PRAIRIE 101

HAVE A BALL!

A Hands-on Conservation/A Restoration Activity

GRADE LEVEL
6-8

SUBJECT AREAS
Science

DURATION
1 day in the field and 50 minutes in class for full lesson. 30 minutes to simply create and discuss seed balls.

SETTING
Outdoors

CORRELATIONS
See page 52

LESSON DONATED BY
Katy Prairie Conservancy

Introduction

The coastal prairie of Texas and Louisiana is one of the most imperiled ecosystems in the United States. Prairie conservationists are racing to save as many remnant (virgin) coastal prairie sites as they can. This is often a difficult task because of the price of land and because there are relatively few remnants remaining. It is for this reason that prairie conservationists are increasingly turning to prairie restoration to achieve their goals. Prairie restoration is the practice of turning a degraded patch of prairie habitat into a habitat with greater plant and animal diversity through:

- Seeding or planting native grasses and wildflowers
- Better grazing practices
- Reintroduction of fire

Although these prairie restorations often occur in rural places on big pieces of property, prairie restorations are also taking place at local schools, parks, corporate headquarters, and even on hospital campuses!

Prairie restoration often begins with bringing back the prairie plants that have disappeared from a site over time. Oftentimes seeds are sown on freshly prepared planting beds and/or potted plants established. One other method, which is often used in conjunction with seeding and planting, is making and distributing seed balls in a prairie restoration area.

* History of Seed Balls – Masanobu Fukuoka, who was a Japanese natural farming pioneer, rediscovered the technique for creating seed balls, which had been used in ancient Egypt to repair farms after the annual spring flooding of the Nile. During the period of the Second World War, Fukuoka, a government plant scientist, who lived on the mountainous island of Shikoku, worked in a government lab to find a technique that would increase food production without taking away from the land already allocated for traditional rice production which thrived in the rich volcanic soils of Japan. The seed balls could be used in mountainous or rocky areas, where normal farming methods would be difficult.
Wikipedia.com

Seed Ball Procedures

Seed balls are made by combining red clay, compost, rich topsoil, or other rich organic matter, and seeds with enough water to make a thick doughy mixture. Form marble size balls and allow the balls to dry. Dry balls are placed on the top of the soil. (The seed balls are not buried.) Seed balls need to be about one foot apart. Slowly the balls will begin to disintegrate as rains bring good growing conditions and the seeds will sprout and put their roots into the ground. The organic matter provides a good start for the seeds.

NOTES

Grade Levels: 6-12th (Biology and Environmental Systems)

Objectives (Note: TEKS in resource section at the end of the lesson)

Students will:

1. Examine maps and descriptions of the ecoregions of Texas.
2. Use the library or Internet to research and describe how ecoregions have changed in the last 100 years.
3. Visit a prairie and use a sampling method to learn about the organisms in a prairie habitat
4. Safely take part in field research on organisms in a prairie ecosystem
5. Use tools including journals, cameras, field guides, a dichotomous key, computers, collecting nets, insect containers, magnifiers, and terrariums and other tool as available and as needed.
6. Collect data and make observations about how humans have affected the prairie ecosystem
7. Record and organize data in tables.
8. Analyze and interpret patterns in data
9. Describe biotic and abiotic parts of an ecosystem in which organisms interact
10. Describe and draw or photograph organisms
11. Observe patterns of structures and functions of prairie organisms
12. Diagram levels of organization including organisms, populations, communities, and ecosystem
13. Construct and communicate, explanations and conclusions supported by data
14. Describe how biodiversity contributes to sustainability of ecosystems
15. Identify parts of a prairie food chain and construct a model of a food chain, food web, or food pyramid
16. Compare food chains on the prairie with food chains that are found on the school grounds
17. Identify autotrophic and heterotrophic organisms
18. Analyze and record example of interactions in an ecosystem (predator/prey, parasite/host, producer/consumer, etc.
19. Describe how organisms depend on and compete for resources in an ecosystem
20. Create seed balls for ecological restoration and place them in areas on the school grounds or nearby park, or other area where students can collect data
21. Describe how short and long term environmental changes affect organisms
22. Meet a scientist and discuss what he/she does on the job and how education helped prepare for the job

Materials:

Note: The Katy Prairie Conservancy has a website that has many resources for teachers including videos, posters, and lessons. Go to: www.katyprairie.org

ENGAGE

Prairies

- Student Activity Page 1
- Journals
- Pencils
- Texas Road map for each group (available from the Texas Department of

Transportation
- Ecosystem maps and information websites:

Websites

1. Website with Ecosystem Map with Counties Identified https://tpwd.texas.gov/publications/pwdpubs/media/pwd_mp_e0100_1070ac_34.pdf

2. Website with Ecoregions Map with Photos, Text, and Videos
   https://tpwd.texas.gov/education/hunter-education/online-course/wildlife-conservation/texas-ecoregions

3. Website for the Bureau of Economic Geology Education Store

Store provides page size maps for various types of regions in the state for only 35 cents each including ecoregions, vegetative regions, geological regions, soil regions, natural resource regions and more
http://begstore.beg.utexas.edu/store/30-state-maps?id_category=30&=50

4. Website for the Texas Conservation Action Plan – For advanced students

http://tpwd.texas.gov/landwater/land/tcap/

EXPLORE
Visit a Prairie

- Clip Boards
- Pencils
- Hula Hoops (or string and stakes)
- Measuring tape
- Cameras or Phones
- Magnifiers
- Butterfly nets
- Insect keepers or small plastic aquariums
- Field Guides and dichotomous key and/or computer access

Student Activity Page 2
- 6-10 strips of construction paper strips cut 6.5" X 1.5 " for each student
- Tape for each group
- Pencils or Markers

Website with List of Land Conservancy Preserves in counties in Texas
   http://www.texaslandconservancy.orgStudent Journals

Website with method for finding biodiversity of an area
http://www.amnh.org/learn/biodiversity_counts/

Explain
Human Effects on Nature

Student Journals
- Chart Paper
- Pencils and Markers
- Copy Paper
- Student Activity Page 3
- Teacher Overhead Page

The following websites:
1. Website for poster of the plastic gyre in the Pacific Ocean:

http://www.nationalgeographic.org/encyclopedia/great-pacific-garbage-patch/

2. Website on old growth forest including photos:
http://www.futuredirections.org.au/publication/role-old-growth-forests-carbon-sequestration/
3. Website for Greenpeace photo of logged forest:
http://www.greenpeace.org/international/en/multimedia/photos/panoramic-shot-of-logged-ancie/
4. Website for native prairie habitat and photos:
https://www.fws.gov/refuge/Attwater_Prairie_Chicken/Habitat.html
5. Website on desertification of grasslands over a 100-year period:
http://climatechange.lta.org/manage-grasslands/
6. Website about overgrazed pasture:
http://www.ext.colostate.edu/sam/pasture.html

E**LABORATE**
Seed Balls and Prairie Restoration

Seed balls video from Katy Prairie website at: www.katyprairie.org

For the class:
- Red potter's clay
- Water
- Native prairie seeds (make sure to only use seeds native to your city or region)
- Compost, topsoil, or potting soil
- Large spoons for mixing
- Large mixing bowls
- Newspaper
- Photos of grasses, wildflower and/or other native prairie species you will be using in the seed mix
- Large aluminum pans (such as turkey roasting pans)
- A place on the school grounds or a nearby park, business, or natural area in which to place the seed balls. The school grounds provide the most convenient area for follow-up observations.
- Rulers
- Pencils
- Journals

EVALUATE
Effects of Human Activities

- Rubric for Presentations
- Computers
- Library
- Rubric for Presentations
- Art supplies
- Materials for costumes or puppets
- Other materials for presentations as needed

Vocabulary
- Prairie – a large, mostly flat area of land or plain in North America that has few trees and is covered in grasses (a vegetative region)
- Savanna – (savannah–spellings vary) grassland region with scattered trees, grading into either open plain or woodland (a vegetative region
- Plain – a large expanse of fairly flat land, usually with few trees (a landform)
- Plateau – an area of relatively level high ground; upland, tableland, plain, mesa (a landform)
- Ecological Restoration – The process of bringing a portion of nature back to a higher functioning state for wildlife and/or humans. This process typically takes place on sites, which still retain some native vegetation.

