SECTION 319 NONPOINT SOURCE POLLUTION CONTROL PROGRAM

INFORMATION/EDUCATION/TRAINING/DEMONSTRATION PROJECT

FINAL REPORT

WETLANDS EDUCATION PILOT PROGRAM

By

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August 11, 2005

This project was conducted in cooperation with the State of South Dakota and the United States Environmental Protection Agency, Region 8.

Grant # C9998185-03

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EXECUTIVE SUMMARY

PROJECT TITLE: WETLANDS EDUCATION PILOT PROGRAM

PROJECT START DATE: MAR.1, 2004 PROJECT COMPLETION DATE: AUG. 31, 2005

FUNDING:	TOTAL BUDGET	$50,000.00
	TOTAL EPA GRANT	30,000.00
	TOTAL EXPENDITURES OF EPA FUNDS	9,306.10
	TOTAL SECTION 319 MATCH ACCRUED	6,793.65
	BUDGET REVISIONS	
	TOTAL EXPENDITURES	$16,099.75

SUMMARY ACCOMPLISHMENTS

While we were not able to accomplish all of our original goals within the time frame of the grant, we did reach a level of accomplishment to enable us to continue the project after the grant has come to a conclusion. We contacted numerous middle school science teachers and selected six to serve in the pilot program. We developed pre and post tests for the students, and an evaluation form for the teachers to fill out at the conclusion of the teaching module. We completed two of the lesson plans and others are in varying stages of completion. We expect to complete those by the end of September. We have collected, evaluated, selected, and distributed supplementary materials to the six teachers. One of the teachers used the supplementary materials and the two completed lesson plans in his classroom and reported excellent results.

1.0 INTRODUCTION

The overall view of the information and education component of the South Dakota State Non-point Source Management Plan is that much NPS control can be achieved by informing land managers of the resource implications of management and giving them the information to improve that management, thereby benefiting both their enterprises and the environment. The continued drainage of wetlands in eastern South Dakota is evidence that land owners and managers are not yet fully aware of the benefits of wetlands protection. Water quality is of great importance to everyone, especially those who are in a position to determine, at least to some extent, the quality of the water that they, and their families, will drink. Land managers who drain their wetlands are either unaware of the water quality benefits of wetlands, or they believe that the presumed financial gain of drainage will in some way offset the loss of water quality.

Pollutants are generally misplaced resources. For example, the nitrates that find their way into a drinking water supply and may threaten the health of the user are valuable to the farmer when kept in the soil near the roots of crops. Much of pollution control is keeping resources where they are beneficial rather than trying to eliminate them from the environment. High nitrate content in rural drinking water is a well know problem, especially in the eastern part of the state. When fertilizer is applied to fields at levels higher than the soil and crop plants can take up, the excess washes into our waterways and eventually into our drinking water. This fertilizer was purchased by the land owners and was intended to feed their crops. Instead, this nutrient resource has become a devastating pollutant. One well field, at Elkton, has already been closed because of high nitrate levels. At least one infant has died of methemaglobinemia, the blue baby syndrome caused by ingesting high levels of nitrates. Studies have shown that drainage water from tiled wetlands contains as much as 70% of the nutrients applied to the fields surrounding the wetlands. These nutrients, along with the drainage water, are piped directly into ditches and steams. Wetlands that are left intact hold the water, allowing wetlands plants to take up the nutrients that enter the water. This project aimed to fill the need for additional education for those who may, in the future, be in a position to protect our wetlands.

This project targeted middle school science class students in the general area of Sioux Falls, South Dakota. This audience was targeted because the students are at an age when they are open to new ideas and the concepts that they learn at this age will shape the decisions they make as adults. These students are the people who will determine the fate of our wetlands ten and twenty years in the future. In addition, students whose attitudes are changed through education will communicate their excitement and ideas to their parents as they talk about the activities that they have participated in. Indirectly, the attitudes of the parents about the values of wetlands may be affected and may lead to more immediate decisions to protect wetlands.

2.0 Project Goals, Objectives, and Activities

The goal of this project was to build positive attitudes in the target groups (Middle School students and their parents) about wetlands and their value in protecting our water quality. The specific goal for the middle school science class audience was to establish an early understanding of the importance of wetlands so that in later years these students will make educated decisions about wetlands protection. The secondary goal was to build more positive attitudes toward wetlands in the parents of the students, leading to more appropriate decisions about wetlands protection.

The objective of this project is to develop, implement and evaluate a tightly targeted, in depth, South Dakota specific educational project. To meet this objective, we intended to complete nine tasks.

Task 1 was to develop one and two week courses of study for middle school science students. Each activity was to have met one or more of the state and national standards for middle school science. The completed modules were to contain lesson plans, quizzes, and a CD of additional supplementary information.

