Salt Plains National Wildlife Refuge – High School
Title: Let's Go Bird Watching at the Salt Plains NWR
Video Title on SDE Website: Bird Watching at S. Plains HS
Length: 0:11:26

Teacher Tool – Primary Focus: High School Biology I

Description of the Bellringer:
Ms. Becky Wolff, of the Salt Plains National Wildlife Refuge, leads students of Enid High School as they take a bird watching tour of wetland habitats within this refuge. These wetlands are part of the refuge's waterfowl and shorebird management programs. Since the refuge was established in 1930, 312 different species of birds have been observed here. Ms. Wolff encourages the students to use both their visual and listening senses as they find and identify bird species. In addition to binoculars and a spotting scope, the students also use a field guide to help them classify the birds they observe. The students learn to use field marks, such as: size of bird, color of plumage, beak, legs, size and shape of wings as ways of distinguishing bird species. Also birders often identify birds by their call or song. Ms. Wolff concludes the activity by explaining how to use the refuge's Bird Checklist. This checklist provides a listing of each bird species that have previously been observed at this refuge. A portion of the Bird Checklist for this refuge is attached. The entire listing contains 312 bird species.

Curriculum Application

***PASS* Process Standards**
Standard 1.2 Use appropriate tools for identifying an organism.
Standard 2.1 Use observable properties to identify an organism.
Biology I
Standard 3.2 Species acquire many of their unique characteristics through biological adaptation.

Additional Resources
For additional information about the wildlife of this refuge: http://saltplains.fws.gov
For information about the national wildlife refuge system, click on: http://www.fws.gov

Partial Checklist of Bird Species for the Salt Plains National Wildlife Refuge

Key to Listing

Occurrence **Sp for Spring (March thru May)**
S for Summer (June thru August)
F for Fall (Sept. thru November)
W for Winter (Dec. thru Feb.)

Abundance **A for Abundant (common species that is very numerous)**
C for Common (certain to be seen in suitable habitats)
U for Uncommon (present, but not certain to be seen)
O for Occasional (seen a few times during the season)
R for Rare (unusual, seen every 1 to 5 years)
• a bird species that nests at this refuge

Common Name	Sp	S	F	W
American White Pelican	A	U	A	O
Double-crested Cormorant	C	U	C	O
Great Blue Heron*	C	C	C	C
Snowy Egret*	C	C	C	
Turkey Vulture*	C	C	C	
Canada Goose*	A	U	A	A
Mallard Duck*	A	U	A	A
Blue-winged Teal*	A	O	A	U
Bald Eagle	C		C	C
Red-shouldered Hawk*	R	R	R	R
Red-tailed Hawk*	C	U	C	C
Sandhill Crane	A		A	R
Whooping Crane	R		O	
American Avocet*	A	A	A	
Snowy Plover*	A	A	A	
Least Tern*	C	C	C	
Franklin's Gull	A	U	A	
Great Horned Owl*	C	C	C	C
Ruby-throated Hummingbird	O	O	O	
Red-headed Woodpecker*	C	C	C	R
Scissor-tailed Flycatcher*	C	A	U	
Blue Jay*	C	C	C	C
American Crow*	C	C	C	C
Carolina Chickadee*	C	C	C	C
Eastern Bluebird*	C	U	C	U
Northern Mockingbird*	U	U	U	O
Orange-crowned Warbler	C		U	
Dark-eyed Junco	A		A	A
Northern Cardinal*	C	C	C	C
Painted Bunting*	U	U	O	

Salt Plains National Wildlife Refuge – High School
Title: Cation Exchange Capacity: An Indicator of Soil Fertility
Video Title on SDE Website: Cation Exchange Capacity HS
Length: 0:08:58

Teacher Tool – Primary Focus: Chemistry and Biology I

Description of the Bellringer:

Led by Ms. Becky Wolff of the Salt Plains National Wildlife Refuge, Enid High School students conduct an analysis of soil samples to determine their **cation exchange capacities.**

This bellringer defines such terms as: adsorption, cation and the cation exchange capacity of a soil. It also explains why cation exchange capacity is important in helping to determine the fertility of a particular soil. The bellringer shows students using Process Standards as they conduct this experiment. Their experiment consists of the analysis of soil samples that the students collected from a wetland within this wildlife refuge.