- Ecological Reconstruction – When a portion of nature is brought back from a sterile or mostly degraded state. The difference between restoration and reconstruction is analogous to remodeling a home (restoration) and building a new home (reconstruction).
- Habitat – the place or environment where a plant or animal naturally or normally lives and grow
- Habitat Degradation – The act of decreasing the amount of appropriate wildlife habitat through reducing the number of indigenous plants, changing the structure of a habitat, or decreasing the biodiversity
- Habitat Loss – Reduction in the quality of natural conditions of the environment, which is degraded or destroyed through fragmentation, pollution, overuse, or natural events
- Germination – the development of a plant from a seed or spore after a period of dormancy
- Ecoregion – a region of a state or other geographic area that has a specific ecology

ENGAGE

Prairies of Texas: Introduction to Ecoregions

Materials:
- Student Journals
- Pencils
- Computer access
- Texas road map for each group (available through the Texas Department of Transportation)

Student Activity Page 1

Ecosystem maps and information websites:

1. Website Ecosystem Map with Counties Identified
http://tpwd.texas.gov/publications/pwdpubs/media/pwd_mp_e0100_1070ac_34.pdf

1. Website with Ecoregions Map with Photos, Text, and Videos
https://tpwd.texas.gov/education/hunter-education/online-course/wildlife-conservation/texas-ecoregions

1. Website for the Bureau of Economic Geology Education Store
Sells page size (8" X 10") maps for various types of regions in the state for only 35 cents including each of the following: ecoregions, vegetative regions, geological regions, soil regions, natural resource regions and more
Maps are useful for comparing geological and soil maps or vegetation and soil, or ecoregions and vegetative regions for more advanced students.
http://begstore.beg.utexas.edu/store/30-state-maps?id_category=30&=50

Time Considerations
2 periods of 50 minutes if research is done in class

Intro to Ecoregions
In Texas we have many types of ecoregions. Many of these were once prairies. However, one of the most endangered ecosystems is the prairie.
Look at the Gould Ecoregion Map on the Texas Parks and Wildlife Department (website 1 in materials list). Look at the names of the different ecoregions. (Names vary with different sources. Below is a list of common Texas Ecoregion names.)

- The Blackland Prairie
- The Cross Timbers and Prairies
- The Edwards Plateau
- The Gulf Coast Prairies and Marshes
- The High Plains
- The Piney Woods
- The Post Oak Savannah
- The Rolling Plains

- The South Texas Plains
- The Trans Pecos

This Gould map has the counties on it. Ask students to find their county and the ecoregion in which they live.
Are they living in a prairie ecoregion? What are the characteristics of their region?
(In some areas there may still be some remnant prairies. Other areas may be completely urban or covered in crops of various farms.)

Discuss the words that name the ecoregions:
- What do you think these words in the names of the ecoregions mean?

If students don't have a clear understanding of the words and the relationship between the words explain that the words, prairie, plain, savannah, and plateau,, all refer to a flat, open area with mostly grasses and a few other plants and some times a few trees or brush. Plateau and Plains are names of geologic features and prairie and savanna are vegetative features
Discuss the idea that many of the Texas ecoregions are prairies. They are a part of the Great Plains that go up into Canada. Because of their rich soils, these prairie lands became the "breadbasket" of our country and the world with wheat, corn, oats, barley, and other crops feeding our citizens and exported to other places.
- What did the planting of crops for food or (in Texas, sometimes cotton for clothes) mean for the native prairie ecosystems? (The prairies were plowed and disrupted and changed from very diverse ecosystems to monoculture crops.)

Researching Ecoregions of Texas

Website 2.
https://tpwd.texas.gov/education/hunter-education/online-course/wildlife-conservation/texas-ecoregions

The website above has a map of Texas Ecoregions videos, and brief text information, on most of the ecoregions. If you don't have a video in your information, look at Keep Texas Wild on www.youtube.com. Videos on ecoregions are available there.

Note: the Rolling Plains and High Plains are together in one video. The Cross Timbers and Prairies Ecoregion is mentioned in the Blackland Prairie video, which is on youtube from Keep Texas Wild.

Give students the Student Activity Page 1.
- Have students work in groups of 2–4.
- Assign each group to learn about one of the ecoregions in the state.
- Ask each group to present their information to the class.
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The information should include:
1. Name of the Ecoregion
2. Ecosystems in the region.
3. Climate–rainfall, temperatures and humidity
4. Soil characteristics
5. Elevation and/or landforms
6. Industries/economic support
7. Natural heritage (Special natural resources)
8. Conservation efforts mentioned
9. How has this ecoregion changed in the last 100 years?
10. Use the Texas road map to find the largest city in your assigned ecoregion. Note: The map has a city index with populations)

(San Antonio-Blackland Prairie; Ft. Worth–Cross Timbers and Prairies; Austin– Edwards Plateau; Houston–Gulf Coast Prairies and Marshes; Lubbock–High Plains; Beaumont–Piney Woods; Bryan/College Station–Post Oak Savannah; Rolling Plains–Abilene; Edinburg/McAllen–South Texas Plains; El Paso–The Trans Pecos.)

11. What were the effects of urban growth on the ecoregion?
12. What city is located where 3 ecoregions meet? (Austin)

For More Advanced Students

Website 3

http://begstore.beg.utexas.edu/store/30-state-maps?id_category=30&=50
If the teacher wishes to go more in depth, the Bureau of Economic Geology has a variety of inexpensive maps, on various topics such as Ecoregions, Vegetative Regions, Geological Regions, Soil Regions, Natural Resource Regions, etc. These maps provide an opportunity for students to look at the relationships between geology and soils, or soils and vegetation, or vegetation and ecoregions, etc.

These maps also include detailed information on the back of each map. Maps are only 35 cents each. They are regular 8" X 10" page size, in beautiful colors, and can be laminated for use over and over. You can purchase them from the Bureau of Economic Geology website at: http://www.begstore.beg.utexas.edu/

Note: In Environmental Systems classes, teachers and students may wish to look at the Texas Conservation Action Plan developed by Texas Parks and Wildlife Department to learn about a pro-active ecosystem approach to conservation.

http://tpwd.texas.gov/landwater/land/tcap/

* "The Texas Conservation Action Plan's (TCAP) purpose is to provide a statewide 'roadmap' for research, restoration, management, and recovery projects addressing Species of Greatest Conservation Need (SGCN) and important habitats. SGCN include terrestrial, freshwater, and marine birds, mammals, reptiles, amphibians, invertebrates, fishes, plants and plant communities. The goal of the plan is ultimately to conserve and improve the status of these species and, as possible, prevent listings under the Endangered Species Act. The Conservation Action Plan has elements for anyone interested in conservation in Texas.

The links below provide background information on plan purpose, revision development, and contents.
- TCAP Handbooks
- Species of Greatest Conservation Need
- Support Documents and Links"

EXPLORE
Visit a Prairie Preserve

- Materials
- Student Journals
- Clip Boards could be stiff box cardboard with a big clamp
- Pencils
- Hula Hoops (or string and stakes)
- Measuring tape
- Cameras
- Magnifiers
- Butterfly nets
- Insect keepers or small plastic aquariums
- Field Guides, Dichotomous key for Insects and/or grasses or wildflowers,
- Computer access

Student Activity Page 2

Website with List of Land Conservancy Preserves–may help you to find a preserve near you
http://www.texaslandconservancy.org

Katy Prairie Preserve is in the Coastal Plains near Houston.

For Food Chains
6.5 X 1.5 inch strips of construction paper (enough for each person to have between 6 and 10 strips
Tape for each group
Pencils and/or markers for drawing

For Food Pyramids
Large pieces of Manila paper
Pencils and/or markers

Time Considerations
1 day in the field and 50 minutes in class

Preparation for Field Trip
Discuss safety, the reason for the field trip (to look at a native prairie ecosystem and to do a population study of a prairie), and your behavioral expectations. Have students take their journals and pencils to write descriptions and make drawings. If you have cameras, ask students to take photos of plants and animals found in the area. Students may take samples of leaves or insects. Students may use collecting nets for insects.

Walk with a Scientist
Have students take a walk with a scientist from the prairie preserve to get an overview of the ecosystem. Students should take notes and ask questions about the prairie ecosystem as they walk.

Ask the scientist to tell about what she/he does in their work and about their education.
Have students ask questions about the work the scientist does. Such as:
- Why did he/she choose that career?
- How did she/he prepare for the position?
- What are some of the benefits and drawbacks of the career?
- What is a typical day like on the job?

Ask the scientist how the population study the students will do today relates to what they do on their job.

Prairie Population Study
Make a grid (meter squares marked off with string and stakes or you can use hula hoops, if they are available) and assign 2-3 students to work each section in the grid taking photos or drawing pictures of as many organisms as possible in a set period of time (15-20 minutes).