Task 2 was to develop pre and post tests for the participating students. These tests were to measure what the student knew about wetlands before exposure to the module and after exposure to the module.

Task 3 was to develop the questionnaire to be administered to participating teachers after completion of the wetlands educational module. This questionnaire asked the teacher to evaluate the module and suggest improvements for it.

Task 4 was to develop the CD of additional information gathered from sources such as SDSU Wildlife Biology publications, guide books, and internet sites, and to assemble supplementary materials gathered from such sources as the Environmental Protection Agency, Project Wild, Wonders of Wetlands, Izaac Walton League, National Wildlife Federation, and others; basic equipment such as flora and fauna identification sheets and collecting equipment for a field trip to a wetland, and simple water tests that students can complete in the Mobile Science Lab.

Task 5 was to work with four to six teachers to present the modules to the students and to administer the measurement instruments. In this pilot program, these teachers were recruited in the Southeastern part of the state and students were to visit wetlands in the Sioux Falls area and the Outdoor Campus.

Task 6 was to evaluate the measurement instruments and work with the participating teachers to make improvement to the modules or tests.

Task 7 was to work with participating teachers to present the improved modules and measurement instruments. Teachers and/or classrooms other than those involved in Task 5 were to be selected for this task.

Task 8 was to work with other organizations to identify additional facilitators to be trained to take the modules to classrooms across the state. Groups such as Izaac Walton League and South Dakota Wildlife Society were to have been asked to help identify members of their organizations who are interested in becoming facilitators.

Task 9 was record keeping and reporting.

2.1 Planned and Actual Milestones, Products, and completion Dates

TASK/RESPONSIBLE ORGANIZATIONS	OUTPUT	QTY	YEAR 1	YEAR 2
			03/04 12/04	01/05 08/05
Objective 1 **Task 1 – Develop one and two week courses of study for middle school science students about the importance of wetlands to protecting our water quality. Groups 1,2,3**	**Lesson plans**	**2**	x x x **X X X X X**	**X X X**
Task 2 – Develop pre and post tests for participating students. Groups 1,3	**Pre and post test**	**2**	x x **X**	
Task 3 – Develop questionnaire to be administered to participating teachers. Groups 1,3	**Teacher questionnaire**	**1**	x x **X**	
Task 4 – Develop CD of additional materials and assemble supplementary materials. Groups 1,2,3	**CD** **Supplementary Materials**	**1** **1**	x x **X X X X** x x **X X X X X**	**X X X** **X X**
Task 5 – Work with four to six teachers to present the lesson modules to students. Groups 1,2,3,4	**Teachers who have presented** **Classrooms that have been exposed to the Material**	**6** **6**	x x x x	**X** **X**

Task 6 – Evaluate measurement instruments. Group 1	**Classroom tested modules**	**2**	x	
Task 7 – Work with teachers to present improved modules. Groups 1,2,3,4	**Improved and classroom tested modules**	**2**		x x
Task 8 – Work with other organizations to identify potential facilitators. Group 1	**Group of potential facilitators**	**1**		x
Task 9 – Record keeping and reporting. Groups 1,2	**Records and reports**	**3**	x **X X X X X**	x **X X**

Group 1 – South Dakota Resources Coalition – Develop, implement and evaluate educational projects.
Group 2 – East Dakota Water Development District – Keep records and prepare reports.
Group 3 – South Dakota Game, Fish and Parks Department – Provide technical assistance, printed materials, access to wetlands.
Group 4 – Governor's Office of Economic Development & SD Dept. of Education – Provide Mobile Science Lab.

x = **Planned time line** **X = Actual time line**

EXPLANATION OF FAILURE TO MEET ANTICIPATED TIME LINE

The original request was for $60,000. This amount was to include hiring one employee complete several of the tasks. We were granted only $30,000 which meant we could not hire a person and had to rely on that person doing the work in spare time while working a full time job elsewhere. This created several problems. One was that it meant far less time was devoted to the grant work than we had anticipated and that we had little control over the time spent, since the person was working only in spare time, more or less as a paid-by-the-hour volunteer. Another problem was that, as a near volunteer, the person did not spend time in our office and, therefore, received far less supervision than we had anticipated. Together, these problems conspired to create a tremendous lag in the time that the various tasks were completed. A separate, but related problem was that the person did not understand what was required in a lesson plan, but that did not become apparent until late in the grant period. At that time, others took over that task, but it was too late to use the plans in a classroom setting before the end of the grant period. Therefore, Tasks 5,6,7, and 8 could not be completed. Another related but separate problem was that the curriculum at the schools was changed twice during the grant period to comply with No Child Left Behind. The changes greatly regimented the classroom activities, leaving little time for innovative programs such as ours. Teachers excited about our program struggled to find a time slot for it. Finally, unforeseeable and, to date, unresolved technical problems made completion of the CD impossible.