Curriculum Application

***PASS* for High School Biology I, Process Standard 3:** conducting an experiment;
***PASS* for High School Chemistry, Process Standard 3:** conducting an experiment;
***PASS* for High School Chemistry, Inquiry Standard 2.1:** a large number of important reactions involve the transfer of either electrons or hydrogen ions.

Background Information:

Brief Review of Some of the Chemical Reactions That Occur in Soil
Soil contains many chemical elements that are essential for plant growth. While water does leach some elements from the soil, many elements are kept in the soil through the process of **adsorption**. By adsorption these elements, as nutrients, cling to the surfaces of tiny particles of soil. Adsorption can be likened to static electricity that causes clothing to cling as it comes out of a dryer. The static-charged clothing isn't **absorbed** as it sticks to us; it's **adsorbed.**

Nutrients that are **adsorbed**, or that cling to soil particles, are thus available for **absorption** into a plant through the plant's root system.

Most essential plant nutrients have a positive charge. This positive charge is because, as ions, their atoms or molecules have fewer electrons than protons. These positively charged ions are called **cations** (pronounced cat-eye-ons). Ions that have a negative charge are called **anions.** Ions of opposite charge are attracted to each other; ions of the same electrical charge are repelled.

Cation Exchange Capacity Cont'd.

Relationship of a Soil's Particle Size and Adsorption
One way to distinguish soil is by the size of its particles. Clay soil consists of microscopic size particles. Silt has larger particles than clay and sand has larger particles that clay and silt. Because clay consists of microscopic particles, it is a **colloid.**

If one had three containers of equal size and filled one with clay, another with silt and the third with sand, the clay sample would consist of many more particles than the other two soil samples. Further, these clay particles have a total surface area that is much greater than the surface area of the larger soil particles of the sand and silt samples.

Clay soil particles, as ions, usually have a negative charge. These negatively charged clay particles, combined with the tremendous amount of surface area of these clay particles within a unit of soil, enables clay particles to adsorb a great number of positively charged plant nutrients.

Humus
Humus is organic matter that is formed from the decomposition of dead plants and animals. Like clay, humus particles are also colloids and have many negatively charged surfaces.

Cation Exchange
Cation exchange is the process by which cations that are adsorbed on the surfaces of soil colloids are exchanged for, or replaced by, other cations in the soil. Calcium, magnesium and potassium are among the plant nutrients that are held by soil particles through adsorption.

Plant roots and microorganisms in the soil give off hydrogen ions (H+). If enough of these hydrogen cations surround an adsorbed nutrient cation, they can bounce the nutrient cation from the soil particle as the hydrogen cation takes its place on the soil particle's negatively charged surface. The nutrient cation is now free of its static bond to the soil particle so that it can now be absorbed into the plant's root system.

Cation Exchange Capacity
The ability of a soil to adsorb and release cations is called its **Cation Exchange Capacity (CEC).** A soil's Cation Exchange Capacity is calculated in terms of the milligrams of cations that can be stored in 100 grams of soil. The amount and type of clay soil, and the amount of humus in the soil, will determine how much Cation Exchange Capacity a soil has. Soils with a high CEC are fertile, having the ability to store a sufficient supply of nutrients for healthy plant growth.

Cation Exchange Capacity Cont'd.

Location and General Description of the Investigation
In this bellringer Enid High School Students calculated the cation exchange capacities for soils that they collected from three different sites within the Salt Plains National Wildlife Refuge of northwest Oklahoma. Three teams of students each collected a soil sample from locations within the wetland of the Bonham Youth Fishing Pond. Thus, the soils from three different locations were examined in this experiment. With the assistance of Ms. Becky Wolff of this refuge, the students conducted their experiment as follows:

Safety Procedures

1. At the work table the students began their experiment by putting on their safety glasses and gloves (Process Standard 3.5). The chemicals that they used are all caustic.
2. Waste chemicals and other materials from this experiment are disposed of in an appropriate manner. None of this waste material was dumped into the lake or onto the ground.

Hypothesis for the Investigation
A hypothesis for this experiment might be stated as follows:

> **If** soils containing clay and organic material normally have high cation exchange capacities, **then** the team of students whose soil contains the greatest amount of these materials should have the highest cation exchange capacity. (Process Standards 3.4 and 6.1).