Students should make a table with information on the types of plants and animals they find and numbers of each type of organism found in their grid. Use hash marks to record numbers of individuals of each type of organism.

From their data, students should be able to tell the group the total number of different types of organisms that each pair found in their section of the grid, and the total number of each type of organism.

Then have students use field guides, and a dichotomous key to identify organisms and us the Internet and field guides to learn about at least 2 organisms for each student (1 plant and 1 animal). As students finish their research have them meet in a group to share what they have learned.

Give students a copy of Student Activity Page 2.
Each person should describe 2 organisms (1 plant and 1 animal) that they chose from their grid and provide the following information:

FIELD DATA
1. The location where the organisms were found (on a flower, on the ground, in the air, etc.)
2. Characteristics of soil where plants are growing. (Color, texture, moisture i.e. wet, damp, dry)
3. The role of the organism in the ecosystem (niche)
4. Any special adaptations the organism has and how the adaptation helps it meet its needs and survive
5. What other types of organisms were located in the same grid section? (Microhabitat) Do these organisms interact? If so, how? (Predator/Prey, Producer/Consumer, Autotroph/Heterotroph, Parasite/Host, etc.)

Using a Field Guide and Dichotomous Key
- Identify your organisms with both the scientific and common names found in a dichotomous key or field guide
- Write a description in your journal to add to your own observations of the two organisms you observed in the field. (one plant and one animal)

- Describe important characteristics noted in the field guide and any interesting facts that you learn about your organisms

Consolidating Data
(This can be done in the classroom if there is not time at the prairie preserve facility.)

Create a class table on the board. Have students post their counts of various organisms. Add up the total number of different species and the total number of each species for the class.
- Are there many or few kinds of organisms in the prairie habitat?
- Are there many of each kind of organism? Or are some organisms few in number?
- What is biodiversity?

There is a simple formula for figuring biodiversity with a simple explanation at the American Museum of Natural History website. See formula below.

How to Calculate a Biodiversity Index*
"The question of how many different species exist in a particular environment is central to the understanding of why it is important to promote and preserve species diversity.

A uniform population of a single species of plants adapted to a particular environment is more at risk if environmental changes occur. A more diverse population consisting of many species of plants has a better chance of including individuals that might be able to adapt to changes in the environment.

Scientists use a formula called the biodiversity index to describe the amount of species diversity in a given area. A simple biodiversity index is calculated as follows:

the number of species in the area (numerator)
–
the total number of individuals in the area (denominator) = biodiversity index

For example, a 4 X 4 meter square area in a carrot patch has 300 carrot plants, all the same species. It has a very low biodiversity index of 1/300, or 0.003.

A 4 X 4 meter square area in the forest has 1 pine tree, 1 fern, 1 spruce tree, 1 moss, and 1 lichen, for a total of 5 different species and 5 individuals. The biodiversity index here is high, 5/5 = 1. "
*American Museum of Natural History

For More Advanced Students
You may want to have advanced students use the Simpson Diversity Index or the Shannon-Weiner Diversity Index. Formulas can be found online.

Figuring Biodiversity
Put four groups together to look at data for a 4 X 4 square meter sample in your prairie plots.
Use the formula above to figure the biodiversity of the prairie using the student data.

- Based on your data, is the prairie a diverse ecosystem?
- How does diversity increase sustainability of the ecosystem?
- Have students discuss with their small group what factors they think could affect the survival of a prairie ecosystem.
- What factors do you think might have made it possible for this prairie habitat to survive? (Soil richness, diverse plant life to support diverse animal life, human intervention in discouraging development by people, etc.)
- What factors influence the diversity in the prairie? (No use of areas for roads, buildings, or farms, planting to increase plant diversity, which brings more kinds of animals into the prairie, etc.)
- How would the ecosystem change if the diversity changed and was less diverse or more diverse?

Diagram the levels of organization in the prairie ecosystem including individual organisms, populations, communities, and ecosystem.
- What would happen to the ecosystem if something caused a key species such

as a major grass to disappear from the ecosystem?

Making a Model of a Food Chain, Food Web, or Food Pyramid
Ask students to look at the class data and see how the organisms in their field investigation might interact in a food chain.

Give each student 6-10 strips of paper about 6.5 inches long and about 1.5 inches wide. Each group should have pencils or markers, and tape.

On each strip students will write the name and/or draw a picture of a member of a food chain from the prairie data. Students use the tape to make a link by taping the ends of the strip together. The next link is threaded through the first and taped closed and continue on through the food chain. There should be at least 6 links in the individual's chain each with a name or a drawing.

Allow students to decide what they wish to have in the food chain.
(Every food chain should include the initial form of energy, light from the Sun, producers, 2-3 levels of consumers, and decomposers.)

Allow students to share their food chain ideas in small groups.

- How are autotrophs and heterotrophs represented in your food chain?

When all food chains are complete, each small group should join their food chains together to make a larger food chain. Students can release links and re-tape them in order to combine their food chains.
Example: One student has a leaf in his chain connected to a beetle, and another has a grasshopper connected to grass. These chains can be connected by connecting the grasshopper to both the grass and the leaf, making a 2 pronged food chain.
Have students continue connecting their food chains until all of the members of the group are connected.

Then the small group should join another small group and see how their chains might fit together into a food web.

You can stop there if it is too much chaos, but if you would like to go on, the two small groups can connect to two other small groups and watch a food web grow.

If your class is not too big, you can let these larger groups' food webs combine until all of the class is in one big food web.

- What does the food web illustrate about the prairie ecosystem? (Seeing all of the small food chains connected in one large food web should help students to see the interdependence in the prairie ecosystem.)
- What might happen to the food web if an exotic species were introduced? (The exotic species may overpopulate the ecosystem and out compete native species, which could all disappear from the ecosystem.)
- What might happen to the ecosystem if a long drought, a flood, or a hurricane were to hit the ecosystem? (Example: if all of the grasses and other plants are killed during a drought, then plant eaters will starve and when they are depleted other consumers will have problems finding enough food and so on up to the top of the food chain.)

Note: You may wish to let students disconnect different organisms affected by the drought and then disconnect other parts of the food chain affect by the loss of part of the food chain and on until students can see how the food web collapses as plants and animals die causing ecosystem loses and eventual collapse such a desertification.

- Why do we use a model?
- How is our model like a real food chain? How is it different from the real food chain? (Differences are limitions

of our model, such as size, complexity, etc. Likenesses help us understand real food chains better.)

Journaling
Have students write a paragraph (at least 3 sentences) in their journals explaining how the organisms interact and depend on each other in the food web in a prairie ecosystem and how changes in the ecosystem can impact the whole system.

For More Advanced Students

Food Pyramid
Ask students to use the class data from the prairie preserve population study to develop a food pyramid diagram. Students should include various organisms from every trophic level including producers, primary consumers, secondary consumers, tertiary consumers, and decomposers.
Pyramid diagrams should be drawn on large pieces of paper in order to have room for the names of organisms. Each trophic level should be labeled. If you have markers available, the pyramid diagrams can be color-coded with each trophic level a different color.

- Where do decomposers fit in the food pyramid? (Decomposers include bacteria, fungi, various invertebrates such as pill bugs, worms, millipedes, etc., which are eaten by birds, armadillos, etc. and decomposers also eat the remains of top predators as well as all other parts of the food chain. Some prefer to put the decomposers at the base of the food pyramid, because there are so many decomposers and they enrich the soil as they clean up dead plants and animals. Others feel that decomposers should go at the top of the pyramid because they use the remains of all other levels to get their energy. Wherever students put the decomposers, they should have a justification as to why they chose that trophic level.) If their data does not include all levels of the pyramid, student should make inferences about what other organisms might be present in the prairie ecosystem. (It is not likely that students will see top predators since they are more secretive and often are nocturnal. They may also not see many decomposers except maybe pill bugs or worms since many decomposers are bacteria and are microscopic.)
- How is the food pyramid like the real prairie ecosystem? How is it different?
- What are the limitations of our model?

Thinking Beyond the Pyramid
Ask students to think about other ways that we might represent the trophic levels.
- Why do we use a pyramid to represent the tropic levels? (It shows the hierarchy of the trophic levels and the importance of large numbers of organisms at the bottom of the pyramid that support the higher-level consumers.)
- Are there other ways that we can make a diagram to show the interdependence of organisms and the hierarchy of the trophic levels?