2.2 Evaluation of Goal Achievement and Relationship to the State NPS Management Plan

We have developed pre and post tests for the students that reflect the information that we would like the students to learn in the modules. The content of the tests may be modified as the lesson plans are completed. We have completed the teacher questionnaire. We have assembled the supplementary materials and distributed it to the six teachers who were selected for the pilot program. Two lesson plans have been completed and six additional ones are at various stages of completion. One of the six teachers used the supplementary materials and the two completed lesson plans in his classroom and said that he will definitely use the materials again. He thought that his students had learned a great deal about wetlands and their value and is eager to receive the remaining lesson plans.

While we have accomplished less than we had hoped, nevertheless, we have achieved a level of success that will enable us to continue the project after the termination of the grant period. The six teachers are excited about the program and intend to present it to their students during school year 2005-2006. The teachers believe that the program will meet the goal of building positive attitudes about wetlands and their value in protecting our water quality. They also believe that the program will be beneficial to the students and that other teachers will want to present it to their students.

The modules will help implement the state's NPS management program by helping students to understand the value of functioning wetlands in filtering out and taking up pollutants that would otherwise enter our waterways. Positive attitudes toward wetlands will enable students, later in life, to make better educated and more appropriate decisions about wetlands, and therefore, help to protect state water quality.

2.3 Supplemental Information

There is no supplemental information.

3.0 Long Term Results in Terms of Behavior Modification, Stream/Lake Quality, Ground Water, and/or Watershed Protection Changes

The major long term result of the project is the changed attitudes of the students toward wetlands. Students who were exposed to the abbreviated program in one teacher's classroom learned the value of wetlands to our water quality and will probably be more likely to want to protect wetlands in the future than they would have been without the program.

A secondary long term result is that the six teachers have been exposed to the idea that South Dakota wetlands can be used to teach myriad science ideas to middle school children. Several of the teachers are excited about using the wetland model to teach not only water quality protection but also life cycles and nutrient cycles. By exposing students to wetlands as repositories of enormous plant and animal diversity, as the nurseries for many species, as living examples of nutrient cycles, and generally exciting

places to visit, students' attitudes toward wetlands will be greatly biased toward protection of the places as valuable in themselves, which will also protect our water quality.

A third long term result is the changing attitudes of the parents of the students, as the children bring home the information and excitement that they derive from studying wetlands.

4.0 Best Management Practices (BMPs) developed and/or revised (For Demonstration Projects)

This section is not applicable to the project.

5.0 Monitoring Results for Demonstration Projects

We developed pre and post tests to be administered to the students before and after exposure to the program. The teachers were to score the tests and send the scores to us to be evaluated. The plan was to see whether students did better on the test after the course than before. Since the course is not yet ready for classroom presentation, testing could not be done. One teacher decided to use the supplementary materials and the two completed lesson plans to present an abbreviated course to his students. He reported that the students learned a great deal about wetlands and their role in protecting our water quality.

5.1 BMP Effectiveness Evaluations

Not applicable.

5.2 Surface Water Improvements

Not applicable.

5.3 Groundwater Improvements

Not applicable.

5.4 Results of BMP Operation and Maintenance Reviews

Not applicable.

5.5 Quality Assurance Reporting

Not applicable.

6.0 Public Involvement and Coordination

The six teachers selected to test the materials in this program and the students of the one teacher who presented an abbreviated course were the only members of the public that participated in the program to date. All indicated considerable enthusiasm for the

program and said they thought other teachers would be interested in it, so we have reason to believe that public involvement will increase.

6.1 State Agencies

South Dakota Game, Fish and Parks employee Chad Tussing, stationed in Pierre, gave us invaluable information and contacts. He was especially qualified for this as he is a former middle school science teacher. Chad spent innumerable hours with us but never submitted a time sheet, so we could not claim his time as part of our match. Nevertheless, we are greatly indebted to him for his valuable help.

6.2 Federal Agencies

The U.S. Fish and Wildlife Service office in Brookings donated a number of excellent brochures that we included in our packet of supplementary materials. In addition, the people in that office gave us valuable information and contacts. They spent many hours helping us on this project, but since they are a federal agency, we could not include their gifts of time and materials as a part of our match. Again, we are deeply indebted to them for their help.

6.3 Local Governments, Industry, Environmental, and Other Groups, Public at Large

The South Dakota Izaac Walton League kindly donated a box of new books to be included in our packet of supplementary materials. They did tell us the cost of the books and we included that in our match. In addition, an individual donated a number of new books to be included in the supplementary materials and that gift was also included in our match.

6.4 Other Sources of Funds.

There was no other source of funds.