Identification of Variables and Constant (Process Standard 6.2)

The three different soil samples serve as the **independent variables;**

The **dependent variable** is the cation exchange capacity that is calculated for each of the three soil samples;

The **constant** for the experiment is that all of the soil samples were collected in the same manner, from the same wetland, on the same day and using the same methods for analysis. (Process Standard 3.2).

Performance of the Investigation (Process Standard 6.2)

1. Each team of students collected a soil sample from different locations around the Bonham Youth Fishing Pond. They brought their sample to a work table at this pond.

2. Each team of students used three test tubes for performing the test on their soil sample. They began by labeling each of the tubes and placing five milliliters of their soil sample into all three tubes.

Cation Exchange Capacity
Performance of the Investigation Cont'd.

3. Each team of students calculated their soil's cation exchange capacity (dependent variable) using the following protocol: (Process Standard 6.3)

   a. Each soil sample, which is in three test tubes, received different quantities of the chemical reagent Barium chloride (8, 14 and 20 drops) and enough distilled water to have a total of 10 milliliters of solution in each test tube;

   b. Once the contents of each test tube formed a precipitate, one milliliter of this solution is removed and placed into a compartment of a testing tray. Each of the three samples, reflecting the three different quantities of Barium chloride, are labeled on the tray.

   c. A fourth compartment of the testing tray serves as a reference sample. This sample contained 18 drops of distilled water and two drops of Barium chloride. It doesn't have any soil precipitate. The students then added one drop of the reagent Potassium dichromate to this reference sample and observed that it turned a bright yellow color. This is because the filtrate solution was saturated with positively charged Barium ions (cations).

   d. The next step in this procedure is the placement of one drop of Potassium dichromate to each of the three soil precipitates. Potassium dichromate is a reagent that will trigger a chemical reaction with the Barium chloride. The Enid High School students found that the addition of Potassium dichromate caused all of the samples to turn different shades of yellow.

Description of the Chemical Reaction Involving Barium chloride and Potassium dichromate (Inquiry Standard 2.1)

Each soil sample contains different quantities of Barium chloride. As the Potassium dichromate reacts to the Barium chloride, Barium chromate and Potassium chloride are formed.

$BaCl_2$ (aqueous)	+ K_2CrO_4 (aqueous)	= $BaCrO_4$	+ 2KCl (aqueous)
Barium chloride	Potassium dichromate	Barium chromate	Potassium chloride

The positively charged Barium cations from the Barium chromate are attracted to the negatively charged sites on the soil particles. The brightest yellow color occurred when the soil particles are saturated with Barium cations, and excess cations are in the solution, just as in the reference sample.

Cation Exchange Capacity Cont'd.

Calculation of Cation Exchange Capacity (CEC)

Two teams of students calculated the cation exchange capacity for their soil samples using the following formula. These students found that their filtrate turned bright yellow when Potassium dichromate was added to the sample that contained 14 drops of Barium chloride. Their CEC calculation was:

$$CEC = \frac{(\text{drops of Barium chloride} - 2) \times 0.2N}{5 \text{ ml}} \times 100$$

CEC = (14 drops of Barium chloride, minus 2) times 0.2N times 100 divided by 5 ml

CEC = 48

The reason that the number two is subtracted from the number of drops of Barium chloride is that the reference sample, which doesn't contain any soil precipitate, contains two drops of Barium chloride, thus 2 is subtracted from the 14 drop input.

Findings

The first two teams of students had soil samples that primarily consisted of organic material (humus) but did not contain a significant amount of clay. As previously calculated, these students had CEC values of 48 (their soil precipitate containing 14 drops of Barium chloride matched the bright yellow color of the reference sample).

The third team of students had a soil sample that contained a high percentage of clay and humus particles. When Potassium dichromate was added to the first two of their test samples, which contained 8 and 14 drops of Barium chloride, the samples kept their pale yellow color. The soil particles in these two samples were still able to absorb all of the positively charged Barium cations, thus keeping the solution a pale yellow color. There weren't any excess Barium cations floating in the filtrate solution.

Once this third team of students added the Potassium dichromate to the sample that contained 20 drops of Barium chloride, they found the cation saturation point for their soil. All of the negatively charged soil particles had combined with the positively charged Barium cations and there were now free Barium cations in the solution. These free cations turned the solution bright yellow, just like the free cations had turned the reference sample this same color.

