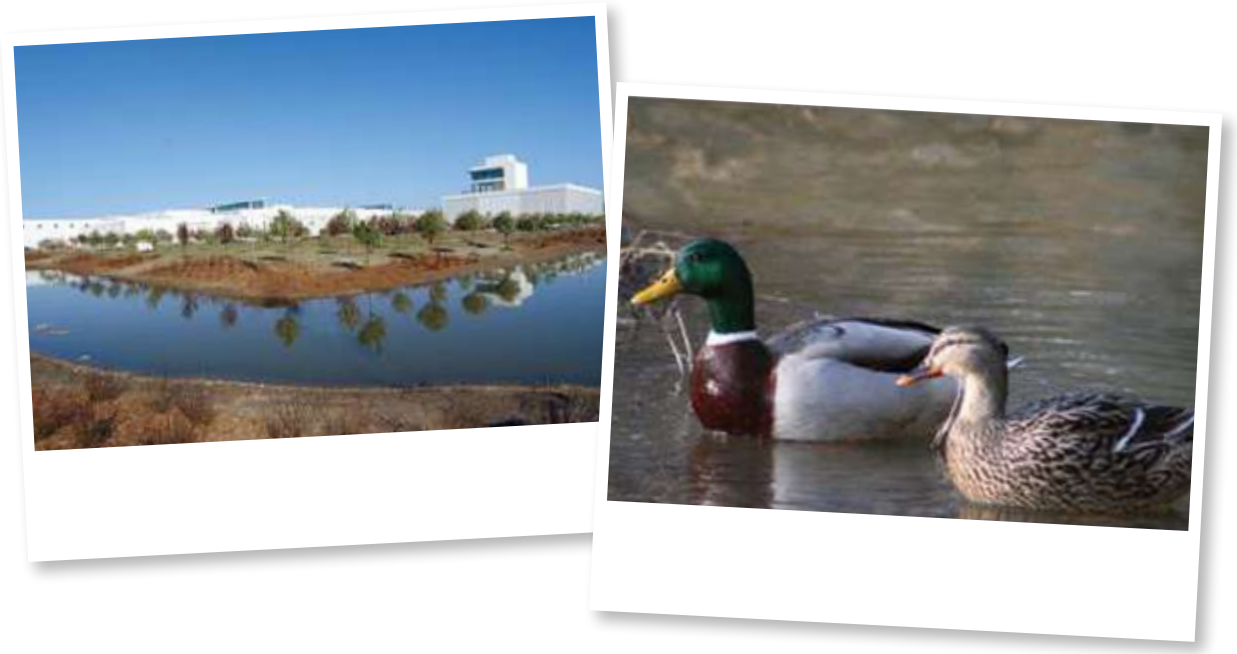
Name .....

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, saltwater 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 (www.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)?

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7. How do wetlands positively affect water quality? .....

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8. How do wetlands offer flood protection? .....

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9. How do wetlands protect shorelines from erosion? .....

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10. How do wetlands provide habitat for wildlife? .....

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11. What other benefits do wetlands offer? .....

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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
Oil company CEO	TV audience	Nightly news interview	Explaining how your company will protect coastal wetlands from effects of oil spill
Zookeeper	Zoo visitors	Podcast	Explaining types of animals in a new wetland exhibit
Actor/Environmentalist	Teenagers	Commercial	Explaining how young adults should help protect wetlands
Middle school student	Elementary students	Coloring/activity book	Explaining what wetlands are and how they are important
Environmentally aware singer	Radio listeners	Song	Explaining the importance of wetlands to our society
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—Use Internet sources to define the following terms. Work together as a team to find and record these definitions.

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 interrelated 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—Use Internet resources to find the best answers to the following questions. Information found online at the United States Environmental Protection Agency's website (www.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? 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: (other combinations are possible)

Water Lily (Producer) → Snail (Primary (1st) Consumer) → Crayfish (Secondary (2nd) Consumer) → Bullfrog (Tertiary (3rd) Consumer) → Northern Water Snake (Quaternary (4th) Consumer) → Bald Eagle (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 shorelines 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 cycles. 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 and plants). Wetlands also offer recreational opportunities such as hunting, fishing and nature photography.

Human Impact on Ecosystems | Lesson 2

Lesson 2 | Damage to Ecosystems

Overview

Main Ideas

– A brownfield site is a parcel of land that was used for industrial or commercial purposes and may be contaminated.
– 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
Remediation
Superfund Site

PowerPoint slide show "Human Impact on Ecosystems" http://www.thehenryford.org/education/erb/HumanImpact.ppt (the PP numbers below correspond to the slide numbers on the "Human Impact" PowerPoint)

Lesson 2 | Damage to Ecosystems
– Aerial view of Ford Motor Company Rouge Plant c. 1930; ID# THF23881 PP6
– Aerial view of Ford Motor Company 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 from PowerPoint
– Sign: What role should citizens have in the restoration of an ecosystem?
– Student Activity Sheet 2: Everybody's Mess
– Answer Key 2

Duration 2 class periods (45-50 minutes)

Instructional Sequence

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 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 byproduct 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 40 to 50 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.