7.0 Aspects of the Project That Did Not Work Well

Difficulty in meeting milestones was caused by several factors. First, since we had only half the funding that we originally requested, we could not hire a full time employee to do much of the work. We had to rely on a part time person who was also working a full time job to do the work. Since the person was not actually a full time employee, we had little control over the time he spent on the project and, since he spent almost no time in our office, we had little control over his activities.

Second, the people who planned the project apparently did not communicate well, because the person who was to do much of the work did not understand some of requirements, even though he seemed to understand them at the time of planning. Each of us apparently heard different things and assumed that everyone else was hearing what we were hearing.

Third, technical difficulties plagued the project from the beginning. Again, we assumed that the information we got was correct, but when we attempted the work, we found that it was not. Given the time, we would have tried the technology before we wrote it into the grant.

In retrospect, it may not have been wise to attempt the project with inadequate funding. We certainly should have given more time and effort to making certain that everyone involved in the planning understood what others were saying. And finally, we should have somehow found a way to test the equipment and software we intended to use in order to make certain that it would do the job.

8.0 Future Activity Recommendations

We still believe the project is worthwhile and intend to complete most parts of it. We are quite certain that we can complete the lesson plans and distribute them to the six teachers selected for the pilot program. We are certain that we can complete the evaluation of the modules if the six teachers will cooperate with us in this. Of course, we have no assurance that they will take the time to evaluate the program in a way that can be measured. We intend to do this work without outside funding.

8.1 Information and Education Outputs

At this time, we have no outputs available for use by others. However, when we complete the project, we will have a list of supplemental materials that others may collect, and a packet of classroom tested lesson plans. These materials will be made available to any group that wishes to distribute them to teachers.

List of Appendices and Written Outputs

Appendix A: Pre and Post Tests For Students

Appendix B: Course Evaluation For Teachers

Appendix C: Lesson Plans

Appendix D: Supplementary Course Materials

Pre-Test on Wetlands

1. The Prairie Pothole Region of North America is named that because of the small bodies of water that are found in this region.

   True or False

2. Wetlands may also be called ponds, marshes, sloughs, swamps or low spots.

   True or False

3. The pioneers never depended on wetlands for their survival.

   True or False

4. Many types of waterfowl and other bird species depend on all types of wetlands for their survival.

   True or False

5. Name three (3) ways people benefit today from wetlands.

   A.

   B.

   C.

6. Write a short paragraph defining your idea of a wetland.

Post-Test on Wetlands

1. Name three (3) characteristics that determine a wetland.

   A.

   B.

   C.

2. Name four (4) values performed by wetlands.

   A.

   B.

   C.

   D.

3. Identify three (3) types of wetlands.

   A.

   B.

   C.

Post-Test on Wetlands

4. What is the average size of a wetland in South Dakota? _____

5. A wetland may support over 200 animal species.

   True or False

6. A wetland may support over 100 plant species.

   True or False

7. Positive management of wetlands can and will produce income in a farming operation.

   True or False

8. Temporary and linear wetlands have little value for wildlife, especially waterfowl.

   True or False

9. Carbon dioxide (CO2) is stored by a wetland and when the wetland is drained and cultivated, the CO2 is released back into the atmosphere.

   True or False

10. A wetland can be a valuable source of food for farm animals during a drought.

    True or False

Course Evaluation For Teachers

School_____ Grade Level_____

Number of Students_____ Number of Classes_____

Please rate the following items on this scale of one to five:

1. Excellent 2. Very Good 3. Average 4. Below Average 5. Poor

1. How effective was this course?	[1 2 3 4 5]
2. How useful were the materials provided?	[1 2 3 4 5]
3. How well did the course enhance student awareness of wetlands?	[1 2 3 4 5]
4. How useful were the tests?	[1 2 3 4 5]
5. How age-appropriate were the provided materials?	[1 2 3 4 5]

Would you use the course again?

What would you change about this course?

What would you eliminate?

What materials did you find most helpful?

Would you recommend this course to other teachers?

Additional comments:

Lesson 1: How South Dakota Got Its Wetlands and Why They Are Important

Summary

Students will learn what caused South Dakotas Prairie Pothole wetlands, where they are mainly located and why they are there. They will learn the value of Prairie Pothole wetlands to people.