EXPLAIN
People and Nature

Materials
- Student Journals
- Chart Paper
- Pencils and Markers
- Copy Paper
- Student Activity Page 3
- Teacher Overhead Page

Websites:
1. Poster of the plastic gyre in the Pacific Ocean:
http://www.nationalgeographic.org/encyclopedia/great-pacific-garbage-patch/
2. Native prairie habitat and photos:
https://www.fws.gov/refuge/Attwater_Prairie_Chicken/Habitat.html
3. Desertification of grasslands over a 100-year period:
http://climatechange.lta.org/manage-grasslands/Overgrazed pasture:
4. Overgrazed pasture
http://www.ext.colostate.edu/sam/pasture.html
5. Old growth forest including photos:
http://www.futuredirections.org.au/publication/role-old-growth-forests-carbon-sequestration/
6. Greenpeace photo of logged forest:
http://www.greenpeace.org/international/en/multimedia/photos/panoramic-shot-of-logged-ancie/

Time Considerations
50 minutes

Journaling
Look on the Internet at the websites above for pictures of at least 3 types of degraded habitats such as plastic garbage in the ocean, a logged forest, or an overgrazed prairie pasture. You may want to show photos of normal ecosystems to compare to degraded systems. Also include photos that show what has happened to ecosystem in which you live.
Note: The Natural Resource Conservation Service in your county have aerial photographs of your area going back to at least the 1950's. You might want to invite them to come and bring the photos to your class or you can go to the office and take photos of the large aerial photos from early years until the latest available (about 3 or 4 photos will give you an idea of the big changes that are happening in your area.) Ask students to look at the photos and compare them to see changes over time to your environment. This can be done in small groups or as a class, or as a special project for more advanced students, who can then present their findings to the class.

Have student describe each photo and answer the questions below in their journals.
Put these questions up on the overhead for students to see as they write. (See Teacher Overhead in Resource Section at the end of the lesson.)
1. What is happening to the ecosystem in each habitat?
2. Is it a positive or negative contribution to the ecosystem?
3. What might have caused this to happen?
4. How might the situation be improved?
5. Will it improve naturally or will humans need to intervene in some way?
6. How does this relate to the carrying capacity of the ecosystem and the relationship to population dynamics?

Class Discussion
Sharing Students' Ideas

Show the photos as you discuss the cause of these environmental problems.
- What happened in this habitat to cause the problems you see?
  - How do you think this happened?
  - Was it a natural process? If so, what natural processes were involved?
- Was it an intentional process by humans? Why do you think so or why not?
- Was it an unintentional process by humans?
- If it was unintentional how did these results occur?
- Are these problems common in various places around the world? \

- What careers are helping to remediate these problems? (Ecologists, marine biologists, wildlife biologists, agronomists, botanists, etc.) .

Drawing Conclusions
Give out Student Activity Page 3. Have students work together in small groups to discuss and answer the following questions in their journals:
1. Are these habitats lost or are they degraded?
2. Do you believe these habitats are healthy for animals? Why?
3. What human activities might affect wildlife in the habitats seen in the photos?
4. What could be done to improve the habitats in these photos?
5. Do you believe that people are part of nature or separate from nature?
6. How do people affect natural ecosystems?
7. How have people affected the ecosystem where we live?
8. How do these changes affect the organisms, including humans that live in the ecosystem?

Taking It Farther
You may wish for students to do some research. Let each group choose a career or an environmental problem to research on-line and share with the class.

Environmental Problem:
Students should look for information on:
- The natural resources of the area
- The uses made of those resources
- Changes that occurred due to the uses made of the resources.
- Do these changes cause any problems?
- How do people benefit?
- Are the changes detrimental in some way to humans or to the environment?
-

Careers in Environmental Fields
Students should look for:
- A field of study in environmental areas that they are interested in
- What are some of the jobs in the field?
- What kind of education is required for these jobs?
- What kinds of tasks are required for the job in which they are most interested?

ELABORATE

Seed Balls and Prairie Restoration

Teacher Preparation

Note: Making seed balls can be a bit of a messy process. We therefore suggest that seed balls would be best made outdoors in a non-windy area. Also, this activity can be done with or without latex gloves. If doing this activity without gloves ask student to get as much mixture off of their hands as possible before visiting a restroom. One easy way of getting extra dirt off of your students hands is to fill up a 5-gallon bucket with water and have your students rub their submerged hands together before visiting a restroom or a water hose to finish cleaning their hands.

Note: Make sure to get permission to put a pocket prairie in places such as on our school grounds, at a park or nature center, or at a business.

Materials

For the class:
Seed ball video from Katy Prairie website at: www.katyprairie.org

- Red potter's clay (do not use white potter's clay!)
- Water
- Native prairie seeds (make sure to only use seeds native to your city or region)
- Compost, topsoil, or potting soil
- Large spoons for mixing
- Large mixing bowls
- Newspaper
- Large aluminum pans (such as turkey roasting pans)
- 5 gallon bucket
- Water

Photos of wildflower, grasses, and other native prairie species included in the seed mix to be used in the seed balls
A place on the school grounds, a nearby park or natural area, or business in which to place the seed balls. The school grounds provide the most convenient area for follow-up observations.
Journals
Pencils

Note: You may wish to use Popsicle sticks to mark group numbers or colors in the pocket prairie so that later small groups will be able to make observations in the plot where they distributed their seed balls.

Website for native prairie habitat and photos:
https://www.fws.gov/refuge/Attwater_Prairie_Chicken/Habitat.html

Time Considerations
50 minutes for making balls and 20 minutes on another day to distribute dry seed balls
Follow up can be done once a week in 10 minute segments

Class Discussion
Pocket Prairies

View the following website and discus the following terms.

http://www.fws.gov/refuge/Attwater__Prairie_chicken/wildlife_and_habitat/index.html

- How does restoring prairie for an endangered species help other species?

Discuss how the following terms help us understand how humans can have a positive impact on the environment.

- Ecological Restoration – The process of bringing a portion of nature back to a higher functioning state for wildlife and/or humans. This process typically takes place on sites, which still retain some native vegetation.
- Ecological Reconstruction – When a portion of nature is brought back from a sterile or mostly degraded state.

The difference between restoration and reconstruction is analogous to remodeling a home (restoration) and building a new home (reconstruction).

- Habitat – The place or environment where a plant or animal naturally or normally lives and grows
- Habitat Degradation – The act of decreasing the amount of appropriate wildlife habitat through reducing the number of indigenous plants, changing the structure of a habitat, or decreasing the biodiversity
- Habitat Loss – The loss of wildlife habitat by various means such as fragmentation, overuse, litter, pollution, etc.

Ask students:

- What is ecological restoration?
- What is the difference between ecological restoration and ecological reconstruction?
- Do you believe ecological restoration will become more important in the future? Why or why not?
- Can you think of any endangered species whose habitat has been degraded and is being restored?

(Ocelot in south Texas brush country, Atwatter Prairie Chickens in restored prairies in Texas, panda bears and bamboo forests, red-cockaded woodpeckers and east Texas forests, and monarch butterflies and pollinator gardens)

- Can we be a part of restoring habitat? (Take any suggestions.) How? (Some students may know about some local restoration efforts of which the class could be a part.)
- What is a pocket prairie? (Have students take it apart and explain "pocket" and "prairie" and get a definition for pocket prairie as a small area planted with prairie plants.
- Why would we plant a pocket prairie? (Restoring prairie plants helps restore a small bit of the prairie and attracts more prairie animals such as butterflies, birds, and rabbits)
- Where would be a good place for a pocket prairie? (The school grounds, at a local business, or in a local park or natural area)
- How could we get permission to make a pocket prairie? (Students may contact the principal, persons owning businesses, or park personnel to get permission to plant prairie plants with their seed balls.)

Note: Follow-up observations are more easily conducted on your school grounds unless the business or park chosen is very nearby.)

Instructions For Seed Balls

Preparing seed ball drying pans

- Once made you and your students will need to dry seed balls for 2-3 days. One of the most convenient ways of drying and moving seed balls is to line large, aluminum pans (such a turkey roasting pan) with newspaper. You will be making seed balls in groups of 3-6 students. Each group should have a pan of their own.

Combining ingredients for seed balls

In a large bowl combine:

- 5-parts red potter's clay
- 3-parts humus or compost
- 1-part native prairie seeds
- Add enough water to create a very thick but moist uniform mixture. The proper consistency of this seed ball mix should allow the students to place a dab of mixture on their finger upside down without falling off.

Note: Mixing can be done by either the teacher or the students.

If students are learning ratios this is a good time to participate in a hands-on learning experience and discuss how changing the ratios of clay to compost, or clay to seed, or compost to seed in the recipe would affect the mixture. What would happen if the ratios were changed? Try it out on a small scale and see what happens before you prepare your big mixture for the class.