By using the CEC calculation formula, this third team of students obtained a CEC value of 72.

Cation Exchange Capacity Cont'd.

Conclusion

In conclusion, the students found that their hypothesis was validated. They found that the soil containing the greatest amount of clay, blended with organic material, provided the highest CEC value. Again, the reason for this is because these clay and humus particles are colloids. As colloids, these clay and humus particles have more surface area, and thus more cation exchange sites, than the two soil samples that primarily consisted of humus. (Process Standard 6.4)

It should be noted that based upon the Cation Exchange Capacity values of 48 and 72, that all three of the soils had CEC values are high and that all of these soils are considered fertile.

Salt Plains National Wildlife Refuge – High School
Title: Determining Dissolved Oxygen of Water Samples
Video Title on SDE Website: Determining Dissolved Oxygen HS
Length: 0:07:23

Teacher Tool- Primary Focus: Biology I; Process Standards

Description of the Bellringer:
Led by Ms. Becky Wolff of the Salt Plains National Wildlife Refuge, Enid High School students calculate the concentration of dissolved oxygen in water samples that they took from Great Salt Plains Reservoir. This lake is located in northwest Oklahoma.

This bellringer explains the importance of dissolved oxygen to aquatic animals. It also shows students applying Process Standard 1 as they use a measurement process called the Azide-Winkler titration to determine the concentration of dissolved oxygen for their water samples.

Curriculum Application

***PASS* for High School Biology I, Process Standard 1 Observe and Measure**

Background Information
Dissolved oxygen is oxygen, in a gaseous state, that is contained within water. Dissolved oxygen is essential for the survival of most aquatic life. Concentrations of oxygen that are in water and the atmosphere are measured in parts per million. The maximum concentration of oxygen that occurs in water is 15 parts per million. In other words, in a volume of water that contains one million molecules, 15 of these molecules are oxygen. In contrast, the air that we breathe contains oxygen at a concentration of 200,000 parts per million.

Most fish require dissolved oxygen at 5 parts per million in order to survive. If dissolved oxygen concentrations go below this number most species of fish will be stressed and if the dissolved oxygen level reaches 3 parts per million they will die.

For this reason, it is important to know the concentration of dissolved oxygen within a lake, river or stream. Even small changes in dissolved oxygen levels can pose serious consequences for many of the animals that live in an aquatic ecosystem.

Description of the Water Analysis
The Enid High School students obtained water samples from Great Salt Plains Reservoir. Led by Ms. Becky Wolff of the Salt Plains National Wildlife Refuge, and using the refuge's lab, these students fixed their samples and then performed a titration to calculate the dissolved oxygen of the lake water.

Lab Safety Procedure (Process Standard 3.50
Before beginning this lab exercise, which involves the use of caustic chemicals, the students put on safety glasses, gloves and lab aprons.

Determining Dissolved Oxygen Cont'd.
Lab Procedure (Process Standard 1)

The first step in beginning this exercise is to properly transfer the water to be sampled from its container into a test tube. If not performed correctly, the water becomes aerated, which adds oxygen into the water. Air bubbles in the water sample will cause the dissolved oxygen reading to be greater than is the actual oxygen concentration of the lake water. The bellringer shows the students carefully filling their test tubes from the bottom of the water bucket and reattaching the tube stopper while it is still submerged. They then check to make sure that there aren't air bubbles in the test tube containing their sample.

The next step involves fixing the water sample. A fixed sample means that it is stable; that it won't be affected by exposure to the atmosphere.

In order to fix their samples, the students add three chemicals to their sample. First, the students use a pipette to add 2 milliliters of manganese sulfate. Next, 2 milliliters of a reagent, alkali-potassium iodide solution is added to the water. After each step the stopper is placed back on the test bottle to keep oxygen that is in the air from entering the sample.

These two chemicals combine with dissolved oxygen to form a brown colored precipitate, also called floc. After the floc settled to the bottom of the test tube, the sample is then mixed by turning it upside down several times. Once the floc has again settled, 2 milliliters of concentrated sulfuric acid is added to the sample. The tube is carefully sealed with the stopper and then inverted to dissolve the floc. Once the floc has again dissolved, the water sample is "fixed".