Objectives

Students should be able to:
explain the genesis of South Dakota's Prairie Pothole wetlands
explain how the past (glaciation events) determines the present (pothole regions)
list two ways that wetlands benefit people
show how wetlands protect us from flooding events
explain why rivers east of the Missouri River flow south while rivers west of the Missouri flow east
explain what causes glaciers and how they move

The Standards

This unit meets the following South Dakota Science and Social Studies Standards for:
Sixth Grade
Earth/Space Science #3: role of water in all three phases in shaping Earth.
Earth/Space Science #4: major geologic processes that have shaped the South Dakota landscape.
Seventh Grade
Geography Standard #3: Study the basics of climate in order to understand the physical settings of this region. Glaciation, caused by earlier ice age climate, formed the topography of our state.
Geography Standard #6: understand the effects of interactions between human and physical systems by describing how human modifications of physical environments in one place often lead to changes in other places.
Geography #7: how people define regions by identifying a region by defining its distinguishing characteristics.
Earth/Space Science # 4: How freshwater resources are influenced by geologic processes and by human activities.
Nature of Science #4: use of hypothesis in science.
Nature of Science #7: control variables to test hypotheses
Nature of Science #10: use research methods to investigate practical scientific problems and questions.

Materials Supplied

Map of major rivers and lakes of South Dakota
Map of Prairie Pothole Region
Map of the most recent glaciation in South Dakota

Materials Needed
Modeling clay
Ice cube
Small container of water
Surface that can be tilted upward. A large book, a board or a piece of corrugated cardboard would work.

Making Connections
Students will understand that weather conditions in the past are connected to the topography of the present, and topography is connected to such things as flooding.

Background

There are two major kinds of wetlands in South Dakota. One is the Prairie Pothole wetland. South Dakota is part of the Prairie Pothole Region that includes parts of North Dakota, South Dakota, Minnesota and Wisconsin. Our Prairie Pothole Region is one of the most important wetlands regions of the world. It is home to more than half of the North American migratory waterfowl. Many species of waterfowl, and of other kinds of animals, depend on the Prairie Pothole wetlands for breeding and feeding. Prairie Potholes are also important because they absorb surges of snowmelt, rainwater, and floodwater, reducing the risk and severity of flooding downstream. So these wetlands are important to us both as homes for birds and other animals, and to help protect our homes from flooding.

The Prairie Pothole Region covers much of South Dakota east of the Missouri River. The reason for this is that the region was shaped by the most recent episode of glaciation, called the Late Wisconsin, in this area. Beginning about 20,000 to 25,000 years ago, glaciers advanced from the north and covered the parts of South Dakota where we now find Prairie Pothole wetlands. The Late Wisconsin glaciation period was not the first time glaciers covered parts of South Dakota. Earlier glaciers shaped the land in such a way that the latest glacier was restricted to certain areas.

Glaciers originate in snowfields. The weight of the uppermost snow presses down on the lower snow until it becomes ice. We can see something similar here in South Dakota in the winter. Snow falls on streets, but as cars drive on the streets, they pack the snow down to ice.

Glaciers have been called rivers of ice. They flow like rivers, but very slowly. As more snow falls and is packed down to become ice, the weight of this new ice presses the older ice outward and downward, and the glacier expands. This growth, usually channeled in a specific direction by gravity (they flow downhill, just like water does) and by the topography of the area, is called glacial advance.

Glaciers are like rivers in another way. When they are not very thick, they flow in the low areas between hills, just like shallow rivers flow between hills and ridges. But as the glaciers get thicker, just like deep water, they cover the lower hills. Glaciers are often

hundreds or thousands of feet thick so a glacier that isn't very thick can still be hundreds of feet thick. They are so heavy that, as they move, they can grind up the hills underneath them into rocks and dirt. This material is called drift. The glaciers push the drift along underneath the ice as the glacier advances. When the climate changes and the ice begins to melt, the glacier starts to retreat. The leading edge of the glacier starts to melt. As it does, it leaves behind the drift it has been pushing along. These piles of drift often form new hills called moraines. The glaciers also sometimes leave behind huge blocks of ice that are totally or partly buried in soil underneath the glacier. These ice blocks melt, leaving holes in the ground. Water collects in these holes and they develop into Prairie Pothole wetlands.

The second major kind of wetland in South Dakota is the linear wetland. Glaciers are partly responsible for these, as well. Because the most recent glacier ground down the lower hills in the eastern part of South Dakota, our land is fairly flat, so the small valleys between low hills have a fairly shallow gradient. Water that collects there does not run downhill very fast, because the slope is so shallow. This gives the water time to soak into the soil. The water drenched soil there is a good place for wetland plants to grow and their presence slows the water down even more. These narrow linear wetlands that form between low hills are the headwaters of our streams and rivers, so they are very important. They often provide habitat for small animals and a source of water for larger ones.

Terms to Learn

Glacial advance: expansion of a glacier.
Glacial retreat: reduction of a glacier.
Glacier: a mass of frozen snow and water that lies entirely or largely on land, and moves slowly under the pressure of its own weight and of gravity.
Gradient: slope of a stream or land surface.
Headwater: the source of a stream or river.
Linear wetland: wetland formed in shallow, narrow valleys.
Moraine: hill formed by drift left behind when glaciers retreat.
Prairie Pothole wetland: wetland formed by deposited glacial ice in the Prairie region.
Topography: the shape of the earth's surface. The local topography may be mountainous, hilly, flat, or some other shape.