Making seed balls

- Once the seed mix batter is prepared, give a large dollop of this batter to groups of 3-6 students. Instruct the

students to create seed balls by rolling the mixture in between their hands in circular patterns. The seed balls should be the size of traditional marbles. Seed balls larger than marbles will waste precious seeds with too many plants too close together. Seed balls smaller than marbles will leave seeds exposed to birds or other animals.

Arranging Seed Balls to Dry

- As students make seed balls have them place them into their newspaper-lined pans. Make sure that your students don't create more than one layer of seed balls per pan, as this will limit drying of seed balls later. Once you are finished making seed balls combine all seed balls into as few pans as possible with one layer in each pan.

Drying Seed Balls

- Find a convenient place with good air conditioning (not a humid place or sealed container – this will cause your seeds to germinate prematurely) and allow seed balls to fully dry for two to three days. When seed balls are fully dried they will be rock hard and will be dry to the touch.

Distributing Seed Balls

- Select a prairie restoration area and distribute seed balls at a rate of approximately one seed ball per square foot. Do not plant or cover seed balls – simply place on the surface of your planting area. As rains break down the seed ball your seeds will begin to germinate. Therefore, you shouldn't water seed balls – they are activated when conditions are suitable.
- Mark each section of the planting area with a Popsicle stick with the group number or color for the group distributing seed balls in that section.

Follow Up Observations

If you have used your seed balls on your school grounds or in a nearby business, park or natural area, you may make follow-up observations of the area where each group placed their seed balls at least one time per week.

Each group will:
Observe

- The deterioration of the seed balls
- The germination of the seeds
- The growth of plants.

Make a table in your journal to show your observations.
Describe plants as they come up and as they grow.
Determine how you will measure growth.
Use at least two methods for measuring plant growth.
The teacher should let students make suggestions for how to measure growth such as:

- Measure the height of the stem
- Count the number of leaves
- Measure diameter of each plant
- Count the number of plants in the group's area
- Note when various parts of the plant appear

EVALUATE

Evaluating the Effects of Human Activities

Materials

- Computers
- Library
- Art Materials

Materials for costumes or puppets
Other materials for presentations as needed
Rubric for Presentations (Found in the Resource Section at the end of the lesson)

Time Considerations
20 minutes for class discussion
30 minutes to decide on subject of research and presentation method and possibly start research
3 days to finish research (either in the classroom or at home)
50 minutes for presentations (limited to 5-7 minutes per group depending on the number of groups)

Class Discussion
Reviewing What We Have Learned
Ask students to think about what they have learned about effects of human activities. Teacher can make notes on the white board or chart paper.

- What kinds of activities that humans do affect the environment? (Building homes, building roads, building businesses and towns, cutting down forests, manufacturing, farming, ranching, industrial growth such as oil and gas refineries, chemical companies, commercial fishing, fertilizer production and use, conservation land projects, community clean-up projects, environmental organizations, etc.)
- Why are these activities important to humans?
- Which things have a negative effect and which have a positive effect on the environment?
- How do these activities impact stability of the ecosystem? (Loss of ecosystem services such as the ecosystems' ability to clean water and air or sequester carbon dioxide, decompose waste, conduct nutrient cycles in soil formation.)
- How do the activities affect the long-term survival of species?
- What limited resources on which species including humans are dependent does it affect? (Example: Loss of ecosystem services such as pollination, changes in quality of water and air, fragmentation of habitat and loss of open spaces for recreation, education and spiritual retreats, climate changes due to loss of plants sequestering carbon dioxide, etc.)
- What effects on the environment are also detrimental to human populations? (Health is affected by pollution of air, soil, and water, climate change. Loss of wild places limits therapeutic characteristics of wild places, food production such as fishing may be changed or lost, etc.)

Research Project
Give out the Rubrics for Presentations. (See Rubric in the Resource Section at the end of the lesson.)
Have students work in groups of 2-4 students on a research project in which they will research different activities in which humans affect the environment including any of the things mentioned in the class discussion (Such as municipal development, various types of land use, farming, harvesting of forests, industries of all kinds, changes in oceans. various conservation efforts, etc.) and make a chart to help you evaluate cost v. s. benefits of the human activity.

Groups must use both Internet and library resources and site their sources.

All students will create a written report in their journals.

Groups must decide what their research area will be and how they will present the information to the class, and check with the teacher to be sure that no one else is researching the same human activity.

Class Presentation
When the research is complete, each group must give a creative presentation of their information to the class and give the group's evaluation of the importance of the effects of human activities on the environment based on what they found in their research. Every member of the group must participate in the presentation.

Give students a copy of the Rubric for Presentations. (See Rubric in Resource Section following the lesson.)
All individuals must also have a written report in their journals.

Rubric:

1. Work cooperatively with a group on researching affects of a human activity on the environment and planning and participating in a creative presentation to the class.
   25 points

- Decide on a human activity to research.
- Choose the type of presentation:
- Skit
- Song or rap
- Poster and explanation
- Oral report
- Debate
- News story for TV, radio, or newspaper
- Children's story
- Other creative presentation method

- Check with teacher on the topic to be researched and the type of presentation. There should be a variety of topics and a variety of presentation methods.

All group members must participate in the presentation.

2. Provide the following information on the human activity you chose to research:
   25 points

- Importance of the activity to people and the environment
- Detrimental effects to both humans and the environment
- Positive effects on the environment
- Impact on long-term stability of the ecosystem
  - Effects on natural resources in the ecosystem that might in turn affect organisms
  - Effects on long-term survival of species due to changes in the ecosystem

3. Make a Chart of the cost vs. benefits of the human activity chosen
   25 points

4. Evaluation and analysis of the cost versus benefits of the activity are illustrated in the presentation and clearly explained in the written report in the individual student journals. (What is the cost of the activity in money, time, and changes to the environment and what are the benefits to humans, wildlife, and the environment? 25 points

Resources

ENGAGE

1. Website Gould Ecosystem Map with Counties Identified
http://tpwd.texas.gov/publications/pwdpubs/media/pwd_mp_e0100_107ac_34.pdf

2. Website with Ecoregions Map with Photos, Text, and Videos
https://tpwd.texas.gov/education/hunter-education/online-course/wildlife-conservation/texas-ecoregions

3. Website for the Bureau of Economic Geology Education Store
With page size maps for various types of regions in the state for only 35 cents each including ecoregions, vegetative regions, geological regions, soil regions, natural resource regions and more
http://begstore.beg.utexas.edu/store/30-state-maps?id_category=30&=50

EXPLORE

1. Website with List of Land Conservancy Preserves in counties in Texas
http://www.texaslandconservancy.org

2. Website with method for finding biodiversity of an area
http://www.amnh.org/learn/biodiversity_counts/

EXPLAIN

1. Website for poster of the plastic gyre in the Pacific Ocean:
http://www.nationalgeographic.org/encyclopedia/great-pacific-garbage-patch/

2. Website about overgrazed pasture:
http://www.ext.colostate.edu/sam/pasture.html

3. Website for native prairie habitat and photos:
https://www.fws.gov/refuge/Attwater_Prairie_Chicken/Habitat.html

4. Website on desertification of grasslands over a 100-year period:
http://climatechange.lta.org/manage-grasslands/

5. Website on old growth forest including photos:
http://www.futuredirections.org.au/publication/role-old-growth-forests-carbon-sequestration/

6. Website for Greenpeace photo of logged forest:
http://www.greenpeace.org/international/en/multimedia/photos/panoramic-shot-of-logged-ancie/

ELABORATE

1. Website about seed balls
www.katyprairie.org

2. Website with restored prairie habitat
http://www.fws.gov/refuge/Attwater_Prairie_Chicken/Habitat.html

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Texas Essential Knowledge and Skills
Middle School

Sixth Grade

6.1 A
(1) Scientific investigation and reasoning. The student, for at least 40% of instructional time, conducts laboratory and field investigations following safety procedures and environmentally appropriate and ethical practices. The student is expected to:
(A) Demonstrate safe practices during laboratory and field investigations as outlined in the Texas Safety Standards; and

6.2 A, C, D, E
(2) Scientific investigation and reasoning. The student uses scientific inquiry methods during laboratory and field investigations. The student is expected to:
(A) Plan and implement comparative and descriptive investigations by making observations, asking well-defined questions, and using appropriate equipment and technology;
(C) Collect and record data using the International System of Units (SI) and qualitative means such as labeled drawings, writing, and graphic organizers;
(D) Construct tables and graphs, using repeated trials and means, to organize data and identify patterns; and
(E) Analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.