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 2: 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 cleanup, 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 slide show 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 that 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 cleanup of contaminated sites?
The cleanup of brownfield sites is mostly regulated by state environmental agencies. The U.S. Environmental Protection Agency (EPA) can provide technical assistance or tax incentives for the cleanup costs. Superfund site cleanup 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 cleanup, which is paid by a government trust fund.

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

– How can citizens get involved in cleanup efforts?
Citizens can make a big difference in cleanup 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.

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, cleanup of polluted sites is in everyone's best interest.

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.

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.

Everybody's Mess

Name .....

Background Information: 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 an extensive impact that cleanup 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://www.epa.gov/cimc.

2. Under Step 1, choose to search by county. Then enter your county and state under Step 2. Click on "map it" and after a moment a map will appear.

3. On the map, you will probably see dots of different colors that represent contaminated sites. If you click on a dot, the name of the site appears in a pop-up box. If you go back to the "Cleanups in My Community" page and click "List it" instead of "Map it", you can see a list of all the contaminated sites in your county

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 triangles) 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 red triangle, a pop-up box will appear with the site name. Click on "Superfund NPL" and a progress profile will appear. In the gray 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	
Cleanup progress	
Future cleanup	
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 PowerPoint 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

1. Use the EPA's "Cleanups in My Community" website tool at http://www.epa.gov/cimc.

2. Under Step 1, choose to search by county. Then enter your county and state under Step 2. Click on "map it" and after a moment a map will appear.

3. On the map, you will probably see dots of different colors that represent contaminated sites. If you click on a dot, the name of the site appears in a pop-up box. If you go back to the "Cleanups in My Community" page and click "List it" instead of "Map it", you can see a list of all the contaminated sites in your county

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? Answers will vary

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

7. How many Superfund sites (red triangles) are located in your county? Answers will vary

8. Give the name and address of a Superfund site in your county: Answers will vary

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 gray 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: Example

Category	My Site
Name of company (past and present)	XYZ Landfill, Inc.
Address	123 W. Outer Beltway Anytown, MI 12435
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 contaminated area	Landfill = 37.6 acres Study area = 800 acres
Cleanup progress	Landfill was capped and fenced; gas vents installed; township installed additional municipal wells; air stripper is running to treat contaminated water
Future cleanup	Cleanup ongoing
Contact person and phone number	Bill Smith, Remedial Project Manager U.S. EPA (312) 555-1000

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

12. 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

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	Porous pavement
Living roof	Responsible manufacturing
LEED certification	Sedum
Orchard	Swale

PowerPoint slide show "Human Impact on Ecosystems" http://www.thehenryford.org/rouge/eduResources/environment3.ppt (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 Ford Rouge Factory Tour 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 3: A Case for Change—Innovation at the Rouge
- 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 http://www.thehenryford.org/education/erb/HumanImpact.ppt.
- OnInnovation.com playlist: Human Impact on Ecosystems http://oninnovation.com/topics/detail.aspx?playlist=2294
- Plastic tub, wallpaper trough or food storage containers (rectangular or round deli type)
- Drill
- Sedum—low-growing varieties; also called stonecrop (large demo requires six 3-inch 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

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 of students from each response group to share their viewpoint 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.

EXPLORE

In this activity, students will be learning more about the innovative changes that were made to the Ford Rouge Factory. Students will watch a PowerPoint 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 3: 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** on the Student Activity Sheet.

– After the students have finished the slide show questions, show them the OnInnovation.com playlist Human Impact on Ecosystems http://oninnovation.com/topics/detail.aspx?playlist=2294. 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 setup.

– Several days ahead of time, start purchasing/accumulating the supplies needed for this activity (see Student Activity Sheet 3 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.

– 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 on 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

EXPLAIN

Environmental innovations like those implemented at the Ford Rouge Factory are creating a resource for other corporations that 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.

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., at http://www.sidwell.edu/about_sfs/envstewardship.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. Scroll to the middle of this page: http://www.earthday.org/ and select the Footprint tab. 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.

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., has begun to rectify the problem by implementing innovative changes at the Ford Rouge Factory not only to 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 slide show "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.

3. What are the four layers of green roof composed of? .....

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

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5. How are scientists cleaning up the soil at the Rouge? .....

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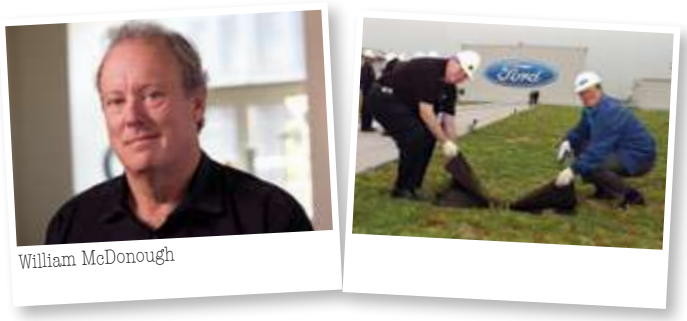
6. Describe one way that daylight and air are being managed at the Rouge. .....