Procedure

Using the map handouts, make copies for each student.

Hand out the maps of the most recent glaciation in South Dakota. Point out the Prairie Coteau and the Missouri Coteau. Explain to the students that these are high ridges that the most recent glacier did not cover. Ask them where they think these ridges came from. The answer is that the drift left by the glacier earlier than the most recent one formed them. Ask them what kind of hills these are. The answer is moraines.

Hand out the maps of the major rivers and lakes in South Dakota. Ask the students if

they see anything different between the east river area and the west river area. They should see that the rivers east of the Missouri River flow from north to south, while the rivers west of the Missouri flow from west to east. Ask the students why they think this is the case. The answer is that the most recent glacier formed the topography of the eastern part of the state and it flowed from the north to the south. When it retreated, it left lines of drift that became the north south hills and valleys in the eastern part of the state. The topography of the western part of our state was formed by gravity. The elevation is higher in the west than in the center of the state, so the streams flowed downhill.

Hand out the map of the Prairie Pothole Region. Direct the students to the part of the region that is in South Dakota. Ask them if they see a similarity to the glaciated area of South Dakota. They should be able to see that the two are very similar. Ask them to explain why that is.

Activity

You can use this activity to explain the difference between a demonstration and an experiment.

Take a piece of the clay and form a thick, flat disc, like a thick pancake. Press the ice cube into the clay and leave it to melt. This demonstrates how Prairie Pothole wetlands were formed.

Take two more pieces of clay and form moderately thick sheets. The two sheets should be as flat as possible and as nearly alike as possible. Put the two side by side on a surface that can be slightly tilted. Explain to the students that you are doing an experiment to see whether depressions can help prevent flooding. Explain that experiments start with a hypothesis. In this case the hypothesis is: Depressions, such as wetlands, hold water and therefore help to prevent flooding. Explain that you are setting up the experiment so that the only difference between the two pieces of clay is that one will have depressions and the other will not. Explain why this is important in an experiment.

(You may want to try this once at home. Pour the water very slowly.) Using the eraser end of a pencil and the point of a pencil, make numerous depressions of various sizes in one of the sheets of clay. These depressions represent Prairie Pothole wetlands. Leave the other sheet flat. Slightly tilt up the book or board that the two sheets of clay are on. Pour a small amount of water (no more than a teaspoon full) on the upper end of the sheet with the depressions. The water should pool in the depressions. This demonstrates the way wetlands absorb floodwater. Now pour the same amount of water on the flat sheet. The water will quickly run off and need to be wiped up. This demonstrates what happens to flood water when wetlands are destroyed.

Ask the students to describe the results of the experiment. Was the hypothesis proven to be correct or false? Why was it important that the only difference be the depressions? Tell the students that humans have destroyed about half of the wetlands that were in

South Dakota when European settlers arrived here. Ask them what they think the result of that destruction might be. Explain that most of the destruction was for agricultural purposes.

Lesson 2: What Is A Wetland?

Summary

Students will learn the definition of a wetland and why it is important. They will learn how wetlands are connected to the water table.

Objectives

Students should be able to:
Explain the three characteristics of a wetland and how they are connected
Explain why the definition of a wetland is important
Name two major types of wetlands found in areas outside South Dakota
Explain how wetlands are connected to the water table
Describe producers, consumers, and decomposers, and explain how they are connected
Explain how draining wetlands destroys the whole wetland ecosystem.

The Standards

This unit meets the following South Dakota Science standards for:
Sixth Grade
Life Science #11: how organisms depend on other organisms and on the nonliving components of the environment.
Life Science #12: roles of producers, consumers and decomposers in a system.
Seventh Grade:
Life Science # 9: processes by which matter and energy flow through an ecosystem.
Life Science #10: effects of environmental changes on dynamic equilibrium in physical and biological systems.
Life Science #11: different relationships among living organisms.

Materials Supplied

Materials Needed

Piece of modeling clay
Toothpicks
Plastic container large enough to hold the piece of clay with plenty of room around the clay

Making Connections

Students will learn how wetlands are connected to the water table and that wet and dry climate cycles can determine whether a wetland has water at a given time. Students will learn that each of the three requirements in the definitions of a wetland is dependent on the others, and learn how producers, consumers, and decomposers depend on each other. Students will learn how changing one thing in the wetland environment can destroy the whole system.