6.3 B
(3) Scientific investigation and reasoning. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to:
B) Use models to represent aspects of the natural world such as a model of Earth's layers;

6.4 A
(4) Scientific investigation and reasoning. The student knows how to use a variety of tools and safety equipment to conduct science inquiry. The student is expected to:
(A) Use appropriate tools to collect, record, and analyze information, including journals/notebooks, beakers, Petri dishes, meter sticks, graduated cylinders, hot plates, test tubes, triple beam balances, microscopes, thermometers, calculators, computers, timing devices, and other equipment as needed to teach the curriculum; and

6.12 D, E, F,
(12) Organisms and environments. The student knows all organisms are classified into Domains and Kingdoms. Organisms within these taxonomic groups share similar characteristics which allow them to interact with the living and nonliving parts of their ecosystem. The student is expected to:
(D) Identify the basic characteristics of organisms, including prokaryotic or eukaryotic, unicellular or multicellular, autotrophic or heterotrophic, and mode of reproduction, that further classify them in the currently recognized Kingdoms;
(E) Describe biotic and abiotic parts of an ecosystem in which organisms interact; and
(F) Diagram the levels of organization within an ecosystem, including organism, population, community, and ecosystem.

Seventh Grade

7.1 A,
(1) Scientific investigation and reasoning. The student, for at least 40% of instructional time, conducts laboratory

and field investigations following safety procedures and environmentally appropriate and ethical practices. The student is expected to:
(A) Demonstrate safe practices during laboratory and field investigations as outlined in the Texas Safety Standards; and

7.2 A, C, D, E
(2) Scientific investigation and reasoning. The student uses scientific inquiry methods during laboratory and field investigations. The student is expected to:
(A) Plan and implement comparative and descriptive investigations by making observations, asking well-defined questions, and using appropriate equipment and technology;
(C) Collect and record data using the International System of Units (SI) and qualitative means such as labeled drawings, writing, and graphic organizers;
(D) Construct tables and graphs, using repeated trials and means, to organize data and identify patterns; and
(E) Analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.

7.3 B
(3) Scientific investigation and reasoning. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to:
(B) Use models to represent aspects of the natural world such as human body systems and plant and animal cells;

7.4 A
(4) Science investigation and reasoning. The student knows how to use a variety of tools and safety equipment to conduct science inquiry. The student is expected to:
(A) Use appropriate tools to collect, record, and analyze information, including life science models, hand lens, stereoscopes, microscopes, beakers, Petri dishes, microscope slides, graduated cylinders, test tubes, meter sticks, metric rulers, metric tape measures, timing devices, hot plates, balances, thermometers, calculators, water test kits, computers, temperature and pH probes, collecting nets, insect traps, globes, digital cameras, journals/notebooks, and other equipment as needed to teach the curriculum;

7.5 A, C,
(5) Matter and energy. The student knows that interactions occur between matter and energy. The student is expected to:
(A) Recognize that radiant energy from the Sun is transformed into chemical energy through the process of photosynthesis;
(C) Diagram the flow of energy through living systems, including food chains, food webs, and energy pyramids.

7.8 A
(8) Earth and space. The student knows that natural events and human activity can impact Earth systems. The student is expected to:
(A) Predict and describe how different types of catastrophic events impact ecosystems such as floods, hurricanes, or tornadoes;

7.10 A, B
(10) Organisms and environments. The student knows that there is a relationship between organisms and the environment. The student is expected to:
(A) Observe and describe how different environments, including microhabitats in schoolyards and biomes, support different varieties of organisms;

7.11 A,

(11) Organisms and environments. The student knows that populations and species demonstrate variation and inherit many of their unique traits through gradual processes over many generations. The student is expected to:
(A) Examine organisms or their structures such as insects or leaves and use dichotomous keys for identification;

7.12 A
(12) Organisms and environments. The student knows that living systems at all levels of organization demonstrate the complementary nature of structure and function. The student is expected to:
(A) Investigate and explain how internal structures of organisms have adaptations that allow specific functions such as gills in fish, hollow bones in birds, or xylem in plants;

Eighth Grade

8.1 A
(1) Scientific investigation and reasoning. The student, for at least 40% of instructional time, conducts laboratory and field investigations following safety procedures and environmentally appropriate and ethical practices. The student is expected to:
(A) Demonstrate safe practices during laboratory and field investigations as outlined in the Texas Safety Standards; and

8.2 A, C, D, E
(2) Scientific investigation and reasoning. The student uses scientific inquiry methods during laboratory and field investigations. The student is expected to:
(A) Plan and implement comparative and descriptive investigations by making observations, asking well-defined questions, and using appropriate equipment and technology;
(C) Collect and record data using the International System of Units (SI) and qualitative means such as labeled drawings, writing, and graphic organizers;
(D) Construct tables and graphs, using repeated trials and means, to organize data and identify patterns; and
(E) Analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.

8.3 B
(3) Scientific investigation and reasoning. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to:
(B) Use models to represent aspects of the natural world such as an atom, a molecule, space, or a geologic feature;

8.4 A
(4) Scientific investigation and reasoning. The student knows how to use a variety of tools and safety equipment to conduct science inquiry. The student is expected to:
(A) Use appropriate tools to collect, record, and analyze information, including lab journals/notebooks, beakers, meter sticks, graduated cylinders, anemometers, psychrometers, hot plates, test tubes, spring scales, balances, microscopes, thermometers, calculators, computers, spectroscopes, timing devices, and other equipment as needed to teach the curriculum; and

8.11 A, B, C
(11) Organisms and environments. The student knows that interdependence occurs among living systems and the environment and that human activities can affect these systems. The student is expected to:
(A) Describe producer/consumer, predator/prey, and parasite/host relationships as they occur in food webs within marine, freshwater, and terrestrial ecosystems;
(B) Investigate how organisms and populations in an ecosystem depend on and may compete for biotic and abiotic factors such as quantity of light, water, range of temperatures, or soil composition;

(C) Explore how short- and long-term environmental changes affect organisms and traits in subsequent populations; and

Texas Essential Knowledge and Skills
High School

Biology

1 A

(1) Scientific processes. The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:
(A) Demonstrate safe practices during laboratory and field investigations;

2 E, F, G, H

2) Scientific processes. The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:
(E) Plan and implement descriptive, comparative, and experimental investigations, including asking questions, formulating testable hypotheses, and selecting equipment and technology;
(F) Collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as calculators, spreadsheet software, data-collecting probes, computers, standard laboratory glassware, microscopes, various prepared slides, stereoscopes, metric rulers, electronic balances, gel electrophoresis apparatuses, micropipettes, hand lenses, Celsius thermometers, hot plates, lab notebooks or journals, timing devices, cameras, Petri dishes, lab incubators, dissection equipment, meter sticks, and models, diagrams, or samples of biological specimens or structures;
(G) Analyze, evaluate, make inferences, and predict trends from data; and
(H) Communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.

3 B, D, E

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:
(B) Communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;
(D) Evaluate the impact of scientific research on society and the environment;
(E) Evaluate models according to their limitations in representing biological objects or events; and

8 A, B

(8) Science concepts. The student knows that taxonomy is a branching classification based on the shared characteristics of organisms and can change as new discoveries are made. The student is expected to:
(A) Define taxonomy and recognize the importance of a standardized taxonomic system to the scientific community;
(B) Categorize organisms using a hierarchical classification system based on similarities and differences shared among groups; and

12 A, B, C, D, F,

(12) Science concepts. The student knows that interdependence and interactions occur within an environmental system. The student is expected to:
(A) Interpret relationships, including predation, parasitism, commensalism, mutualism, and competition among organisms;

(B) Compare variations and adaptations of organisms in different ecosystems;
(C) Analyze the flow of matter and energy through trophic levels using various models, including food chains, food webs, and ecological pyramids;
(D) Recognize that long-term survival of species is dependent on changing resource bases that are limited;
(F) Describe how environmental change can impact ecosystem stability.