During the next step of this exercise the students perform a titration. Using a syringe, the students carefully add sodium thiosulfate to their sample. After each drop of sodium thiosulfate is added, the sample is swirled. At a certain point the sodium thiosulfate causes the brown solution to turn a pale yellow or straw color. When this occurs the students then add 2 milliliters of starch solution, which turns their sample to a blue color.

The final step of this exercise involves the students placing additional sodium thiosulfate, drop by drop, into their sample. Once their sample turns from the blue color to clear the students recorded the total milliliters of sodium thiosulfate that they added to the water sample. The number of milliliters of sodium thiosulfate that were added is equal to the milligrams per liter (mg/L) of oxygen that is in the lake water.

The students calculated the dissolved oxygen of their lake sample to be 6.10 milligrams per liter. A milligram per liter is equivalent to 1 part per million (ppm) because a liter of water weighs 1000 grams and a milligram is one thousandth of a gram.

Thus the dissolved oxygen reading obtained by the students can also be expressed as 6.10 parts per million. This is an acceptable dissolved oxygen level for Great Salt Plains Reservoir.

Salt Plains National Wildlife Refuge – High School
Title: Determining the pH of Soil Samples
Video Title on SDE Website: Determining pH of Soil HS
Length: 0:07:19

Teacher Tool: - Primary Focus: Process Standard for Biology I and Chemistry

Description of the Bellringer:

Led by Ms. Becky Wolff of the Salt Plains National Wildlife Refuge, Enid High School students conduct a pH analysis of soil samples.

This bellringer defines pH and why this chemical measurement of soil is important in understanding a soil's ability to sustain plant and animal life.

Curriculum Application

***PASS* for High School Biology I, Process Standard 1: Observe and Measure**
***PASS* for High School Chemistry, Process Standard 1: Observe and Measure**

Background Information

Soil is an essential component of all land-based food chains. Soil contains nutrients, water and oxygen that are fundamental to the survival of plant life. Important microscopic animals also live in soil.

While the soil of different places may look similar, a soil's chemistry determines its usefulness to plant life. For example, many plants can't survive when they try to grow on soils that are either too acidic or too basic.

What is an acidic soil? It's a soil that has a much greater percentage of positively charged hydrogen ions (H^+) than negatively charged hydroxide ions (OH^-).

Some plants, like azaleas, cranberries and blueberries, have adapted so that they are most healthy when they are growing on acidic soils. Other plants, like the date palm tree, salt grass, and cotton, have adapted so that they can grow on soils that are basic, which also may be salty or alkaline soils.

Most plants grow on soil that is neutral, meaning it's not too acidic nor is it too basic. Nutrients that are essential to plant survival are most easily absorbed by plant roots when the plants are growing on a neutral soil.

By using a pH test, scientists are able to tell if a soil is acidic, basic or neutral. pH is a measure of the concentration of positively charged hydrogen ions that are in a soil or solution. There are two methods of calculating pH: one is called electrometric and involves measuring the electrical conductivity of a liquid that is being tested.

Determining pH of a Soil Cont'd.

The other method of determining pH is called colorimetric. In a colorimetric test an indicator solution, which contains chemical reagents, is mixed with a water or soil sample. By comparing the resulting color of the sample with a color key that represents known pH values, the researcher can determine the pH of their soil sample. Colorimetric pH tests are most common for field experiments because they don't require the use of high precision instruments.

pH readings of a soil sample can range from 0 to 14. Readings below 7 are considered acidic reactions, while readings above 7 are basic reactions. A neutral reading has a pH of 7. As a reading approaches 0, the sample is increasingly acidic. Likewise, as a sample approaches a value of 14, it is increasingly basic. The pH of most agricultural soils is from 5 to 8.

Description and Procedure of the Soil pH Study

This bellringer shows Enid High School students as they use a colorimetric pH test to determine the pH of soil samples that they took from a wetland in the Salt Plains National Wildlife Refuge. Ms. Becky Wolff of this refuge is their instructor for this experiment.

1) The three teams of Enid students obtained their soil samples from locations around the Bonham Youth Fishing Pond. Before starting their test, the students first put on their safety glasses and gloves. At the work table, the students then placed a small portion of their soil sample into the compartment of a test tray.

2) In the next step the students added enough of the pH indicator solution to saturate their soil sample. Using a clean, plastic spatula, the soil sample is thoroughly mixed with the indicator.