Background:
In addition to the linear wetlands and prairie pothole wetlands that we find in South Dakota, there are many other kinds of wetlands. In coastal regions we can find tidal salt marshes, tidal freshwater marshes and mangrove swamps. Inland, there are non-tidal freshwater wetlands, which includes our types of wetlands, and riparian forested wetlands. The peat bogs of the north east, which are non-tidal wetlands, and the cypress swamps of the south east, which are riparian forested swamps, look very different from each other and from the tidal salt marshes. They get their water from different sources and they provide habitat for different plants and animals. Yet they are all wetlands. What do they have in common?

In 1985, Congress passed a farm bill that included a section called "Swampbuster." It required land owners who receive federal farm payments to protect their wetlands. The Natural Resources Conservation Service (NRCS) was given the task of determining what counts as a protected wetland and what doesn't. That meant there had to be a definition of a wetland that everyone could use, all across the nation. Is a puddle a wetland? How about a farm pond, or a lake? These questions are important, because a land owner who destroyed a protected wetland would lose his federal farm payments, but plowing through an unprotected wet spot would be acceptable. The questions had to be answered, so NRCS scientists wrote a definition:

> *"Wetlands are defined as areas that have a predominance of hydric soils and that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions, except lands in Alaska identified as having a high potential for agricultural development and a predominance of permafrost soils."*

In this definition, there are three requirements. They are:

1. Hydric soils
2. Inundation or saturation by surface or ground water at least part of the time
3. Hydrophytic vegetation.

The U.S. Fish and Wildlife Service maintains an inventory of wetlands in the United States, so it, too, needed a definition of wetlands. This is theirs:

> *"Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water... Wetlands must have one or more of the following three attributes: 1) at least periodically, the land supports predominantly hydrophytes, 2) the substrate is predominantly undraind hydric soil, and 3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year."*

Again, there are three requirements in this definition. They are:

1. Hydrophytes (hydrophytic vegetation)

2. Hydric soils
3. Saturated with water at least part of the time

We see the same three requirements in each of these definitions of wetlands. What do these requirements mean?

A hydric soil is one that has been saturated with water for so long that it has taken on characteristics that are easily recognized. The presence of water limits the amount of oxygen available to the soil. This low oxygen level causes gleying in the soil, which is characterized by a greenish or blue gray color. Gleyed soils in South Dakota are generally grayish. Low oxygen also causes minerals to mottle. In South Dakota, hydric soils usually display specks of red color, so our hydric soils usually look grayish with small red spots. These spots are iron oxide, or rust. These special colors in hydric soils make them easy to recognize. Both definitions require the presence of hydric soils, because it takes a long time in a saturated condition for these soils to form. Puddles don't count as wetlands because the soil under the water hasn't been saturated long enough to become hydric.

Inundated land is flooded land. It will be standing in water. The flooding can be the result of runoff caused by heavy local rainfall, or it may be the result of a rising water table caused by rainfall in other areas. Saturated land is mud so wet that it can't hold any more water. A high water table often causes this. The water table is defined as "The surface marking the upper level of the water-saturated zone extending beneath the ground to depths determined by the thickness of the permeable strata." That means, the water table is the top of the ground water. In eastern South Dakota, the ground water is usually very near the surface of the ground. Farmers dig dugouts to water their cattle, because they don't have to dig very deep to reach ground water. The surface of the water you see in a dugout is the water table. The definitions both require that the land be inundated or saturated at least part of the time. This is important, because many functioning wetlands are dry part of the year, or even for several years. That doesn't change the fact that they are wetlands. They still have hydric soil and can still support hydrophytes. In eastern South Dakota, a wetland may have standing water in May, but be dry in August. We also experience long wet and dry cycles. We may have several wet years when wetlands are saturated all during the growing season, followed by several years when these same wetlands are dry year round. Sometimes our South Dakota wet and dry cycles can last as long as 20 years! But that isn't long enough for hydric soil to lose its characteristics.

Hydrophytic vegetation is a category of plants that are adapted to living in wet conditions. Each species is a hydrophyte. Hydrophytes often can be recognized by their shape, or morphology. Some, such as the cattails and bulrushes prevalent in South Dakota wetlands, have inflated leaves, stems or roots that provide buoyancy and a reservoir for oxygen. Water lilies have floating leaves and some plants, such as the common duck weed, float on the surface of the water and their roots never reach the soil, but take in nutrients directly from the water. Different kinds of hydrophytes are found in different depths of water. Some, like the duck weed, can thrive in fairly deep water, while cattails and bulrushes need shallow water. You can see that different plants grow

in different parts of a wetland. When these plants die, they fall to the saturated or inundated soil and decompose. If the soil is inundated, it will take a long time for this process to occur, so there is often a layer of partially decomposed plant material on top of the soil. This organic material adds to the fertility of the soil and helps to make wetlands very productive.