Environmental Systems

1 A
(1) Scientific processes. The student, for at least 40% of instructional time, conducts hands-on laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:
(A) Demonstrate safe practices during laboratory and field investigations, including appropriate first aid responses to accidents that could occur in the field such as insect stings, animal bites, overheating, sprains, and breaks; and

2 E, F, G, H, I, J, K
(2) Scientific processes. The student uses scientific methods during laboratory and field investigations. The student is expected to:
(E) Follow or plan and implement investigative procedures, including making observations, asking questions, formulating testable hypotheses, and selecting equipment and technology;
(F) Collect data individually or collaboratively, make measurements with precision and accuracy, record values using appropriate units, and calculate statistically relevant quantities to describe data, including mean, median, and range;
(G) Demonstrate the use of course apparatuses, equipment, techniques, and procedures, including meter sticks, rulers, pipettes, graduated cylinders, triple beam balances, timing devices, pH meters or probes, thermometers, calculators, computers, Internet access, turbidity testing devices, hand magnifiers, work and disposable gloves, compasses, first aid kits, binoculars, field guides, water quality test kits or probes, soil test kits or probes, 100-foot appraiser's tapes, tarps, shovels, trowels, screens, buckets, and rock and mineral samples;
(H) Use a wide variety of additional course apparatuses, equipment, techniques, materials, and procedures as appropriate such as air quality testing devices, cameras, flow meters, Global Positioning System (GPS) units, Geographic Information System (GIS) software, computer models, densitometers, clinometers, and field journals;
(I) Organize, analyze, evaluate, build models, make inferences, and predict trends from data;
(J) Perform calculations using dimensional analysis, significant digits, and scientific notation; and
(K) Communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.

3 B, E, F
(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed
(B) Communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;
(E) Describe the connection between environmental science and future careers; decisions within and outside the classroom.

4 A, B, F, G, H
(4) Science concepts. The student knows the relationships of biotic and abiotic factors within habitats, ecosystems, and biomes. The student is expected to:
(A) Identify native plants and animals using a dichotomous key;
(B) Assess the role of native plants and animals within a local ecosystem and compare them to plants and animals in ecosystems within four other biomes;

(F) Predict how the introduction or removal of an invasive species may alter the food chain and affect existing populations in an ecosystem;
(G) Predict how species extinction may alter the food chain and affect existing populations in an ecosystem; and
(H) Research and explain the causes of species diversity and predict changes that may occur in an ecosystem if species and genetic diversity is increased or reduced.

5 A, E
(5) Science concepts. The student knows the interrelationships among the resources within the local environmental system. The student is expected to:
(A) Summarize methods of land use and management and describe its effects on land fertility;
(E) Analyze and evaluate the economic significance and interdependence of resources within the environmental system; and

7 A
(7) Science concepts. The student knows the relationship between carrying capacity and changes in populations and ecosystems. The student is expected to:
(A) Relate carrying capacity to population dynamics;

8 A, B
(8) Science concepts. The student knows that environments change naturally. The student is expected to:
(A) Analyze and describe the effects on areas impacted by natural events such as tectonic movement, volcanic events, fires, tornadoes, hurricanes, flooding, tsunamis, and population growth;
(B) Explain how regional changes in the environment may have a global effect;

9 A, D, E, F, I,
(9) Science concepts. The student knows the impact of human activities on the environment. The student is expected to:
(A) Identify causes of air, soil, and water pollution, including point and nonpoint sources;
(D) Describe the effect of pollution on global warming, glacial and ice cap melting, greenhouse effect, ozone layer, and aquatic viability;
(E) Evaluate the effect of human activities, including habitat restoration projects, species preservation efforts, nature conservancy groups, hunting, fishing, ecotourism, all terrain vehicles, and small personal watercraft, on the environment;
(F) Evaluate cost-benefit trade-offs of commercial activities such as municipal development, farming, deforestation, over-harvesting, and mining;
(I) Discuss the impact of research and technology on social ethics and legal practices in situations such as the design of new buildings, recycling, or emission standards;

North American Association for Environmental Education

Eighth Grade
Strand 1 Questioning, Analysis and Interpretation Skills
Guidelines:
A) Questioning–Learners are able to develop, focus, and explain questions that help them learn about the environment and do environmental investigations.

- Identify environmental questions based on personal experiences both in and outside school, newspaper and magazine articles, television or radio news, or videos.
- Summarize an environmental problem or situation to provide context for, or explain

the origin of, a particular question. Create visual presentations (such as maps, graphs,

or video tapes) and written and oral statements that describe their thinking about the problem.
- Clarify their own beliefs about the environment and discuss how those beliefs are reflected in the questions they ask.

C) Collecting information Learners are able to locate and collect reliable information about the environment or environmental topics using a variety of methods and sources.
- Observe systematically, measure accurately, and keep thorough and accurate records, which may include written notes and data tables, sketches, and photographs.
- Assess, choose, and synthesize materials from resources such as aerial photographs, topographic maps, and satellite images; library and museum collections, historical documents, and eyewitness accounts; computerized databases and spreadsheets; the Internet; and government records.
- Collect firsthand information about their own community using field study skills.

E) Organizing information Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation.
- Present environmental data in a variety of formats including charts, tables, plots, graphs, maps, and flow charts. For example, chart stream flows, create a map of local businesses that require air quality permits, or organize survey results into a table.

F) Working with models and simulations Learners understand many of the uses and limitations of models.
- Evaluate models based on the question being investigated. Account forvariables such as the complexity of the model, its scale, its ability torepresent important features of the process being modeled, and its reliability and accuracy.

G) Drawing conclusions and developing explanations Learners are able to synthesize their observations and findings into coherent explanations.
- Propose explanations based on what they observed or learned through research, selecting which evidence to use and accounting for discrepancies. Synthesize and interpret information from a range of sources.

Strand 2 Knowledge of Environmental Processes and Systems

Strand 2.1 The Earth as a Physical System
Guidelines:
A) Processes that shape the Earth Learners have a basic understanding of most of the physical processes that shape the Earth. They are able to explore the origin of differences in physical patterns.
- Analyze physical patterns such as climate, areas of geothermal activity, soil types, sea level rise, and arid regions, suggesting reasons for these patterns. Explain these patterns in terms of abrupt forces (such as earthquakes or major storms) and long-term processes (such as erosion and rock formation), as well as those that are human-caused (such as increases in greenhouse gases, suburban development or agricultural practices)
- Predict the consequences of specific physical phenomena such as a hurricane in a coastal area or heavy grazing in an arid region.

Strand 2.2 The Living Environment
Guidelines:
A) Organisms, populations, and communities Learners understand that biotic communities are made up of plants and animals that are adapted to live in particular environments.
- Define and give examples to illustrate the concepts of species, population, community, and ecosystem. Trace and give examples of connections among organisms at those levels of organization.
- Link features of internal and external anatomy with the ability of organisms to make or find food and reproduce

in particular environments.

B) Heredity and evolution Learners have a basic understanding of the importance of genetic heritage.
- Discuss the possible implications of permanent loss of a species and how it affects interdependence within an ecosystem.

C) Systems and connections. Learners understand major kinds of interactions among organisms or populations of organisms.
- Describe and give examples of producer/consumer, predator/prey, and parasite/host relationships.

Identify organisms that are scavengers or decomposers. Describe the roles they play within particular systems focuing on their relationship to other organisms and physical elements of the system.
- Summarize how abiotic and biotic components in combination influence the structure of an ecosystem. For example, create a map for the local region that shows average temperature and rainfall correlated with local forest, grassland or desert ecosystems. Or discuss the process of soil formation in terms of the interaction of climate, geology, and living organisms.

D) Flow of matter and energy Learners understand how energy and matter flows among the abiotic and biotic components of the environment.
- Trace the flow of energy through food webs that identify relationships among organisms in natural systems.
- Explain how matter is transferred among organisms and between organisms and their environment in these food webs. Describe the role played by organisms in the global carbon cycle.
- Describe how energy, which enters ecosystems as sunlight, changes form and is transferred in the exchanges (production, consumption, and decomposition) that comprise food webs.

Strand 2.4 Environment and Society
Guidelines:
A) Human/environment interactions Learners understand that human-caused changes have consequences for the immediate environment as well as for other places and future times.
- Describe intended and unintended environmental and social consequences associated with the changing use of technologies. Consider consequences that may be positive as well as negative. For example, discuss particular irrigation methods, different ways of generating electrical power, or the use of synthetic pesticides.
- Explain how human-caused environmental changes cause changes in other places. For example, discuss the effects of building a dam on downstream plant and animal communities as well as on human communities or how climate change might reduce the availability of food, water and land.
- Describe the effects of a local environmental restoration effort, such as wetlands creation. Predict the long-term consequences of such efforts, or a particular restoration project.

E) Environmental issues Learners are familiar with a range of environmental issues at scales that range from local to national to global. They understand that people in other places round the world experience environmental issues similar to the ones they are concerned about locally.
- Identify other places, either contemporary or historical, experiencing issues similar to those in the learner's community or region.

Twelfth Grades

Strand 1 Questioning, Analysis and Interpretation Skills
Guidelines:
A) Questioning Learners are able to develop, modify, clarify, and explain questions that guide environmental investigations of various types. They understand factors that influence the questions they pose.