3) In the final step the students compared the color of their soil sample with a color key. All of the students found that their soil samples were in the slightly basic range. Two teams had samples that were green in color, indicating a pH value of 8, while one team had a sample that was greenish-blue in color, which meant that their soil had a pH of 9, or was slightly more basic than the soil samples of the other two teams.

Conclusion

The pH readings for the soils at Bonham Youth Fishing Pond indicate that these soils are suitable for healthy plant growth.

While the pH readings that were obtained by the Enid students are important, of even greater importance to scientists is knowing when there are changes, over time, in the pH measurements of a particular place. By noting if pH, or other chemical or biological changes are occurring within an environment, scientists attempt to determine the cause or causes of these changes. In this way it is hoped that corrective action can be taken to prevent significant harm to the environment.

Salt Plains National Wildlife Refuge – High School
Title: Determining the pH of Water Samples
Video Title on SDE Website: Determining pH of Water HS
Length: 0:04:20

Teacher Tool – Primary Focus: Process Standard 1 for Biology I and Chemistry

Description of the Bellringer:
Led by Ms. Becky Wolff of the Salt Plains National Wildlife Refuge, Enid High School students conduct a pH analysis of water samples that they took from the Great Salt Plains Reservoir. This lake is located in northwest Oklahoma.

This bellringer will define pH and why this chemical measurement of water is important in evaluating the health of an aquatic ecosystem.

Curriculum Application

***PASS* for High School Biology I, Process Standard 1: Observe and Measure**
***PASS* for High School Chemistry, Process Standard 1: Observe and Measure**

Background Information

pH is a measure of the concentration of positively charged hydrogen ions that are in water or soil. pH readings can range from 0 to 14. Readings that are below 7 indicate acidic conditions, while readings above 7 reflect basic conditions. A neutral reading has a pH of 7. As a reading approaches 0, the water or soil is increasingly acidic. Likewise, as water or a soil's pH approaches 14, it is increasingly basic.

Many plants and animals are very sensitive to conditions that are highly acidic or basic. When such conditions occur these plants and animals can't survive; they die.

Description and Procedure of the Water pH Study

In this bellringer Enid High School students begin by taking water samples from Great Salt Plains Reservoir. These samples are brought into the refuge's lab for this activity. Before beginning the pH study, the students first put on safety glasses, gloves and lab aprons.

1) For the first step in this analysis the students place 5 milliliters of their lake water sample into a test tube. Next they add ten drops of an indicator solution to this test tube. After capping the test tube, the solution is mixed by inverting the tube three times.

2) Using a color indicator, the students compare the color of their water sample to the range of colors that are displayed in the LaMotte water test reader. By comparing their sample with the matching color of this testing device the students are able to determine the pH of their water sample.

Determining pH of Water cont'd.
Findings and Conclusion

The students found that their lake water samples have a pH reading of 8.5, indicating that the lake has a basic pH. This level of pH is not harmful to most aquatic plants and animals.

While the pH readings that were obtained by the Enid students are important, of even greater importance to scientists is knowing when there are changes, over time, in the pH measurements of a particular environment. By noting if pH, or other chemical or biological, changes are occurring within a place, scientists attempt to determine the cause or causes of these changes. In this way it is hoped that corrective action can be taken to prevent significant harm to the environment.

Acid Rain

Acid rain is a pollutant that has significantly changed the pH of many forest and aquatic ecosystems. Caused by emissions of sulfur dioxide and nitrogen oxides from coal-fired electrical plants, factories and motor vehicles, these chemicals react with water molecules in the atmosphere, producing sulfuric acid and nitric acid. Any form of precipitation, such as rain and snow, remove these acids from the atmosphere and bring them to the earth's surface. Because acid rain is air-borne, it can drift hundreds of miles from the factory or other source of the emission.

Acid rain harms trees and other forest plants by damaging their leaves which impairs the plant's ability to produce its food through photosynthesis. Also as the soil pH is lowered (becomes more acidic) chemical changes occur that eliminate essential nutrients in the soil. A third problem is that as a soil becomes more acidic aluminum is released in the soil. Aluminum ions can be harmful to trees and to other plants. The combined impact of these changes is that trees become weakened, and thus are more susceptible to the effects of disease, insect damage and adverse weather conditions.