So the three things that must be present for a wet area to be a protected wetland are hydric soil, inundation or saturation at least part of the time, and hydrophytic plants. These three are connected to each other and dependent on each other. Without the long term inundation or saturation, the soil could not become hydric. Without the hydric soil and the presence of water during some part of the year, hydrophytes could not live in the area. Without the organic materials supplied by the dead hydrophytes, the soil couldn't maintain the fertility required to support the living plants. Without the living plants, many linear wetlands would not be able to hold the water long enough for it to saturate the soil. All three components are necessary for a wetland ecosystem to exist.

Wetlands support the growth of wetland plants. Plants are called producers, because they take energy directly from sunlight and use it to produce stems and leaves. Many animals eat plants. Ducks and other water fowl found in wetlands eat plant materials. Many insects eat plant material. Because they consume plant material, these animals are called consumers. Other animals eat animals. Raccoons that use wetlands eat small animals like fish and crustaceans. They also eat bird eggs. Because they consume animals, they, too, are called consumers. When plants and animals die, they decompose, but not all by themselves. Many insects eat dead plants and animals. Some animals will eat dead animals. These are called decomposers. The decomposed plants and animals provide nutrients for living plants. All three types of creatures are necessary and all three can be found in and around wetlands. This energy cycle, from producer to consumer to decomposer to producer enables a system to continue functioning.

When wetlands are drained, hydrophyte roots can live in the soil for several years, and begin growing again if the wetland is restored. But eventually, if the wetland is not restored, the hydrophytes will die. Without water and hydrophytes, habitat for animals is lost. By changing one thing in a wetland environment, the whole system can be destroyed.

Terms to Learn

Gley: A clayey soil rich in organic material that usually develops in areas where the soil is waterlogged for long periods. It usually precipitates iron oxide as mottles.
Habitat: The native environment of an animal or plant.
Hydric soil: Soil that has been saturated for so long that it has gleyed.
Hydrophyte: A herbaceous plant, which has parts beneath water that survive when the parts above water die back.
Inundated soil: Flooded soil. Standing in water.
Riparian: Related to a river or stream. Growing on the bank of a river or stream.

Saturated soil: Soil holding all the water that it can. Mud.
Water table: The upper level of the ground water.

Activity

Take a thick piece of clay and make a large depression in it. Using a toothpick, make a hole running through the side of the clay into the depression. Put the clay in the plastic container and slowly pour in some water. The depression will remain dry until the "water table" rises above the hole, then water will run into the depression. This demonstrates how wetlands are connected to the water table.

Wetlands can be inundated or saturated as a result of a high water table. This means that as the water table rises, it reaches a level higher than the low spot that is the wetland. Standing water in wetlands provide habitat for some small water animals and drinking water for larger ones.

Course Materials

1. **Handbook for Wetlands Conservation and Sustainability**---Izaak Walton League of America (IWLA)
   This manual will provide the teacher with reliable information to teach students the values of wetlands from classroom information to hands-on activities.

2. **Eastern South Dakota Wetlands**---South Dakota State University (SDSU)
   Fish and Wildlife Service (FWS) Game Fish and Parks (GFP)
   This booklet is very well illustrated and is easy for the student to read and understand.

3. **Hands-On Save Our Streams--Teacher's Manual**---IWLA
   To be used by the student for additional hands-on activities

4. **Science Project Guide For Students**---IWLA
   This student manual may provide useful project ideas for wetlands study.

5. **Sand County Almanac** by Aldo Leopold
   A must for the students to read. It will help students understand the delicate ecological balance of the world we live in.

6. **Monitor's Guide to Aquatic Macroinvertebrates**---IWLA
   Used to aid in field identification of macro invertebrates.

7. **A Volunteer Monitor's Field Guide to Aquatic Macroinvertebrates**---IWL
   Used to identify bugs when conducting hands-on wetlands monitoring.

8. **American Wetlands-A Reason to Celebrate**--Terrene Institute
   Wetlands brochure

9. **Wetlands Across the United States**-Terrene Institute
   Wetlands brochure. Both brochures give a quick reading experience to learn the values and functions of wetlands.

10. **EPA Flyers**---Environmental Protection Agency (EPA)
    Flyers depict individual problems or benefits dealing with wetlands.

11. **American's Wetlands-Our Vital Link Between Land and Water**---EPA
    This booklet gives a quick overview of values, functions, degradation, and loss of wetlands.

12. **The Prairie Pothole Region-Land of Extremes-Landscape of Change**---FWS
    This booklet ties together how land use affects, wetlands, wildlife and the land itself.

13. **The Prairie Pothole Joint Venture**---FWS
    This booklet addresses working together to save wetlands---a win-win situation.

14. **Wetlands in the Northern Great Plains: A Guide to Values and Management**---FWS and SDSU
    This booklet promotes working together to manage and save wetlands.