.....



Part II—Interview with an Innovator

OnInnovation.com playlist Human Impact on Ecosystems http://oninnovation.com/topics/detail.aspx?playlist=2294

1. William McDonough: "The Rouge Plant and Ford Motor Company" (length 5:48)

A. What was the guiding principle of the Rouge Plant redevelopment? .....

.....

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

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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?

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

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2. William McDonough: "The Green 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:

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....

C. What surprised McDonough about the living roof project at the Ford Rouge? .....

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Part III—Building a Living Roof Model

Materials (small-group setup):

- 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—3" pot—1 per group
- Ruler or measuring tape
- Digital scale
- Sharp object for poking holes in bottom of container (such as a compass point)
  (Note: A photo demonstration of how to build this model can be found at http://www.thehenryford.org/education/erb/MakeaGreenRoofModel.ppt)

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 4¾ becomes 4.75.) Divide this number by 2 to get the radius of the circle. Use the formula $A = \pi r^2$ 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 4¾ 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 rainstorm 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 runoff!

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

Data Table:

Roof Conditions	Weight (lbs.)	Surface Area (sq.in.)	PSI
Dry			
Wet			

Lab Extensions:
– Measure the water before and after the "rainstorm" 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 runoff 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.

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? .....

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

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

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

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A Case for Change—Innovation at the Rouge

Name **Answer Key**

Part I—Changes at the Rouge—Watch the PowerPoint slide show "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 water, soil, daylight and fresh air.

2. The green roof at the Rouge covers 10.4 acres.

3. What are the four layers of green 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 green 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

OnInnovation.com playlist "Human Impact on Ecosystems" http://oninnovation.com/topics/detail.aspx?playlist=2294

1. William McDonough: "The Rouge Plant and Ford Motor Company" (length 5:48)

A. What was the guiding principle 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 Motor Company 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?

hope | creativity

teamwork | leadership

2. William McDonough: "The Green 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 building in summer and warms in winter | shunts the wind load

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

Human Impact on Ecosystems | Supplemental Resources

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

Human Impact on Ecosystems | Culminating Project Ideas

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.

Off-Line 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.

Off-Line 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 its new board game, groups can trade and play each other's games.

Human Impact on Ecosystems

Name .....

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

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

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

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

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

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

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

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Human Impact on Ecosystems

Name **Answer Key**

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's 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 between 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 Complex to address contamination, wetland destruction and employee health?

To address contamination, Ford has planted native plants and an orchard. These plants 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.

Credits

The Henry Ford sincerely thanks the following individuals who contributed to the development of the environmental science Teacher Packets for the Ford Rouge Factory Tour.

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Project Direction: Concept, Strategic Focus, Final Review of Edits of Content and Unit Organization

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Project Director, USGBC Excellence in Green Building Education Grant

For nearly 100 years, the Ford Rouge Complex has been an icon of American innovation. Now you and your students can view an industrial marvel through the lens of environmental innovation. This unit uses resources, documents and photographs from The Henry Ford's Ford Rouge Factory Tour experience in Dearborn, Michigan to explore the overarching question, What role should citizens have in the restoration of an ecosystem? Meets National Standards for Science Education. Grades 6-8.

EXPLORE THESE OTHER 21ST-CENTURY TEACHING AND LEARNING TOOLS FROM THE HENRY FORD!

DOWNLOADABLE RESOURCES

Transportation in America

www.thehenryford.org/education/TransportationInAmerica.aspx

- Henry Ford and the Model T
(Social Studies, Grades 3-5)

- Impact of the Model T — Then and Now
(Social Studies, Grades 9-12)

- Early 20th-Century Migration
(Social Studies, Grades 3-5)

- Transportation Systems
(Social Studies, Grades 8-12)

- Moving to Michigan: Immigration, Migration and Transportation
(Social Studies, Grades 9-12)

America's Industrial Revolution

www.thehenryford.org/education/americasIndustrialRev.aspx

- Over 150 lesson plans created by the teachers for the teachers on various angles of America's Industrial Revolution
(Science, Social Studies and Language Arts, Grades K-12)
Not for purchase; free online version only!

Science and Technology

www.thehenryford.org/education/scienceTechnology.aspx

- Science, Life Skills and Innovations in American Automobile Racing (Science, Grades 3-8)

- Physics, Technology and Engineering in Auto Racing
(Science, Technology, Engineering and Math {STEM}, Grades 9-12)

- Life Requirements
(Science, Grades 2-5)

- Human Impact on Ecosystems
(Science, Grades 6-8)

- Sustainability: Environmental Management and Responsible Manufacturing
(Science, Grades 9-12)

American Democracy and Civil Rights

www.thehenryford.org/education/AmericanDemo.aspx

- Lincoln's Legacy of Leadership
(Social Studies, Grades 9-12)

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ISBN 978-0-911720-03-5