Perhaps the greatest negative impact from acid rain has been to aquatic ecosystems. As acid rain makes a lake, river or wetland more acidic, many plant and animal species die. These species aren't able to tolerate habitat conditions that have a low pH. Also, aluminum is released through acidic conditions. The combined effect of aluminum and low pH can directly kill fish. While some aquatic animals can tolerate these conditions they often are stressed by these chemical changes to their aquatic habitat. As fish and other aquatic animals die, the food chain is disrupted. The aquatic animals that are killed from acid rain area an essential food source for many other animal species.

The only solution to acid rain pollution is to reduce emissions of sulfur dioxide and nitrogen oxide. In recent years many countries, including the United States, have implemented acid rain programs. While such programs have reduced the emission of pollutants, some contend that even if acid rain could be stopped today, that it will still take many years for its harmful effects to disappear.

Determining pH of Water cont'd.

Several websites that contain additional information about acid rain are:

The Environmental Protection Agency (EPA)
www.epa.gov/acidrain/effects

National Geographic Society
http://environment.nationalgeographic.com/global-warming/acid-rain-overview

Salt Plains National Wildlife Refuge – High School
Title: Estimating Wildlife Populations at the Salt Plains NWR
Video Title on SDE Website: Estimating Wildlife at Salt Plains HS
Length: 0:05:50

Teacher Tool – Primary Focus: Process Standards

Description of the Bellringer:
This bellringer demonstrates several ways that wildlife surveys are conducted at this refuge. Mr. Ron Shepperd, a biologist at the Salt Plains National Wildlife Refuge, shows students of Timberlake High School how he performs wildlife surveys of migrating waterfowl, shorebirds and other bird species at this refuge. Because many of these birds number in the thousands it isn't possible to count every bird. For this reason a sampling technique is used to estimate the number of birds that are observed from shoreline locations.

A second part of this bellringer contains aerial footage of Mr. Greg Birkenfeld, manager of the Salt Plains National Wildlife Refuge, and Mr. Jim Bredy, wildlife biologist and pilot for the US Fish and Wildlife Service's Division of Migratory Bird Management, as they conduct a waterfowl survey from an airplane. Mr. Birkenfeld and Mr. Bredy explain the importance of their survey in helping their agency manage and protect our Nation's wildlife resources. The sampling technique for this aerial survey is similar to the method used by Mr. Shepperd for his ground-based surveys.

Curriculum Application

***PASS* Process Standards**
Standard 1.2 Use appropriate tools in measuring populations.
Standard 2.1 Use observable properties to classify organisms.
Standard 3.3 Use mathematics to show relationships within a given set of observations for population studies.

Additional Resources
The Salt Plains National Wildlife Refuge is a key resting and feeding location for many migrating birds. For example, many shorebirds migrate thousands of miles from their nesting habitats in the Arctic, to their winter habitats in Central and South America. The Salt Plains refuge is a designated site within the Western Hemisphere Shorebird Reserve Network. It is used by at least 20,000 shorebirds each year.
http://www.whsrn.org/western-hemisphere-shorebird-reserve-network

U.S. Fish and Wildlife Service's Migratory Bird Program:
www.fws.gov/migratorybirds/dmbmdbhc.html

Salt Plains National Wildlife Refuge – High School
Title: Using Transects to Perform Wildlife Surveys at the Salt Plains NWR
Video Title on SDE Website: Using Transects HS
Length: 0:07:10

Teacher Tool – Primary Focus: Process Standards; Biology I

Description of the Bellringer:
Mr. Ron Shepperd, biologist for the Salt Plains National Wildlife Refuge, describes to students of Timberlake High School how he uses transects in order to estimate the population of the endangered interior least tern, which nests on the salt flats of this refuge. Mr. Shepperd notes how the territorial behavior of this bird helps him to locate the nest of each pair of least terns.

Curriculum Application

***PASS* Process**
Standard 3.3 Use mathematics to show relationships within a given set of observations for population studies.
Biology I
Standard 6.2 Broad patterns of behavior exhibited by animals have changed over time to ensure reproductive success.

Additional Resources

U.S. Fish and Wildlife Service's Endangered Species Program- Interior Least Tern
www.fws.gov/southwest/es/oklahoma/lestern.htm