- Articulate environmental phenomena or topics to be studied at scales ranging from local to global.

C) Collecting information Learners are able to locate and collect reliable information for environmental investigations of many types. They know how to use sophisticated technology to collect information, including computer programs that access, gather, store, and display data.
- Use basic sampling techniques such as spatial sampling and random sampling. Evaluate when these techniques are appropriate.
- Apply data collection skills in field situations, such as interviewing community members about environmental concerns or sampling water in a local stream.

E) Organizing information Learners are able to organize and display information in ways appropriate to different types of environmental investigations and purposes.
- Integrate and summarize information using a variety of media ranging from written texts to graphic representations, and from audiovisual materials to maps and computer-generated images.

F) Working with models and simulations Learners are able to create, use, and evaluate models to understand environmental phenomena.
- Evaluate and report the limitations of models used.
- Compare the applicability of models for particular situations, considering the models' assumptions as one factor. Explain how a single model may apply to more than one situation and how many models may represent a single situation.

G) Drawing conclusions and developing explanations
Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.
- Speak in general terms about their confidence in proposed explanations as well as possible sources of uncertainty and error. Distinguish between error and unanticipated results in formulating explanations. Consider the assumptions of models and measuring techniques or devices as possible sources of error.

Strand 2 Knowledge of Environmental Processes and Systems

Strand 2.2 The Living Environment
Guidelines:
A) Organisms, populations, and communities Learners understand basic population dynamics and the importance of diversity in living systems.
- Discuss the relationship of habitat changes to plant and animal populations. Consider such factors as variations in habitat size, fragmentation, and fluctuation in conditions such as pH, oxygen, temperature, available light, or precipitation. For example, describe the effects of a lake's eutrophication on plant, insect, bacteria, and fish populations, or why organisms might be vulnerable to rapid or significant climate changes.
- Explain how diversity of characteristics among organisms of a species increases the likelihood of the species surviving changing environmental conditions.
- Explain how variation among species in a system increases the likelihood that at least some species will survive changes in environmental conditions.

B) Heredity and evolution Learners understand the basic ideas and genetic mechanisms behind biological evolution.
- Explain the idea that the more biological diversity there is today, the more there may be in the future. Offer examples of exceptions to this general rule, and use it to help explain past mass extinctions.

C) Systems and connections Learners understand the living environment to be comprised of interrelated, dynamic

systems.

- Apply the concepts of ecosystem and ecoregion to organize the multitude of relationships among organisms and environments encountered in earlier studies.
- Discuss the interactions among organisms and their environments. Explain ecosystem change with respect to variables such as climate change, the introduction of new species, and human impacts; and explain processes such as desertification and soil formation as mechanisms for such change.

D) Flow of matter and energy Learners are able to account for environmental characteristics based on their knowledge of how matter and energy interact in living systems.

- Illustrate how energy for life is provided primarily by continual inputs from the sun, captured by plants through photosynthesis and converted into carbon-based molecules. Describe exceptions such as geothermal energy.
- Trace the flow of matter and energy through living systems, and between living systems and the physical environment, identifying feedback loops. For example, show how oxygen is released to the atmosphere by the interaction of plants, animals, and nonliving matter in the global carbon cycle. Or use the carbon cycle to explain the existence of fossil energy sources.

Strand 2.4 Environment and Society
Guidelines:
A) Human/environment interactions Learners understand that humans are able to alter the physical environment to meet their needs and that there are limits to the ability of the environment to absorb impacts or meet human needs.

- Analyze specific examples of environmental change in terms of qualitative and quantitative costs and benefits for different groups of people and specific species or ecosystems. For example, evaluate the effect of sea level rise and other possible impacts of climate change.
- Describe factors that limit the physical environment's capacity to support particular types of human activity such as suburban development, flood control, or particular agricultural practices.
- Evaluate the cumulative effects of human actions on a specific species or environmental system, such as a stream or a watershed.

E) Environmental issues Learners are familiar with a range of environmental issues at scales that range from local to national to global. They understand that these scales and issues are often linked.

- Evaluate a range of costs and benefits of particular policies that affect the environment. For example, consider the effects of free trade agreements on the ability of signatory nations to protect the environment, or examine the effects of programs for trading "pollution credits" among companies.

Student Activity Page 1

Engage: Ecoregion Reports

Work in groups to learn about one of the ecoregions in the state. Present your information to the class. All members of your group should participate in the presentation

In your presentation you should include all of the following information:

1. Look at the photo and write a one-sentence description of the Ecoregion.
2. Watch the video and add to your description of the ecoregion including: – –– Ecosystems in the region.
   – Conservation efforts in the region.

3. Read the text and add other information including:
   – Climate–rainfall, temperatures and humidity
   – Soil characteristics
   – Elevation and/or landforms
   – Industries or economic support
   – Natural heritage (Special natural resources)
   – Conservation efforts mentioned

4. How has this ecoregion changed in the last 100 years?
   – Use the Texas road map to find the largest city in your assigned ecoregion.
   – What were the effects of urbanization on the ecoregion?
   – What city in the state is in a location where 3 ecoregions meet?

Student Activity Page 2

EXPLORE: Prairie Population Count

Each person should describe 2 organisms (1 plant and 1 animal) that they choose from those found in their grid plot and write the following in their journal.

FIELD DATA

1. Describe the location of the organism in your plot. (Example: on a leaf, on a flower, on the ground, in the air) Explain why that location fits with the animal's or plant's adaptations.
2. Describe characteristics of soil where plants are growing. (Color, texture, moisture i.e. wet, damp, dry)
3. Describe the organism and any special adaptations the organism has and how the adaptation helps it meet its needs and survive (leaf shape, appendages, size, color, etc.)
4. What is the role of the organism in the ecosystem (its niche)?
5. What other types of organisms were located in the same grid section?

(Microhabitat) Do these organisms interact? If so, how? (Predator/Prey, Producer/Consumer, Autotroph/Heterotroph, Parasite/Host, etc.)

Using a Field Guide

Either in the Field or in class use a field guide to help you:

Find the scientific and common names of the organism in a dichotomous key or field guide. Write a description in your journal to add to your own observations of the two organisms you observed in the field. (one plant and one animal)

- Write a description in your journal to add to your own observations of the two organisms you observed in the field. (one plant and one animal)
- Describe important characteristics noted in the field guide and any interesting facts that you learn about your organisms

Teacher Page for Overhead or PowerPoint

EXPLAIN: Do the Following Activities in your Journal

Look at the photos of ecological problems from the websites.
Wrote a description of each habitat in your journal.

Answer the following questions in your journal about each of the environments in the photos:

1. What is happening to the ecosystem in each environment?
2. Is it a positive or negative contribution to the ecosystem?
3. What might have caused this to happen?
4. How might the situation be improved?
5. Will it improve naturally or will humans need to intervene in some way?
6. How does this relate to carrying capacity of the ecosystem and the relationship to population dynamics?

Student Activity Page 3

EXPLAIN: Looking at Ecological Problems

1. Do you believe these habitats are healthy for animals? Why or Why not?
2. What human activities might affect wildlife in the environments seen in the photos?
3. What could be done (or has been done) to improve the habitats in these photos?
4. Do you believe that people are part of nature or separate from nature?
5. How do people affect natural ecosystems in negative and in positive ways?
6. How have people affected the environment where we live?
7. How do these changes affect the organisms, including humans that live in the ecosystem?

EVALUATE: Rubric for Presentations

1. Work cooperatively with a group on researching effects of a human activity on the environment and planning and participating in a creative presentation to the class.
25 points

- Decide on a human activity to research.
- Choose the type of presentation:
- Skit
- Song or rap
- Poster and explanation
- Oral report
- Debate
- News story for TV, radio, or newspaper
- Children's storY
- Other creative presentation method
- Check with teacher on the topic to be researched and the type of presentation. There should be a variety of topics and a variety of presentation methods.

All group members must participate in the presentation.

2. Provide the following information on the human activity you chose to research:
   25 points

- Importance of the activity to people and the environment
- Detrimental effects to both humans and the environment
- Positive effects on the environment
- Impact on long-term stability of the ecosystem
  - Effects on natural resources in the ecosystem that might in turn affect organisms
  - Effects on long-term survival of species due to changes in the ecosystem

3. Make a Chart of the cost vs. benefits of the human activity chosen
   25 points

4. Evaluation and analysis of the cost versus benefits of the activity are illustrated in the presentation and clearly explained in the written report in the individual student journals. (What is the cost of the activity in money, time, and changes to the environment and what are the benefits to humans, wildlife, and the